FDI and economic growth in Indonesia: a provincial and sectoral analysis

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Abstract

Foreign direct investment (FDI) plays an essential role in growing the economy, where this role runs through two things, namely capital accumulation and technology transfer. However, in the literature, previous research findings are still inconclusive to show positive contributions of FDI on economic growth. Furthermore, while the impact of FDI on economic growth has been studied using sectoral data, there has been less research done using data at the provincial and sectoral levels. This study aims to analyze the impact of foreign direct investment (FDI) on economic growth employing sectoral data at the provincial level (33 provinces) in Indonesia over 2010–2019. Based on the fixed effects estimator, our estimation results prove that, in general, FDI significantly positively impacts economic growth in the Indonesian provinces. We also find that FDI in the mining, manufacturing, water, gas and electricity, hotels and restaurants, and real estate sectors has a significant positive effect on economic growth. Meanwhile, only FDI in the agricultural sector has a significant negative impact. Our estimation results confirm that FDI in the manufacturing sector contributes positively and has a considerable impact. The results are robust to the GMM System estimator, which considers the endogeneity problem.

Keywords: FDI, Economic growth, Sector, Province, Indonesia

1 Introduction

FDI is critical to economic growth, and it accomplishes this through two channels: capital accumulation and technology transfer (De Mello 1997). Regarding the latter channel, the presence of foreign companies is considered to increase the productivity and efficiency of domestic companies through productivity spillover. Foreign companies can stimulate spillover through various channels, including forwarding and backward relations with domestic firms, workers training in foreign companies, demonstration effects, and competition effects (Blomström and Kokko 1998).

Although theoretically, FDI is convinced as the beneficial growth engine, there is a possibility of failure to implement empirically. Furthermore, prior research findings are still inconclusive to show positive contributions of FDI on economic growth, which previous research yielded disparate results. This motivation has consistently prompted scholars to investigate the FDI-growth nexus up to the present. At least in the last decade, the first debate can be traced back to previous studies using cross-country data that

resulted positive (Zghidi et al. 2016; Tahir et al. 2019; Sahu 2021) and negative or non-significant impact (Herzer 2012; Agloboyor et al. 2016; Alvarado et al. 2017).

In the second debate, the disparity in empirical study results employing data on a single country also contributes to the debate over identifying the FDI-growth nexus. In general, using a single country allows controlling of country-specific factors that are likely to affect growth when analyzing the impact of FDI. Furthermore, the controversy stems from the results of previous papers that found both positive (Zaman et al. 2012; Choi and Baek 2017; Owusu 2020) and negative or not significant (Yalta 2013; Bermejo Carbonell and Werner 2018) when using a single country to evaluate the impact of FDI on growth.

As a result, to more accurately assess the impact of FDI on economic growth, the researchers attempt to investigate using disaggregate FDI data at the sectoral level (Ingham et al. 2020; Hanafy and Marktanner 2019; Doytch and Uctum 2011). Although the analysis of the effect of FDI on economic growth has been tested employing sectoral data, it is less research explored with data at the provincial and sectoral levels.

This study aims to analyze the impact of FDI on economic growth by sector with data at the provincial level in Indonesia over the period 2010–2019, where this study will cover two primary research questions: Does FDI inflow in sectors affect provinces' growth in Indonesia? Which sector FDI has the more significant impact on economic growth in Indonesia? In this regard, the benefits of employing data at the provincial and sectoral levels are twofold. First, it will sharpen in measuring the extent to which the impact of FDI on economic growth at the sub-national level. Second, for Indonesian policymakers, it would be great to understand which economic sector gains mostly from FDI and simultaneously recommend which sector of FDI should be promoted.

This paper is organized as follows. Section 2 will discuss graphical information of FDI inflow by regions and sectors in Indonesia. Section 3 will discuss the literature review. Next, Sect. 4 will elaborate on data and methods. Results and discussion will be provided in Sect. 5. The last Sect. 6 is the conclusion and policy discussion.

2 FDI inflow by regions and sectors in Indonesia during the last decade

Overall, FDI inflow of Java region increased over the given period, while for Non-Java regions varies (see Fig. 1). Regarding the amount of FDI inflow in the Java region, it began at around 103 trillion rupiahs and peaked at approximately 182 trillion rupiahs in 2013 before falling dramatically to about 149 trillion rupiahs in the last year. On the other hand, FDI inflow in Non-Java regions such as Sumatera and Sulawesi experienced dramatically increase, even though the amount is lower than Java region. This figure suggests that FDI is more attracted to the Java region than the Non-Java regions. Thus, more clarification to investigate FDI's effect on growth is essential in a province in a single country.

In addition, FDI inflow by sectors in Indonesia should also receive considerable critical attention. As observed in Fig. 2, FDI inflow in the manufacturing sector is far higher than in the other FDI sectors throughout the whole time frame, starting at approximately 30 trillion rupiahs and rapidly soaring at above 160 trillion rupiahs in 2013 and finishing at just under 100 trillion rupiahs. Interestingly, FDI in the mining sector started at around 20 trillion rupiahs experienced an upward trend, reaching a peak of approximately 53 trillion rupiahs
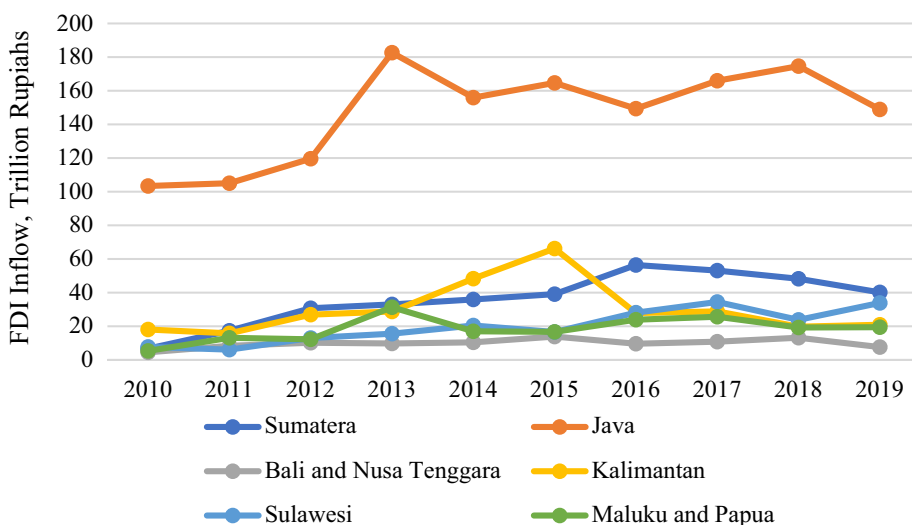
Fig. 1 FDI inflow by regions in Indonesia, constant price 2010. Source: BKPM, 2021
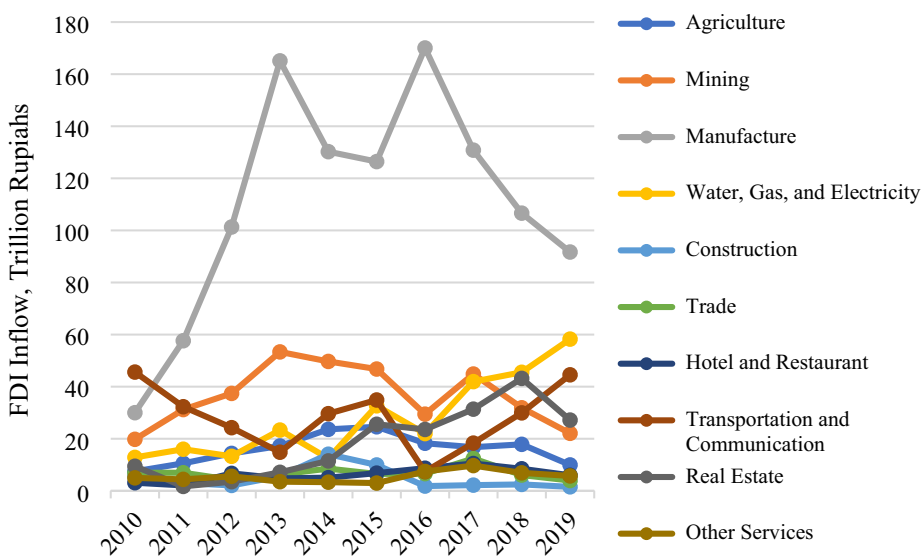

