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Determinants of Manufacturing Industry Agglomeration in Indonesia

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Abstrak

- **Tujuan:** Studi ini bertujuan untuk mengidentifikasi determinan aglomerasi industri manufaktur di Indonesia.
- **Desain/metodologi/pendekatan:** Data yang digunakan terdiri dari 34 provinsi pada periode 2015-2023 yang dianalisis menggunakan regresi data panel dengan fixed effect model.
- **Temuan:** Studi ini menemukan bahwa aglomerasi industri manufaktur memiliki determinan yang berbeda di setiap wilayah. Rata-rata lama sekolah, infrastruktur jalan, upah, dan pendapatan per kapita berpengaruh positif signifikan, angkatan kerja dan produktivitas pekerja berpengaruh negatif signifikan, sedangkan FDI tidak berpengaruh signifikan terhadap aglomerasi industri manufaktur di Indonesia. Selain itu, studi ini juga menemukan bahwa terjadi diseconomies of agglomeration di mana perusahaan di industri manufaktur mulai melakukan relokasi dan menyebar keluar dari wilayah ekonomi aglomerasi.
- **Batasan penelitian/dampak:** Studi ini hanya mengidentifikasi determinan aglomerasi industri manufaktur dari sisi produksi, distribusi, dan konsumsi, serta belum melakukan identifikasi terhadap disekonomi aglomerasi. Selain itu, metode analisis spasial juga belum diterapkan untuk mengetahui pengaruh ekonomi aglomerasi terhadap daerah yang bertetangga. Studi berikutnya dapat meneliti pengaruh dari teknologi, keterbukaan perdagangan, migrasi, dan kelembagaan terhadap aglomerasi industri manufaktur. Lebih lanjut, titik ambang batas ekonomi aglomerasi menuju disekonomi aglomerasi juga perlu diidentifikasi.
- **Implikasi praktis:** Pembuat kebijakan diharapkan dapat meningkatkan alokasi FDI untuk industri manufaktur dan menurunkan skill mismatch agar dapat meningkatkan penyerapan tenaga kerja dan produktivitas pekerja. Lebih lanjut, pemerintah perlu mempercepat pembangunan infrastruktur yang lebih merata di luar Jawa untuk menarik minat sektor swasta dalam berinvestasi guna menciptakan aglomerasi industri manufaktur.
- **Keaslian/nilai:** Keterbaruan dari studi sebelumnya terletak pada variabel independen yang merepresentasikan aktivitas produksi, distribusi, dan konsumsi.



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- **Jenis Makalah:** Artikel Penelitian

Kata Kunci: Ekonomi aglomerasi, Deindustrialisasi, Pertumbuhan ekonomi, Pekerja, Industri manufaktur