Fig. 2 FDI inflow by sectors in Indonesia, constant price 2010. Source: BKPM, 2021

in 2013, and ended plummeting at around 22 trillion rupiahs. Regarding FDI inflow in services sectors, such as water, gas, and electricity, hotel and restaurant, transportation and communication, they have seen steady increases, particularly since 2016. In contrast, FDI in agriculture has declined slightly since that period. Thus, we expect that the volume dispersion of FDI inflow between sectors would lead to different effects on growth.

3 Literature review: the impact of sectoral FDI on economic growth

The theory underlying the relationship between FDI and economic growth is based on Neoclassical and Endogenous growth. In his discussion, De Mello (1997) summarizes that the former theory considers FDI to only play a role in accelerating income in the

short term, assuming a diminishing return from physical capital. Meanwhile, the latter theory contends that FDI can stimulate long-term growth by increasing returns through externalities and production spillovers. In addition, domestic firms are critical economic agents in this context because they benefit from the technological externalities of FDI.

Furthermore, Aoki and Todo (2008) provided a more in-depth interpretation of these externalities. The possibility of FDI contributing positively to economic growth relies on two primary conditions. First, technology transfer from FDI should be free of charge. The costs here are for domestic enterprises' research and development (R&D) in absorbing technology transfer from foreign firms. Moreover, the other costs can come up from the government's efforts to increase human capital capacity to absorb technology transfer by foreign companies.

Second, FDI must be the sole channel for acquiring knowledge from abroad. In this context, imitation activities carried out by domestic enterprises in imitating products from foreign companies are critical to absorbing the transfer of technology and knowledge from FDI. However, domestic firms will only be able to successfully carry out this imitation activity to absorb technology if they have a sufficient level of technology. These two conditions imply that the effect of FDI on accelerating growth is not immediate and is determined by the level of absorption capacity of domestic firms.

Furthermore, the literature also pays attention to the role of sectors when explaining the possible effect of FDI on growth. An important argument for this can be reviewed from Aykut and Sayek's (2007) discussion. They argue that FDI in the primary sector is likely to harm growth because FDI projects in this sector have a weak link to the domestic sector. Meanwhile, FDI in the manufacturing sector is expected to boost growth because FDI in this sector is closely related to the domestic sector, such as job creation and knowledge transfer through employee training. Not to mention, FDI in this sector has a tight relationship with local intermediate products. Likewise, FDI in the service sector is also likely to contribute to growth positively. The argument is that FDI in this sector has a forceful link with forwarding linkage, where generally, the motive for FDI in this sector is market seeking.

However, empirical research findings based on sectoral data also show no agreement. For example, using cross-country data from 1981 to 1999, Alfaro (2003) discovered that FDI in the agricultural sector harmed economic growth. Likewise, Vu and Noy (2009) found a negative effect of FDI on the agricultural sector for the case of developed OECD member countries (use data from 1980 to 2003). Bunte et al. (2018) documented the insignificant effect of FDI in the agricultural sector for the case in Liberia during the period 2004–2015. In the recent empirical study, Abouelfarag and Abed (2020), employing data for the period 1985–2014, also find that FDI in the agricultural sector does not affect growth in Egypt. They argue that this non-significant result is likely due to the low spillover effects in agricultural FDI.

On the contrary, Chandio et al. (2019), employing data from 1991 to 2013 in Pakistan, demonstrate that agricultural FDI has a long-term enhancing effect on growth. According to their discussion, one of the primary motivations for this research is that 70% of Pakistan's rural population is heavily reliant on agriculture. They also argue that their finding implies that FDI in the agricultural sector can be the primary factor in sustaining Pakistan's economy in both the short and long term.

There are also consensus gaps in the empirical evidence analyzing the growth effects of FDI in the mining sector. Using a case study in Nigeria from 1970 to 2001, Akinlo (2004) documents that FDI in the extractive sector, such as the oil sector, contributed less to growth than FDI in the manufacturing sector. The author contends that FDI in the extractive sector has weak backward and forward linkages with the economy, owing to capital and technology-intensive and export-oriented. Chakraborty and Nunnenkamp (2008) found that FDI in the mining sector does not affect growth. Also, Vu and Noy (2009) found that FDI in the mining sector affects growth negatively.

In contrast, Bunte et al. (2018) found that FDI in the mining sector positively impacts growth. They argue that FDI in sectors that require more public goods, such as mining, is more likely to boost growth. In addition, Gochero and Boopen (2020), which use data in Zimbabwe from 1988 to 2018, found that FDI in the mining sector is associated with growth enhancement in the long run. They also find that FDI in the mining sector has a more remarkable effect than FDI in other sectors and more than domestic investment.

Similar to the effects of FDI in the agricultural and mining sectors, empirical research on the effects of FDI in the manufacturing sector also has less conclusive results. Chakraborty and Nunnenkamp (2008) and Vu and Noy (2009) found a positive effect of FDI in the manufacturing sector on growth. Doytch and Uctum (2011), using data cross-countries, also document a growth-enhancing effect of FDI in the manufacturing sector on growth.

In comparison, Inekwe (2013), in analyzing the effect of FDI on economic growth in Nigeria during the period 1990–2009, the author found that FDI in the manufacturing sector harms economic growth. The author argues that policymakers should selectively encourage which manufacturing sub-sectors are productive from these results. More recent research, such as Abouelfarag and Abed (2020), also found that manufacturing sector FDI had an insignificant impact on growth. They argue that the possibility is due to the low absorptive capacity of domestic companies in absorbing the spillover effects of FDI in the manufacturing sector.

The impact of FDI in the service sector is also inextricably linked to differences in previous studies' findings. Chakraborty and Nunnenkamp (2008) found that FDI in the service sector did not affect growth. They argue that the effects of FDI in the service sector may take time to impact growth. They also advanced another argument, claiming that due to the scarcity of data on FDI in the service sector in the sub-sector, thus it is difficult to obtain more accurate results in answering the mechanism for the effect of FDI in the service sector on growth. Recent empirical findings of Abouelfarag and Abed (2020) note that FDI in the construction sector does not contribute significantly to growth. The argument is that complicated procedures can stifle the impact of FDI in this sector.

In contrast, Inekwe (2013) found that FDI in the service sector positively impacts growth. Hanafy and Marktanner (2019) found that the interaction between domestic investment and FDI in the service sector positively impacts economic growth. This result implies a spillover effect from service sector FDI both horizontally and between sectors.

To sum up, past studies exploring the association between FDI and growth steam up debate can be rooted in the diversity of the sample countries and sectors studied and the different methods used. However, there is still a gap to sharpen the analysis results, where previous research has not deeply explored the use of data at a country's

sub-national or provincial level. Using sectoral data at the provincial level is critical to account for the province's specific effects, which may vary, especially in Indonesia, which has a large area and different economic characteristics in each province. Hence, in this study, we attempt to dig deeper into the effect of FDI on growth with the unique data we collect, namely sectoral data at the provincial level.

4 Data and method

4.1 Data

We use dataset FDI inflow provided by the Investment Coordinating Board (Badan Koordinasi Penanaman Modal, BKPM), which the dataset is available online (retrieved from https://www8.bkpm.go.id/). Since the unit of FDI inflow is measured in the US dollar, we manually convert the unit into Rupiah (Indonesian currency) and transform it to constant price with the base year of 2010. Gross Domestic Products (GDP) are obtained from Statistics Indonesia (Badan Pusat Statistik, BPS), which is also available online (retrieved from https://www.bps.go.id/).

Furthermore, the control variables, including population, education, domestic investment, government expenditure, bank lending, and inflation, are also obtained from the BPS. Our dataset consists of 10 years period (2010–2019) and 33 provinces in Indonesia. We exclude one province (North Kalimantan) in this analysis as the province was born in 2012. Thus, we have a balanced panel dataset in our analysis. Moreover, our FDI inflow and GDP dataset are at the sectoral level. We use ten sectors in this study: agriculture, mining, manufacturing, water, gas, and electricity, hotel and restaurant, trade, construction, transportation and communication, real estate, and other services. The details of variable descriptions and descriptive statistics are shown in Tables 1 and 2, respectively. Table 2 describes that our variable interest, FDI and GDP, does not significantly vary with the mean 29.51 and 24.88, respectively. Table 3 describes the correlations matrix among variables. It shows a high correlation between population and domestic investment, population and government expenditure, population and bank lending, domestic investment and government expenditure, domestic investment and bank lending, and government expenditure and bank lending.

Table 1 Variable descriptions

Variables	Labels	Descriptions	Source
GDP	lgdp	Natural log of sectoral GDP	BPS
FDI	lfdi	Natural log of sectoral FDI inflow	BKPM
Population	lpop	Natural log of population	BPS
Education	ys	Mean years of schooling (year)	BPS
Domestic investment	ldi	Natural log of gross capital fixed formation	BPS
Government expenditure	lgov	Natural log of government expenditure	BPS
Bank lending	lcre	Natural log of bank lending	BPS
Inflation	inf	Inflation rate (%)	BPS

Source: Authors' compilations

Table 2 Descriptive statistics

Variable	Obs	Mean	Std. Dev	Min	Max
lgdp	3300	29.51	1.904	23.556	34.095
lfdi	2380	24.885	2.893	13.709	31.9
lpop	3300	15.284	0.983	13.542	17.714
ys	3300	7.94	1.014	5.3	11.62
ldi	3300	31.333	1.191	28.864	34.247
lgov	3300	30.325	0.805	28.792	32.976
lcre	3300	31.078	1.248	28.097	34.491
inf	3300	4.82	2.456	0.234	11.579

Source: Author's estimation

Table 3 Correlations matrix

	lgdp	lfdi	lpop	ys	ldi	lgov	lcre	inf
lgdp	1							
lfdi	0.331***	1						
lpop	0.539***	0.267***	1					
ys	0.101***	0.153***	−0.0880***	1				
ldi	0.587***	0.362***	0.854***	0.256***	1			
lgov	0.523***	0.308***	0.830***	0.196***	0.894***	1		
lcre	0.580***	0.373***	0.871***	0.252***	0.956***	0.903***	1	
inf	0.0113	0.00241	0.00426	−0.0924***	−0.0479*	−0.0487*	−0.0581**	1

$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

Source: Author's estimation

4.2 Estimation method

Our study investigates the effect of FDI inflow on economic growth at a sectoral and provincial level in Indonesia from 2010 to 2019. Following the growth literature of endogenous growth model, which allows for technological change as FDI taking role Aghion and Howitt (2009) and previous empirical works which focus on a provincial case such as Hoang et al. (2010), Hanafy and Marktanner (2019), and Van Bon (2019), we specify our specification model as follow:

$$GDP_{sit} = \beta_0 + \beta_1 FDI_{sit} + U'_{sit}\beta_2 + + \varepsilon_{sit} \tag{1}$$

where, GDP_{sit} is real GDP of sector s in province i at time t; FDI_{sit} is FDI inflow of sector s in province i at time t; U'_{sit} is the set of control variables (population, education, domestic investment, government spending, bank lending, and inflation).