Abstract

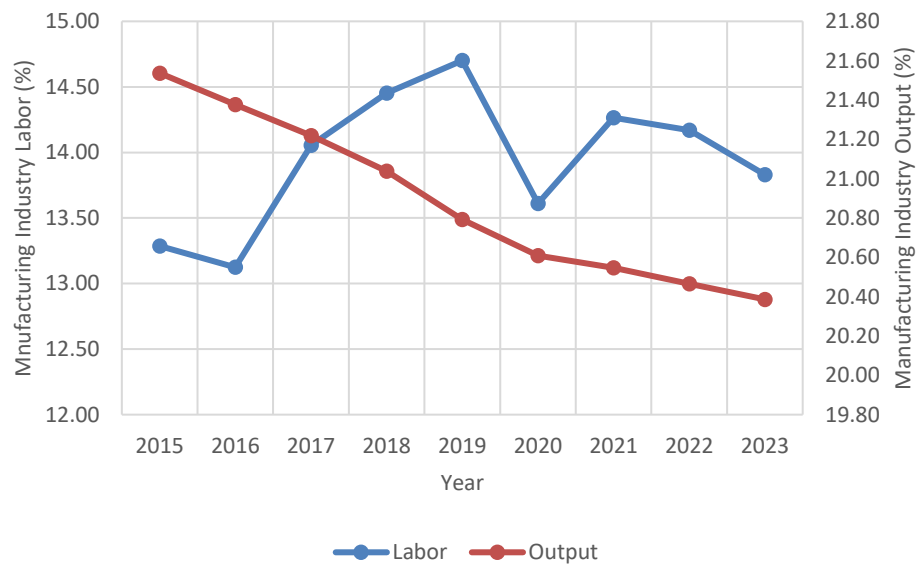
- **Purpose:** *This study aims to identify determinants of manufacturing industry agglomeration in Indonesia.*
- **Design/methodology/approach:** *Data used consists of 34 provinces over the period 2015-2023, which are analyzed using panel data regression with a fixed effect model.*
- **Findings:** *This study found that manufacturing industry agglomeration has different determinants in each region. Average years of schooling, road infrastructure, wage, and per capita income have a significant positive effect, labor force and labor productivity have a significant negative effect, while FDI has no significant effect on manufacturing industry agglomeration in Indonesia. Furthermore, this study also found that there are diseconomies of agglomeration where manufacturing firms begin to relocate and spread out from the agglomeration economic area.*
- **Research limitations/implications:** *This study only identifies the determinants of manufacturing industry agglomeration from the perspectives of production, distribution, and consumption. It has not yet addressed the diseconomies of agglomeration. Additionally, spatial analysis methods have not been used to determine the impact of economic agglomeration on neighboring provinces. Future studies could examine how technology, trade openness, migration, and institutions affect manufacturing industry agglomeration in Indonesia. Additionally, the threshold at which agglomeration leads to diseconomies also needs to be identified.*
- **Practical implications:** *In order to enhance labor absorption and labor productivity, policymakers are expected to increase the allocation of FDI to manufacturing industry and reduce skill mismatches. Furthermore, to attract private sector investment and create manufacturing industry agglomerations, the government needs to accelerate infrastructure development outside Java.*
- **Originality/value:** *Novelty of this study compared to previous studies lies in the independent variables representing production, distribution, and consumption activities.*
- **Paper Type:** *Research Paper*

Keywords: *Agglomeration economies, Deindustrialization, Economic growth, Labor, Manufacturing industry.*

Introduction

Agglomeration economies in manufacturing industry can take the form of localization economies and urbanization economies. Agglomeration economies can provide numerous benefits to manufacturing industry firms in the form of a skilled labor supply, specialized firms, and advanced technology adoption to increase output and reduce production costs (Edwards, 2007). Agglomeration economies can also stimulate aggregate economic growth.

Figure 1. Distribution of Manufacturing Industry Labor and Output in Indonesia

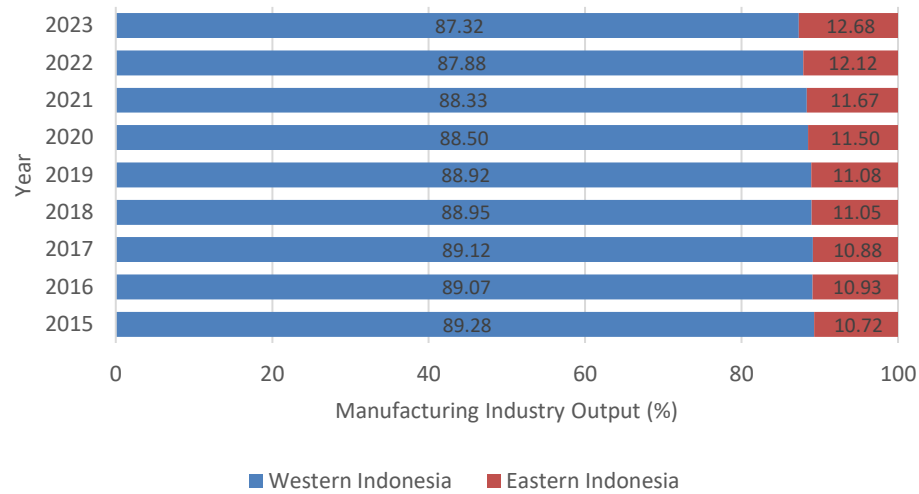


Source: Statistics Indonesia (2024)

Manufacturing industry is an engine of economic growth (Dasgupta & Singh, 2007). Manufacturing industry can absorb a large number of labor and has high value added. Therefore, the manufacturing industry plays an important role in accelerating economic growth in the context of economic transformation to a developed country.