Furthermore, previous studies predominantly examined the growth effect of FDI using the GMM estimator to avoid the endogeneity issue associated with FDI and growth. However, the prior empirical works less considered the high-dimensional fixed effects such as including sectoral level in the analysis such in our study. Including sectoral level beside province and time series is considered a large panel data. In this setting, running the regression model with multiple fixed effects would allow for control of unobserved heterogeneity specific to province or sectoral. For these reasons, we apply the regressions with high-dimensional fixed effects (Stata command "reghdfe" by Correia (2017)).

In our estimation strategy, we start with estimating the impact of FDI on growth without evaluating the effect of particular sectoral FDI. Hence, to obtain the estimation results of which FDI sector affects growth, we carry out the interaction between FDI and dummy variable of a sector. In addition, we estimate the following regression:

$$GDP_{sit} = \beta_0 + \beta_1 FDI_{sit}\beta_1 + \beta_2 FDI_{sit} \text{x} Dummy_s + U'_{sit}\beta_3 + \varepsilon_{sit} \tag{2}$$

where Dummy denotes dummy variable for a specific economic sector. For instance, to build a dummy variable for FDI in agriculture, we construct with agricultural FDI takes value 1, and the other sectors are 0. These interaction terms allow us to seek the impact of sectoral FDI on growth.

Eventually, to estimate the model for robustness check purposes, we apply the GMM estimator to examine the impact of FDI on growth in our study. Moreover, previous empirical papers have analyzed the impact of FDI on growth, such as Gönel and Aksoy (2016) and Bird and Choi (2020) argued that this approach is one of the best options to deal with endogeneity problems and omitted variables in panel data analysis.

5 Results and discussion

5.1 Empirical results

Table 4 shows the estimation results for the influence of FDI on growth without control variables. Column 1 reports the effect of FDI on growth while accounting for the province fixed effect. The result shows that FDI has a positive and statistically significant impact on growth. Columns 2 and 3 report the magnitude of the relationship between FDI and growth by controlling for province and year fixed effects (Column 2) and province, year, and sector fixed effects (Column 3). The results did not change, where FDI has a statistically significant positive effect. However, the association's size increased also the R-squared is sharply improved (Column 3). This result indicates that control for the sector is crucial to single out the impact of FDI on growth using sectoral data.

Table 4 Baseline regression—the impact of FDI on economic growth

	(1) lgdp	(2) lgdp	(3) lgdp	(4) lgdp	(5) lgdp	(6) lgdp	(7) lgdp
lfdi	0.0925***	0.0925***	0.0926***	0.0926***	0.0899***	0.0929***	0.0906***
	(0.0115)	(0.0116)	(0.00656)	(0.00656)	(0.0117)	(0.00660)	(0.0116)
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	No	No	No
Sector FE	No	No	Yes	Yes	No	No	No
Island FE	No	No	No	Yes	No	No	No
Year × Province FE	No	No	No	No	Yes	No	No
Year × Sector FE	No	No	No	No	No	Yes	No
Year × Island FE	No	No	No	No	No	No	Yes
Observations	2380	2380	2380	2380	2380	2380	2380
R-squared	0.391	0.392	0.847	0.847	0.395	0.847	0.392

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Author's estimation

In Column 4, we introduce island fixed effect to capture the unobserved heterogeneity and does not change over time that could arise from an island since Indonesia is an archipelagos country. In this setting we divide into six archipelagos: Sumatra, Java, Kalimantan, Bali and Nusa Tenggara, Sulawesi, Maluku, and Papua. The result shows that FDI has to remain positively affect growth.

Columns 5 and 6 report the estimation results of the effect of FDI on growth by controlling for the province fixed effect and adding the interaction between province and year fixed effect (Column 5) and sector and year fixed effect (Column 6). The results describe that FDI has a positive and statistically significant impact, where the relationship is slightly increased (Column 6). Further, in Column 7, we control for province fixed effect and add the interaction between island and year fixed effect to explain the effect of FDI on growth. The result is still robust, where FDI positively impacts growth and relatively high magnitude.

Table 5 shows the estimation results of the growth impact of FDI while controlling for other determinants such as population, education, domestic investment, government expenditure, bank lending, and inflation. Column 1 presents the estimation results of the effect of FDI on growth by including control variables and controlling for the province fixed effect. The results show that FDI has a positive and statistically significant impact

Table 5 Main regression—the impact of FDI on economic growth

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	lgdp	lgdp	lgdp	lgdp	lgdp	lgdp	lgdp
lfdi	0.0917***	0.0924***	0.0924***	0.0924***	0.0905***	0.0925***	0.0908***
	(0.0116)	(0.0117)	(0.00657)	(0.00657)	(0.0118)	(0.00662)	(0.0116)
lpop	−1.943	−2.600*	−0.939	−0.939	−1.706	−0.756	−2.082
	(1.401)	(1.542)	(0.776)	(0.776)	(2.413)	(0.753)	(1.611)
ys	−0.0948	−0.0456	−0.0174	−0.0174	−0.0897	−0.0209	−0.110
	(0.114)	(0.137)	(0.0691)	(0.0691)	(0.130)	(0.0577)	(0.116)
ldi	0.255	−0.0266	0.136	0.136	−0.350	0.196	−0.127
	(0.462)	(0.515)	(0.260)	(0.260)	(0.927)	(0.256)	(0.581)
lgov	0.451	0.434	0.371	0.371	−0.421	0.334	0.196
	(0.711)	(0.740)	(0.372)	(0.372)	(1.070)	(0.360)	(0.732)
lcre	0.0848	0.262	0.253	0.253	0.0587	0.0227	−0.0102
	(0.298)	(0.444)	(0.223)	(0.223)	(0.397)	(0.160)	(0.329)
inf	−0.00813	0.00280	−0.00500	−0.00500	−0.00599	−0.00506	−0.00641
	(0.0148)	(0.0284)	(0.0143)	(0.0143)	(0.0160)	(0.00778)	(0.0156)
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	No	No	No
Sector FE	No	No	Yes	Yes	No	No	No
Island FE	No	No	No	Yes	No	No	No
Year × Province FE	No	No	No	No	Yes	No	No
Year × Sector FE	No	No	No	No	No	Yes	No
Year × Island FE	No	No	No	No	No	No	Yes
Observations	2380	2380	2380	2380	2380	2380	2380
R-squared	0.392	0.393	0.847	0.847	0.395	0.848	0.393

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Author's estimation

on growth, with a stable magnitude compared to the finding in Table 4. All control variables, such as population, education, domestic investment, government spending, bank lending, and inflation, statistically insignificant affect growth. However, the signs are mixed, with negative consequences for population, education, and inflation. Meanwhile, domestic investment, government spending, and bank lending are positive signs.

Columns 2 and 3 show the estimation results of the growth effect of FDI by adding control variables and controlling for province and year fixed effects (Column 2) and controlling for province, year, and sector fixed effects (Column 3). The results show that FDI has a statistically significant positive effect on growth. Meanwhile, the effect of control variables remains statistically insignificant except for population, which becomes statistically significant and has a negative sign.

Column 4 describes the estimation results of the effect of FDI on the growth by controlling for the control variables and province, year, sector, and island fixed effect. The result shows that FDI has to remain positively affect growth and statistically significant with the size of magnitude no significant difference from previous results in Columns 2 and 3.

Columns 5 and 6 report the estimation results of the FDI's influence on growth by adding control variables and controlling for province fixed effect, the interaction between province and year fixed effect (Column 5) and the interaction between sector and year fixed effect (Column 6). The results show that FDI still has a statistically significant positive effect on growth, the magnitude of the relationship increases (Column 6). Meanwhile, the effect of all control variables is still statistically insignificant.

Column 7 shows the estimation result from FDI's effect on growth by adding control variables and controlling for province fixed effect and the interaction between year and island fixed effect. The result shows that the impact of FDI on growth is positive and statistically significant, whereas the control variables also indicate statistically no significance.

According to earlier work, such as Adams (2009) and Chaudhury et al. (2020), FDI in affecting economic growth takes time. As a result, past research proposes using lagged FDI. In this work, we included a lagged FDI variable (L.lfdi) in the regression model estimate. This lag FDI variable is defined as the FDI value in period *t-1*.

Table 6 shows the influence of lagged FDI on economic growth that we added to the model. The estimation findings in Table 6 (for all columns) reveal that lagged FDI and FDI in the current period have a statistically significant and beneficial impact on economic growth. The magnitude of FDI for the current period and lagged FDI does not reveal a significant difference, with the coefficient value in the range of 0.06.

Table 7 reports the results of the estimated impact of FDI by sector on growth. To obtain the results, we interact between FDI and dummy sectoral. Further, we estimate separately for Agricultural FDI since the interactions only provide results for nine sectors (to avoid perfect collinearity among dummy variables). Hence, the coefficient estimated of Agricultural FDI we added to the table.

Columns 1, 2, and 3 present the estimation results after controlling for province fixed effect (Column 1), province and year fixed effect (Column 2), province and island fixed effect (Column 3), and adding control variables. The results generally show that the sectoral effect of FDI on growth varies, and there is no significant difference either both

Table 6 Main regression—the impact of lagged FDI on economic growth

	(1) lgdp	(2) lgdp	(3) lgdp	(4) lgdp	(5) lgdp	(6) lgdp	(7) lgdp
lfdi	0.0651***	0.0656***	0.0691***	0.0691***	0.0635***	0.0693***	0.0639***
	(0.0164)	(0.0165)	(0.00835)	(0.00835)	(0.0165)	(0.00834)	(0.0165)
L.lfdi	0.0690***	0.0690***	0.0629***	0.0629***	0.0684***	0.0638***	0.0680***
	(0.0162)	(0.0163)	(0.00824)	(0.00824)	(0.0164)	(0.00821)	(0.0162)
lpop	− 2.919*	− 3.300*	− 0.896	− 0.896	− 1.677	− 0.729	− 2.566
	(1.704)	(1.810)	(0.885)	(0.885)	(2.649)	(0.857)	(1.867)
ys	− 0.115	− 0.0702	0.0111	0.0111	− 0.0963	− 0.00517	− 0.121
	(0.118)	(0.143)	(0.0701)	(0.0701)	(0.135)	(0.0577)	(0.120)
ldi	− 0.296	− 0.450	− 0.0727	− 0.0727	− 1.110	0.0510	− 0.476
	(0.577)	(0.637)	(0.312)	(0.312)	(1.145)	(0.307)	(0.711)
lgov	0.641	0.696	0.507	0.507	− 0.281	0.398	0.374
	(0.802)	(0.835)	(0.408)	(0.408)	(1.215)	(0.392)	(0.829)
lcre	0.425	0.759	0.226	0.226	0.536	0.0627	0.317
	(0.477)	(0.665)	(0.325)	(0.325)	(0.783)	(0.279)	(0.625)
inf	− 0.00748	0.0122	0.00307	0.00307	− 0.00951	− 0.00357	− 0.00762
	(0.0164)	(0.0324)	(0.0158)	(0.0158)	(0.0189)	(0.00865)	(0.0179)
Province FE	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year FE	No	Yes	Yes	Yes	No	No	No
Sector FE	No	No	Yes	Yes	No	No	No
Island FE	No	No	No	Yes	No	No	No
Year × Province FE	No	No	No	No	Yes	No	No
Year × Sector FE	No	No	No	No	No	Yes	No
Year × Island FE	No	No	No	No	No	No	Yes
Observations	1943	1943	1943	1943	1943	1943	1943
R-squared	0.411	0.411	0.860	0.860	0.418	0.861	0.412

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Author's estimation

columns, especially for the level of significance for each variable. Only FDI in the agricultural sector has a negative and statistically significant effect on growth. In contrast, the effect of FDI in the mining; manufacturing; water, gas, and electricity; hotels and restaurants; and real estate show positive results and statistically significantly affected growth. The non-significant effect of sectoral FDI is on trade, construction, transportation and communication, and other services sectors. Interestingly, when we compare each sectoral effect of FDI, we conclude that the magnitude of FDI in the manufacturing sector is the highest among sectors.