However, premature deindustrialization can be a serious obstacle to economic transformation in developing countries. Deindustrialization will increase poverty, slow economic growth, and reduce the demand for low-skilled labor in the manufacturing industry (Liu & An, 2023). Deindustrialization in Indonesia became increasingly evident after the 1997 monetary crisis in the form of declining labor and value added distribution in the manufacturing industry (Andriyani & Irawan, 2018). Based on Figure 1, labor and output distribution in the manufacturing industry in Indonesia has continued to decline. Labor distribution in the manufacturing industry has decreased from 14.26% to 13.83% after the Covid-19 pandemic. Meanwhile, output distribution in manufacturing industry has decreased from 21.53% in 2015 to 20.38% in 2023.

Figure 2. Distribution of Manufacturing Industry Output in Indonesia



Source: Statistics Indonesia (2024)

In addition to hindering economic growth, deindustrialization may also hinder Indonesia's economic development, as evidenced by the disparity in manufacturing industry output across Indonesia's regions. Western Indonesia has a more dominant manufacturing industry performance than eastern Indonesia. Figure 2 shows that manufacturing industry output is largely concentrated in Java and Sumatra, accounting for 88.59% of the total during the period 2015 to 2023. Nevertheless, manufacturing industry output distribution is beginning to spread from western to eastern Indonesia, as the contribution of manufacturing industry output from Kalimantan, Sulawesi, Bali, Nusa Tenggara, Maluku, and Papua steadily increases from 10.71% in 2015 to 12.68% in 2023.

Deindustrialization must be addressed promptly to promote economic development. Manufacturing industry agglomeration can serve as a lever to increase manufacturing industry output and accelerate economic growth. Manufacturing industry agglomeration can enhance physical capital, human capital, and trade openness (Zeng et al., 2023), thereby improving labor productivity (Hoang & Schiller, 2023) through efficiency (Otsuka et al., 2014). On the other hand, manufacturing industry agglomeration can also promote the spread of manufacturing industry to surrounding areas for equitable economic development (Cerina & Mureddu, 2014) or attract essential production factors from surrounding areas, which may increase economic disparities (H. Zheng & He, 2022). Therefore, determinants of manufacturing industry agglomeration need to be considered so that policies aimed at creating an agglomeration economies can be effectively implemented.

Several previous studies have found that variables used to determine agglomeration economies include labor productivity, manufacturing sector, labor-based agglomeration economies, and developing countries (Grover et al., 2023). Narjoko (2008) found that manufacturing industry development in Indonesia is affected by agglomeration economies which determined by investment, domestic markets, infrastructure, labor, and technology. Zuliastri et al. (2018) found that agglomeration economies in Indonesia are determined by firm size, manufacturing industry value added, industry diversification, industry competition, wages, and road infrastructure.

This study is conducted based on the phenomenon gap, namely the important role of agglomeration economies in improving manufacturing industry, which can have either positive or negative effect on economic development disparities among regions. Manufacturing industry in Indonesia is heavily concentrated on the island of Java, attracting production factors such as physical investment and labor from outside the island. This further widens the disparities between regions. As a developing country, Indonesia should not yet be experiencing deindustrialization like developed countries. However, the concentration of production factors in Java's economic and manufacturing centers increasingly indicates the occurrence of a backwash effect. Meanwhile, limitations of previous studies on manufacturing industry agglomeration in Indonesia and various determinants of agglomeration economies are used as a research gap. Previous studies have not considered manufacturing industry agglomeration as a research variable.