The sectoral impact of lagged FDI on economic growth is reported in Table 8. In general, there are no significant differences between the estimation findings and the results in Table 7. However, there are minor discrepancies in the level of importance of some of the FDI's lag sectoral effects. The effect of lagged FDI in agriculture indicates a non-statistically significant impact, but the sign is still negative. The impact of lagged FDI in the mining, manufacturing, water, gas, electricity, hotel and restaurant, and real estate sectors, on the other hand, has constantly remained statistically significant and favorable. Meanwhile, the effect of lagged FDI in other sectors such as trade, construction,

Table 7 Main regression—the impact of sectoral FDI on economic growth

	(1) lgdp	(2) lgdp	(3) lgdp
lfdi	0.00929	0.00962	0.00962
	(0.0182)	(0.0183)	(0.0183)
Agricultural FDI	− 0.081**	− 0.081**	− 0.081**
	(0.0377)	(0.0377)	(0.0377)
Mining FDI	0.188***	0.189***	0.189***
	(0.0251)	(0.0252)	(0.0252)
Manufacturing FDI	0.196***	0.198***	0.198***
	(0.0237)	(0.0238)	(0.0238)
Water, Gas, Electricity FDI	0.0494**	0.0483**	0.0483**
	(0.0232)	(0.0232)	(0.0232)
Hotel and Restaurant FDI	0.172***	0.174***	0.174***
	(0.0255)	(0.0255)	(0.0255)
Trade FDI	0.0328	0.0319	0.0319
	(0.0255)	(0.0255)	(0.0255)
Construction FDI	0.0149	0.0154	0.0154
	(0.0302)	(0.0302)	(0.0302)
Transportation and Communication FDI	0.0294	0.0273	0.0273
	(0.0255)	(0.0256)	(0.0256)
Real Estate FDI	0.0644**	0.0636**	0.0636**
	(0.0266)	(0.0267)	(0.0267)
Other Services FDI	0.0106	0.00841	0.00841
	(0.0264)	(0.0264)	(0.0264)
Province FE	Yes	Yes	Yes
Year FE	No	Yes	Yes
Sector FE	No	No	No
Island FE	No	No	Yes
Year × Province FE	No	No	No
Year × Sector FE	No	No	No
Year × Island FE	No	No	No
Control Variables	Yes	Yes	Yes
Observations	2380	2380	2380
R-squared	0.858	0.859	0.859

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Author's estimation

transportation and communication, and other services remains steady, albeit statistically negligible.

5.2 Robustness check

In this session, we present the findings of robustness tests in examining the impact of FDI on growth using the GMM System estimator. Table 9 shows estimation results employing the GMM System technique. The estimate confirms that FDI has a positive and statistically significant effect on growth, indicating the effect of FDI on growth in the present study is robust. Further, the GMM System estimator results show a lower magnitude than regression with high-dimensional fixed effects. Thus, our robustness test

Table 8 Main regression—the impact of lagged sectoral FDI on economic growth

	(1) lgdp	(2) lgdp	(3) lgdp
lfdi	− 0.00393	− 0.00517	− 0.00517
	(0.0246)	(0.0247)	(0.0247)
Agricultural FDI	− 0.0779	− 0.0796	− 0.0796
	(0.0529)	(0.0532)	(0.0532)
Mining FDI	0.140***	0.141***	0.141***
	(0.0336)	(0.0337)	(0.0337)
Manufacturing FDI	0.142***	0.147***	0.147***
	(0.0369)	(0.0371)	(0.0371)
Water, Gas, Electricity FDI	0.0549*	0.0558*	0.0558*
	(0.0300)	(0.0301)	(0.0301)
Hotel and Restaurant FDI	0.0970***	0.0980***	0.0980***
	(0.0353)	(0.0354)	(0.0354)
Trade FDI	0.0552	0.0582	0.0582
	(0.0356)	(0.0357)	(0.0357)
Construction FDI	0.0307	0.0341	0.0341
	(0.0438)	(0.0440)	(0.0440)
Transportation and Communication FDI	0.0388	0.0393	0.0393
	(0.0334)	(0.0336)	(0.0336)
Real Estate FDI	0.0544	0.0581	0.0581
	(0.0363)	(0.0365)	(0.0365)
Other Services FDI	0.0273	0.0290	0.0290
	(0.0392)	(0.0393)	(0.0393)
L.lfdi	− 0.00401	− 0.00272	− 0.00272
	(0.0244)	(0.0245)	(0.0245)
L.Agricultural FDI	− 0.072	− 0.0711	− 0.0711
	(0.0522)	(0.0525)	(0.0525)
L.Mining FDI	0.127***	0.127***	0.127***
	(0.0338)	(0.0339)	(0.0339)
L.Manufacturing FDI	0.116***	0.113***	0.113***
	(0.0354)	(0.0355)	(0.0355)
L.Water, Gas, Electricity FDI	0.0560*	0.0537*	0.0537*
	(0.0303)	(0.0304)	(0.0304)
L.Hotel and Restaurant FDI	0.133***	0.134***	0.134***
	(0.0350)	(0.0351)	(0.0351)
L.Trade FDI	0.0304	0.0274	0.0274
	(0.0342)	(0.0343)	(0.0343)
L.Construction FDI	0.0194	0.0178	0.0178
	(0.0419)	(0.0421)	(0.0421)
L.Transportation and Communication FDI	0.0261	0.0241	0.0241
	(0.0318)	(0.0319)	(0.0319)
L.Real Estate FDI	0.0649*	0.0620*	0.0620*
	(0.0355)	(0.0357)	(0.0357)
L.Other Services FDI	0.0216	0.0192	0.0192
	(0.0379)	(0.0381)	(0.0381)
Constant	17.59*	33.35**	33.35**
	(9.507)	(15.45)	(15.45)
Province FE	Yes	Yes	Yes
Year FE	No	Yes	Yes

Table 8 (continued)

	(1) lgdp	(2) lgdp	(3) lgdp
Sector FE	No	No	No
Island FE	No	No	Yes
Year × Province FE	No	No	No
Year × Sector FE	No	No	No
Year × Island FE	No	No	No
Control Variables	Yes	Yes	Yes
Observations	1943	1943	1943
R-squared	0.874	0.874	0.874

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Author's estimation

Table 9 Robustness check, GMM system—the impact of FDI on economic growth

Variables	(1) GMM-SYSTEM
L.lgdp	0.884***
	(0.045)
lfdi	0.009**
	(0.004)
lpop	0.018
	(0.025)
ys	− 0.005
	(0.009)
ldi	0.057*
	(0.033)
lgov	− 0.032
	(0.026)
lcre	0.052*
	(0.030)
inf	− 0.001
	(0.002)
Constant	0.577
	(0.483)
Observations	2203
Number of sector-province	314
AR(1)	0.002
AR(2)	0.833
Hansen	0.579
Sargan	0.002
Number of Instruments	18.000

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Author's estimation

result indicates that the regression with high-dimensional fixed effects outperforms the GMM approach in capturing the effect of FDI on growth employing sectoral level data.

We also examine robustness for FDI sectoral impacts. Table 10 displays the outcomes of this test. Using the GMM System approach, we find that the sectoral effect of FDI on economic growth is no different from the estimates in Tables 7 and 8 (using the fixed effect technique). Table 10 shows that agricultural FDI has a continuously negative and statistically significant effect.

Furthermore, mining, manufacturing, hotels and restaurants, and real estate FDI all have favorable and statistically significant effects. Meanwhile, the effect of FDI in the water, gas, and electricity sectors is not statistically significant, which is fairly surprising. The impact of FDI in this industry differs significantly from the findings in Tables 7 and 8, but the sign remains consistent, namely positive. FDI has a continuously insignificant and favorable impact on other sectors such as trade, construction, transportation and communication, and other services.

5.3 Discussion

This study sets out to assess the importance of FDI in driving growth at the sectoral level. Overall, the current study found that FDI has an enhancing effect on growth in the Indonesian province. This study produced results that corroborate the findings of a great deal of the recent previous empirical work in this field, such as Luu et al. (2017) and Van Bon (2019), which found a positive impact of FDI on provincial growth in Vietnam. This finding underscores the importance of FDI in improving growth in Indonesian provinces, which can occur through direct and indirect effects, with the direct effect being an increase in capital stock and the indirect effect being an increase in knowledge stock (Mehic et al. 2013).

Turning to the results of the sectoral effect of FDI, we find that the effect of sectoral FDI on growth differs significantly across sectors. These findings corroborate prior research, which found various sectoral FDI effects (Chakraborty and Nunnenkamp 2008; Vu and Noy 2009; Abouelfarag and Abed 2020). Further, we find that FDI in the agricultural sector has a detrimental influence on growth. Our finding is as expected and consistent with previous findings in which the effect of FDI in the agricultural sector is negative or insignificant (Alfaro 2003; Vu and Noy 2009; Bunte et al. 2018; and Abouelfarag and Abed 2020). This result implies that FDI in the agricultural sector has a weak relationship with the domestic economy and exports oriented (Aykut and Sayek 2007). That reason is plausible for the Indonesian case since foreign enterprises operating in agriculture mainly invest in oil palm. They may export the product in raw material (such as crude palm oil) without first adding value. Another possible explanation for this is that the less technology transfer from FDI in agriculture can be associated with the low absorptive capacity of domestic firms (Aoki and Todo 2008).

The negative impact of agricultural FDI can be attributed to a lack of absorptive capacity of the host country, a subject that has garnered a significant deal of attention in the literature. In Indonesia, there are at least two issues that can lead FDI to have a negative influence on economic growth if it is accompanied by low technology absorption ability (Pasaribu et al. 2021).

Table 10 Robustness check, GMM system—the impact of sectoral FDI on economic growth

Variables	(1) lgdp	(2) lgdp	(3) lgdp	(4) lgdp	(5) lgdp	(6) lgdp	(7) lgdp	(8) lgdp	(9) lgdp	(10) lgdp
Agricultural FDI	− 0.110* (0.064)									
Mining FDI		0.027* (0.015)								
Manufacturing FDI			0.067*** (0.024)							
Water, Gas, Electricity FDI				0.055 (0.061)						
Hotel and Restaurant FDI					0.041* (0.024)					
Trade FDI						0.012 (0.082)				
Construction FDI							0.015 (0.030)			
Transportation and Communication FDI								0.014 (0.037)		
Real Estate FDI									0.062** (0.030)	
Other Services FDI										0.042 (0.069)
Constant	0.328 (1.165)	2.372 (1.690)	0.457 (0.344)	1.145 (0.964)	0.504 (0.534)	0.313 (0.727)	0.360* (0.201)	0.224 (0.195)	0.334 (0.302)	1.047 (0.719)
Control Variables	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,203	2,203	2,203	2,203	2,203	2,203	2,203	2,203	2,203	2,203
Number of sector-province	314	314	314	314	314	314	314	314	314	314

Table 10 (continued)

Variables	(1) lgdp	(2) lgdp	(3) lgdp	(4) lgdp	(5) lgdp	(6) lgdp	(7) lgdp	(8) lgdp	(9) lgdp	(10) lgdp
AR(1)	0.016	0.006	0.011	0.074	0.002	0.007	0.004	0.006	0.001	0.004
AR(2)	0.796	0.995	0.655	0.459	0.329	0.557	0.620	0.433	0.226	0.399
Hansen	0.809	0.206	0.424	0.816	0.241	0.292	0.094	0.194	0.114	0.419
Sargan	0.000	0.000	0.000	0.003	0.000	0.000	0.000	0.000	0.000	0.000
Number of Instruments	31.000	38.000	29.000	23.000	46.000	25.000	34.000	27.000	38.000	34.000

Standard errors in parentheses

* $p < 0.10$, ** $p < 0.05$, *** $p < 0.01$

Source: Author's estimation

First, according to a survey conducted by Statistics Indonesia (BPS) in August 2020, just 9.7% of the workforce in Indonesia is a university graduate. According to Nambiar et al. (2019), agriculture employs barely 2% of college graduates. As a result, limited labor capacity to absorb FDI-brought technologies in the agriculture sector appears to be a severe issue in driving economic growth.

Second, in the agriculture sector, state-owned enterprises (SOEs) dominate economic activity more than the private sector, including FDI. The government bestows different benefits to SOEs, including incentives, subsidies, and tax cuts. This results in SOEs' dominance in the agricultural sector, which ultimately leads to a lack of competition and market failures such as a lack of supply and high agricultural product prices, potentially undermining economic growth.

In contrast, our findings show that FDI in the mining sector positively impacts growth. This conclusion differs from what is expected in the literature, which generally contends that FDI in extractive industries like mining is detrimental to growth. Our results support Gochero and Boopen's (2020) empirical finding, which found that FDI in the mining sector has a beneficial influence on Zimbabwean growth. One possible explanation for this finding is an economic turnover impact caused by FDI in the mining sector via a better supply of public goods (Bunte et al. 2018). This indicates that foreign investment in the mining sector contributes to growth by boosting the supply of public goods, hence increasing the economy's efficiency and growth.

Another important finding was that FDI in the manufacturing sector positively affects growth and the magnitude is more potent than FDI in other sectors. The present findings seem consistent with other research that found the positive impact of manufacturing FDI on growth (Chakraborty and Nunnenkamp 2008; Vu and Noy 2009; and Doytch and Uctum 2011). The positive impact of manufacturing FDI suggests that foreign firms have a close link with domestic firms through providing intermediate input (Aykut and Sayek 2007). For instance, in the case of the automotive industry in Jabodetabek, Indonesia (Syah 2019), hence the transfer technology exists. Our result also corroborates the recent empirical evidence of Haini and Tan (2022), which found that the magnitude of FDI in manufacturing is more prominent than in other sectors. The authors suggest that FDI in the sector would generate enormous growth spillover since the sector has a tremendous potential link with other sectors and intra-industry. Our evidence of the more considerable growth-promoting effect of manufacturing FDI also indicates that attracting FDI in the sector will be the policy option to enhance growth faster.