This study presents a novelty that is different from previous related studies. This study uses several variables that represent production, distribution and consumption activities to identify the determinants of manufacturing industry agglomeration in Indonesia.

Problem statement in this study is the determinants of manufacturing industry agglomeration in Indonesia, which have not yet been definitively identified, despite the important role of agglomeration economies in increasing productivity through efficiency. Moreover, each region in Indonesia has different production factor, endowments, and characteristics, which requires a more detailed identification of manufacturing industry agglomeration determinants. Therefore, this study is crucial to understand the determinants of manufacturing industry agglomeration in order to reduce deindustrialization and accelerate economic growth.

This study aims to identify determinants of manufacturing agglomeration in Indonesia. This study can contribute to the literature by providing empirical evidence on determinants of agglomeration from a country experiencing early deindustrialization. It is also expected that this study will benefit policymakers by accurately understanding and strengthening determinants of manufacturing industry agglomeration in Indonesia, thereby supporting economic development.

Literature review and hypothesis development Signaling Theory

Agglomeration economies in manufacturing industry can occur when firms are located in close proximity to each other and spatially cluster (Edwards, 2007). Agglomeration economies can take the form of localization economies and urbanization economies. Localization economies occur when several firms in the same industry are spatially close to each other, while urbanization economies occur when several firms in a city are close to each other, even if they are not in the same industry.

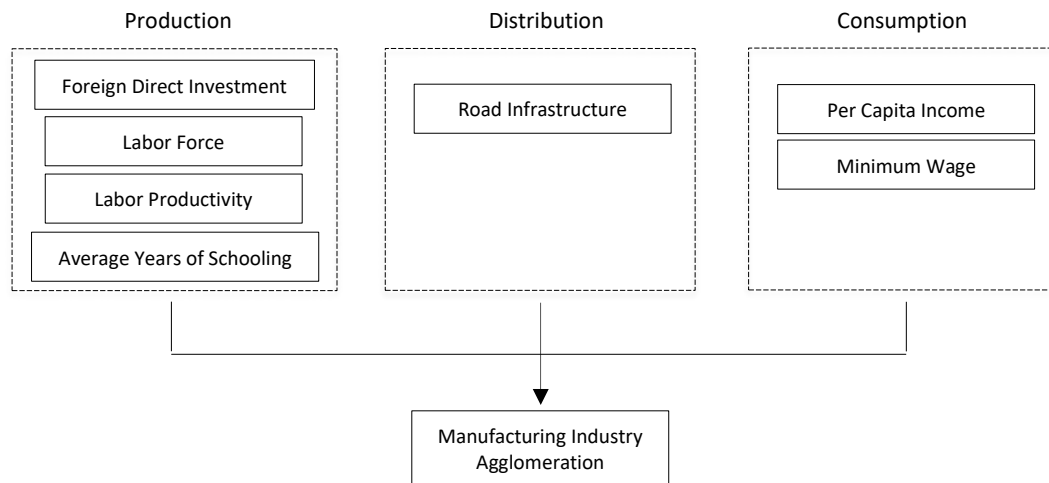
Agglomeration economies will provide positive externalities to each firm within agglomeration area in the form of increased productivity and reduced production costs through the availability of skilled labor, firm specialization, and advanced technology adoption (Edwards, 2007). Agglomeration economies can attract new firms to invest in the agglomeration economies area, thereby absorbing more labor (Zeng et al., 2023). The availability of an abundant labor supply encourages knowledge spillovers (Grieser et al., 2022) and skilled labor recruitment with relatively low wages (Fafchamps & Hamine, 2017). New firms tend to bring with them advanced technology for production efficiency. Knowledge spillovers and advanced technology adoption can ultimately increase productivity (Hoang & Schiller, 2023).

The government's role in providing adequate transportation infrastructure can reduce transportation costs (Tan et al., 2022). In addition, firms' location, which is close to raw materials and market access, can further reduce transportation costs (Edwards, 2007). Increased productivity and decreased transportation costs will benefit firms in the form of production cost savings.