The evidence on the effect of FDI in the service sector is equivocal, with FDI in the water, gas, electricity, hotel and restaurant, and real estate sectors positively impacting growth. Meanwhile, foreign direct investment (FDI) in trade, construction, transportation and communication, and other service sectors does not affect growth. Because service sector FDI has a distinct character across the industry, these findings should be interpreted cautiously. One probable explanation for this is that FDI in the service sector with a forward link will boost growth (Aykut and Sayek 2007). This argument could explain the influence of FDI on the water, gas, and electricity sectors, the hotel and restaurant industries, and real estate, where the motive is commonly to serve the local market.

Meanwhile, to explain the effect of services FDI in other sectors, the possibility is that service FDI in that sector is based on "soft" knowledge (technical, management and marketing know-how, expertise, organizational skills, and information), which makes it more difficult to transfer knowledge and technology as our findings in the transportation and communication sector (Doytch and Uctum 2011). Furthermore, FDI in that sector is linked to foreign aid's role in accelerating growth. Younsi et al. (2021) found that aid and FDI have a significant positive complementarity effect on economic growth. Hence, our findings suggest that FDI in the transportation and communication sectors may have less influence on growth when it is not accompanied by aid. Another possible explanation for the insignificant effect is that the effect is likely to be long term rather than short term. The argument is that investing in the transportation and communication sectors may take a long time to reap economic benefits.

The insignificant impact of FDI in construction is in line with the finding of (Haini and Tan 2022). They argued that the FDI services sector, such as construction, has no significant effect on growth, possibly due to tight restrictions related to national security and the difficulty of transmitting knowledge and technology. Another possible reason could be that complicated procedures may hinder the construction of FDI's effect on growth (Abouelfarag and Abed 2020).

Another unresolved issue in responding to the challenge of harnessing FDI to stimulate economic growth is the host country's absorption capacity. Scholars have paid close attention to this issue, and they have formalized a study of the role of absorption capacity in capturing the benefits spread by FDI (see Silajdzic and Mehic 2016; Hanafy and Marktanner 2019). Absorption capacity refers to the ability of domestic firms to absorb FDI-brought technology or knowledge (Görg and Greenaway 2004).

However, the proxies used to capture absorption capacity vary across the literature, such as human capital and domestic firms. According to Tang and Zhang (2016), absorption capacities such as human capital, government policies that encourage FDI, infrastructure capacity, and research and development are required for China to benefit from FDI in manufacturing exports. Their findings may also imply that intense export activity will stimulate economic growth.

To summarize, the influence of each sectoral FDI ranging from mining, manufacturing, water, gas, electricity, hotels and restaurants, and real estate should be various processes. The processes that can be utilized to explain the effects of FDI in these sectors are through two channels: technology transfer and capital accumulation.

Technology transfer can be used to link FDI in the manufacturing and hotel and restaurant sectors. Zhang's (2023) findings, for example, reveal that FDI in China establishes R&D centers and focuses on high-tech businesses and knowledge-intensive services. Furthermore, the introduction of new managerial skills in the tourism industry sector might explain how the FDI mechanism in the hotel and restaurant sector can have a favorable effect on economic growth (Sokhanvar 2019); in this context, technology transfer happens.

In the second channel, FDI in the mining, water, gas, electricity, and real estate industries can be linked to capital accumulation, thereby positively impacting economic growth. Vu and Noy (2009) discovered that FDI in the real estate industry can have a crowding-in effect on domestic capital. Similarly, FDI in the mining and water, gas, and

power industries, which are often capital intensive, will stimulate an increase in domestic capital to boost economic growth.

6 Conclusion remarks

This study aims to estimate the impact of FDI on sectoral economic growth in 33 provinces in Indonesia during the 2010–2019 period. By applying the regressions with many levels of fixed effects estimator, our estimation results prove that, in general, FDI positively impacts economic growth in the Indonesian provinces. We also find that specifically, FDI in the mining, manufacturing, water, gas and electricity, hotels and restaurants, and real estate sectors have a positive effect and statistically significant on economic growth. Meanwhile, only FDI in the agricultural sector has a negative impact. Our estimation results confirm that FDI in the manufacturing sector contributes positively and has a considerable impact.

From the above findings, our study expands the policy spectrum of the Indonesian policymaker to foster economic growth via FDI. First, the government must realize that not all FDI sectors can be formulated as direct drivers of economic growth, which means that the government should sort out which sectoral FDI stimulates economic growth. Second, enhancing economic growth by promoting FDI in the manufacturing sector will be more efficient considering that FDI in this sector has a more remarkable driving effect than other sectoral FDI. Third, the government needs to prepare sufficient absorption capacity, such as improving labor skills for domestic companies to harness FDI that shows a deteriorating effect (FDI in the agricultural sector) or does not have a significant effect (trade, construction, and transportation and communication FDI).

Regarding study limitations, our research does not look into which absorptive capacity channels (such as human capital and domestic firms) in the host province for FDI can affect economic growth. In addition, the connection between foreign firms and domestic firms is needed for gearing the technological and knowledge transfer brought by FDI, which domestic firms can provide intermediate inputs for foreign firms. Thus, this motivation can be triggered future studies to sharpen the analysis of the impact of sectoral FDI on economic growth. Furthermore, our study may suffer from the fact that several of the control variables included in our analysis are endogenous. This endogeneity may have an impact on the results of our analysis. As a result, future studies could take into account the possibility of endogeneity of control variables while investigating the influence of FDI on economic growth.

Abbreviations
BKPM   Badan Koordinasi Penanaman Modal (The Investment Coordinating Board)
BPS   Badan Pusat Statistik (Statistics Indonesia)
FDI   Foreign Direct Investment
FE   Fixed Effect
GDP   Gross Domestic Products
GMM   Generalized Method of Moment
OECD   The Organisation for Economic Co-operation and Development

Author contributions
The author contributes to the writing, compilation of the dataset, analyzing data, and reading and approving of the final manuscript. This manuscript is part of the author's dissertation chapter for his doctoral studies.

Availability of data and materials
Data can be obtained by contacting the respective author.

Declarations

Competing interests
We declare that we have no competing interests in writing this paper.

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