Increased number of firms located in close proximity to each other within agglomeration clusters can, in the long run, lead to negative effects such as rising land prices, pollution, crime, and transportation costs (Edwards, 2007). Firms will decide to disperse from the agglomeration economic area when the savings from agglomeration economies no longer match the rising costs of production. Declined number of firms due to dispersal to other areas are referred to as diseconomies of agglomeration.

Several previous studies have found that manufacturing industry agglomeration is determined by various determinants. X.-P. Zheng (2001) found that agglomeration economies in Japan occur due to the spatial concentration of corporate headquarters, financial industries, and government organizations. Lu & Tao (2009) found that agglomeration economies in China are driven by local protectionism. Ferragina & Mazzotta (2014) found that agglomeration economies in Italy are determined by firm size, firm age, foreign firms, capital-intensive firms, labor productivity, and wages. Meanwhile, Gokan et al. (2019) found that agglomeration economies in Vietnam are determined by localization economies, urbanization economies, trade, knowledge spillovers, and labor.

Figure 3. Conceptual Framework



Source: Data Processed (2024)

This study uses the variables detailed in Figure 3, which represent production, distribution, and consumption activities related to agglomeration economic theory, to identify the determinants of manufacturing industry agglomeration. Foreign direct investment (FDI), labor force, labor productivity, and average years of schooling are used to represent production activities. Road infrastructure is used to represent distribution activities. Minimum wage and per capita income are used to represent consumption activities. This study has several hypotheses as follows.

H1: FDI has a significant positive effect on manufacturing industry agglomeration.

H2: Labor force has a significant positive effect on manufacturing industry agglomeration.

H3: Labor productivity has a significant positive effect on manufacturing industry agglomeration.

H4: Average years of schooling has a significant positive effect on manufacturing industry agglomeration.

H5: Road infrastructure has a significant positive effect on manufacturing industry agglomeration.

H6: Minimum wage has a significant negative effect on manufacturing industry agglomeration.

H7: Per capita income has a significant positive effect on manufacturing industry agglomeration.

Research Method

This study utilizes a quantitative research approach to examine the impacts of interest rates, inflation, and foreign exchange reserves on Indonesia's exchange rate. It concentrates on secondary data obtained from the World Bank, ensuring the reliability and validity of the information utilized in the analysis.

This study was conducted using a quantitative approach with secondary data obtained from official government institutions, as shown in Table 1. Data sample consists of a panel dataset from 34 provinces during the period of 2015-2023.

Table 1. Data Variable

Variable	Description	Unit	Source
Manufacturing Industry Agglomeration (Agglomeration)	Agglomeration economies in manufacturing industry.	Index	Statistics Indonesia
Foreign Direct Investment (FDI)	Net investment value of foreign investors in Indonesian economy.	Million (USD)	Statistics Indonesia
Labor Force (Labor)	People aged 15 and older who are employed or unemployed.	Million (People)	Statistics Indonesia
Labor Productivity (Productivity)	Manufacturing industry output at constant price divided by labor.	Million (IDR)	Statistics Indonesia
Average Years of Schooling (School)	Average number of formal education years attained by people aged 25 and over.	Year	Statistics Indonesia
Road Infrastructure (Road)	Road infrastructure in good and medium condition at district level.	Percent	Ministry of Public Works
Minimum Wage (Wage)	Minimum wage received by labor in their main job at provincial level.	Million (IDR)	Statistics Indonesia
Per Capita Income (Income)	Gross domestic regional product at constant price divided by population.	Million (IDR)	Statistics Indonesia

Source: Data Processed (2024)

This study uses all provinces in Indonesia as a data sample to obtain more comprehensive analysis results. Data sample at provincial level are used because several data variables are not fully available at district level. In addition, data sample is divided into two regions, namely western Indonesia and eastern Indonesia,

in order to obtain more detailed results. Western Indonesia consists of the provinces on Java and Sumatra, while eastern Indonesia consists of the provinces on Bali, Nusa Tenggara, Kalimantan, Sulawesi, Maluku, and Papua. The division into regions is made because each region has different production factors, endowments, and characteristics. Western Indonesia has better production factors, superior distribution infrastructure, and higher purchasing power than Eastern Indonesia. Dividing the regions will reduce outlier data caused by significant disparities, making the estimation results more accurate. Additionally, dividing the regions will generate more specific empirical findings for policy recommendations for stakeholders in each region.

This study is conducted for the period of 2015-2023 to capture deindustrialization phenomenon in Indonesia. Declined distribution of labor and output in manufacturing industry has the potential to significantly affect determinants of manufacturing industry agglomeration in Indonesia. In addition, North Kalimantan was split in 2012, so all data variables are officially available from Statistics Indonesia since 2015.

This study follows Sbergami (2002) who used Balassa index to measure agglomeration economies. Manufacturing industry agglomeration in Indonesia is measured by the ratio of manufacturing industry labor to total labor at provincial level compared to national level as shown in equation (1) as follows.

$$\text{Balassa Index: } \left(\frac{E_{ij}}{\sum_j E_{ij}} \right) / \left(\frac{\sum_i E_{ij}}{\sum_i \sum_j E_{ij}} \right) \quad (1)$$

where, E: employment, i: manufacturing industry, j: province in Indonesia.

In addition, this study also follows the study conducted by Grover et al. (2023), which conducted a meta-analysis related to agglomeration economies in developing countries to identify the data variable used to determine agglomeration economies determinants. This study also considers related studies that identify agglomeration economies determinants, such as those conducted by X.-P. Zheng (2001), Lu & Tao (2009), Ferragina & Mazzotta (2014), and Gokan et al. (2019). Several data variables are transformed into natural logarithm form to avoid multicollinearity and to simplify the subsequent analysis. This study focuses on identifying the determinants of manufacturing industry agglomeration. Therefore, expressing all variables as percentages will make it easier to interpret the estimation results and understand the magnitude of each independent variable. Model equation of the panel data regression to identify manufacturing industry agglomeration determinants can be written in equation (2) as follows.

$$\ln \text{Agglomeration} = \alpha_0 + \beta_1 \ln \text{FDI}_{it} + \beta_2 \ln \text{Labor}_{it} + \beta_3 \ln \text{Productivity}_{it} + \beta_4 \ln \text{School}_{it} + \beta_5 \ln \text{Road}_{it} + \beta_6 \ln \text{Wage}_{it} + \beta_7 \ln \text{Income}_{it} + \varepsilon_{it} \quad (2)$$

where, " α " - "0" : intercept, " β " - "1,2,3,4,5,6,7" : coefficient, i: province, t: year, ε : error term.

Panel data regression can be performed using several models such as common effect, fixed effect, and random effect. Model selection is performed using the Chow, Lagrange multiplier, and Hausman tests. In addition, model equation must satisfy Gauss-Markov assumptions to ensure that model estimates are best linear unbiased estimators using normality test, multicollinearity test, heteroscedasticity test, and autocorrelation test so that they can be used for further analysis (Gujarati & Porter, 2009).

Result and discussion

Descriptive statistics contain concise information on determinants of manufacturing industry agglomeration in Indonesia during the period 2015-2023, which can be detailed as shown in Table 2. This study presents descriptive statistics divided into two regions to obtain more detailed results.

Table 2. Descriptive Statistics

Variable	Obs.	Mean	Std. Dev	Min.	Max.
Western Indonesia					
Agglomeration	144	0.86	0.45	0.31	1.84
FDI	144	1,381.87	1,700.85	9.70	8,283.70
Labor	144	6.60	7.36	0.66	25.57
Productivity	144	188.08	162.92	31.08	796.97
School	144	8.76	0.94	7.03	11.45
Road	144	0.66	0.13	0.41	0.99
Wage	144	2.30	0.73	0.91	4.90
Income	144	46.19	35.87	20.30	192.13
Eastern Indonesia					
Agglomeration	162	0.56	0.24	0.07	1.84
FDI	162	638.83	1,043.71	2.00	7486
Labor	162	1.62	1.00	0.28	4.69
Productivity	162	194.16	287.66	2.63	1,676.24
School	162	8.25	0.94	5.99	10.20
Road	162	0.53	0.10	0.28	0.83
Wage	162	2.43	0.53	1.25	3.86
Income	162	39.07	27.52	11.08	137.51

Source: Data Processed (2024)

Based on Table 2, western Indonesia has a higher agglomeration economies index value for manufacturing industry than eastern Indonesia. However, the average Balassa index value below 1 indicates that agglomeration economies in manufacturing industry have not yet occurred in Indonesia. Western Indonesia has higher quality production factors than eastern Indonesia. In fact, western Indonesia has 2.16 times more FDI and 4.07 times more labor force than eastern Indonesia. However, eastern Indonesia has slightly higher labor productivity and minimum wage. This condition indicates the occurrence of economic development disparities between western and eastern Indonesia.

Based on Table 3, agglomeration economies in manufacturing industry do not occur in the strong and moderate categories. Indonesia only has manufacturing industry agglomeration in the weak category, which is found in 7 (20.58%) provinces. Riau Islands is the province with the highest level of manufacturing industry agglomeration in Indonesia.

Table 3. Manufacturing Industry Agglomeration in Indonesia

Balassa Index	Category	Province
> 4	Strong	-
2-4	Moderate	-
1-2	Weak	Riau Islands, Banten, Central Java, West Java, Yogyakarta, East Java, Bali
< 1	None	Jakarta, West Nusa Tenggara, North Maluku, Lampung, North Sumatra, East Nusa Tenggara, Maluku, North Sulawesi, Gorontalo, West Sumatra, Southeast Sulawesi, South Kalimantan, South Sulawesi, North Kalimantan, Riau, West Sulawesi, Aceh, Bangka Belitung Islands, Central Sulawesi, East Kalimantan, South Sumatra, West Kalimantan, Bengkulu, Central Kalimantan, Jambi, West Papua, Papua

Source: Data Processed (2024)

All provinces in Java, except Jakarta, also have higher manufacturing industry agglomeration compared to other regions. Meanwhile, the majority of regions in Indonesia, consisting of 27 (79.42%) provinces, do not have manufacturing industry agglomeration during the period 2015-2023. Papua is the province with the lowest level of manufacturing industry agglomeration in Indonesia.

Table 4. Panel Data Regression Model

Model Selection Test	Western Indonesia		Eastern Indonesia	
	P-value	Decision	P-value	Decision
Chow test	0.0000	FEM	0.0000	FEM
Lagrange Multiplier test	0.0000	REM	0.0000	REM
Hausman test	0.0000	FEM	0.0000	FEM

Source: Data Processed (2024)

Based on Table 4, this study uses panel data regression analysis with a fixed effect model. In addition to the results of the model selection test, fixed effect model is chosen because it can account for heterogeneity of the independent variables in each province and remains constant throughout observation period. Fixed effect model assumes that the influence of the error term is constant, which allows it to address the omitted variable bias. (Ekananda, 2019).

Normality test performed using skewness kurtosis test has a significant p-value and rejects "H" _"0", indicating that residuals are not normally distributed. This condition occurs because several independent variables have high value gaps in the data sample. Agglomeration economies and most of manufacturing industry agglomeration determinants are dominated by provinces in Java. Nevertheless, data outlier were not excluded from data sample in order to obtain a more comprehensive analysis result. In addition, for large data sample (>100), F-stat and t-stat values are obtained based on assumption that residuals follow a normal data distribution (Gujarati & Porter, 2009).

Multicollinearity test is performed to determine partial correlation among independent variables used in model equation. Multicollinearity test result using correlation matrix show values below 0.75, indicating that there is no multicollinearity in model equation.

Heteroskedasticity test performed using Wald test has a significant p-value and rejects "H" _"0", indicating the presence of heteroskedasticity. Autocorrelation test performed using Wooldridge test also has a significant p-value and rejects "H" _"0",

indicating the presence of autocorrelation. Model equation that exhibits heteroskedasticity and autocorrelation remains unbiased and consistent, but it is inefficient because it does not have minimum variance, resulting in smaller and insignificant F-stat and t-stat values. Therefore, heteroskedasticity and autocorrelation need to be addressed using robust standard errors to facilitate further analysis (Gujarati & Porter, 2009).

Table 5 shows model estimated results to identify determinants of manufacturing industry agglomeration in Indonesia. Based on $P > |t|$ values, average years of schooling has a significant positive effect in western Indonesia, while road infrastructure, minimum wage, and per capita income have a significant positive effect in eastern Indonesia. Meanwhile, labor force and labor productivity have a significant negative effect, while FDI has no significant effect on manufacturing industry agglomeration in Indonesia.

Based on Prob>F values, FDI, labor force, labor productivity, average years of schooling, road infrastructure, minimum wage, and per capita income simultaneously have a significant effect on manufacturing industry agglomeration. R-squared value indicates that dependent variable is affected by independent variables by 83.56% in western Indonesia and 66.04% in eastern Indonesia during the observation period, while the rest is affected by error term or other determinants outside the model equation.

Table 5. Panel Data Regression Result

Independent Variable	Dependent Variable: lnAgglomeration			
	Western Indonesia		Eastern Indonesia	
	Coefficient	P-value	Coefficient	P-value
lnFDI	-0.001	0.896	0.012	0.604
lnLabor	-0.572***	0.003	-0.117	0.834
lnProductivity	-0.772***	0.000	-0.651***	0.000
lnSchool	1.267***	0.000	-2.176	0.103
Road	0.071	0.274	0.650**	0.014
lnWage	-0.049	0.372	0.460*	0.079
lnIncome	0.122	0.334	1.661***	0.005
Obs.	144		162	
Prob>F	0.0000		0.0000	
R-squared	0.8356		0.6604	

Notes: Significance * $p < 0.10$; ** $p < 0.05$; *** $p < 0.01$

Source: Data Processed (2024)

FDI does not have a significant effect on manufacturing industry agglomeration. FDI should be able to promote agglomeration economies as new firms seek to obtain knowledge spillovers and technological spillovers to reduce production costs when establishing operations in manufacturing industry agglomeration areas (Ramachandran & Sasidharan, 2022). New firms also benefit from lower transportation costs and greater labor availability (Edwards, 2007). However, increasingly dense agglomeration economies will raise land costs, wage, pollution, and crime, so that savings from agglomeration economies will be less than increased production costs (Edwards, 2007). This condition will lead to diseconomies of agglomeration, characterized by relocation of firms from agglomeration economies to other regions. In addition, FDI that brings advanced technology for production processes will make domestic firms with lower physical capital and advanced technology adoption unable to compete. This finding is consistent with study conducted by Choi (2018) who found that foreign firms crowd out small domestic

firms in South Korea, resulting in their inability to compete and loss of market share in domestic market. Orlic et al. (2018) found that spillover effect of FDI is largely determined by absorptive capacity of local firms. Hsu et al. (2023) found that FDI can have a negative effect on agglomeration economies in China by increasing competition in agglomeration areas, leading foreign firms to disperse from manufacturing agglomeration areas.

Labor force has a significant negative effect on manufacturing industry agglomeration. Increased labor force by 1% will reduce manufacturing industry agglomeration in western Indonesia by 0.57%, *ceteris paribus*. Increased labor force should increase agglomeration economies because a larger labor supply will make it easier for firms to acquire more skilled labor at lower wage. Moreover, the availability of abundant labor will also enhance knowledge spillovers through more routine interactions, thereby increasing productivity. However, the condition of deindustrialization in Indonesia, as indicated by declined manufacturing labor proportion and declined savings from agglomeration economies compared to increased production costs, has led firms to relocate to other regions with lower production costs, even though these regions have a lower availability of labor force. In addition, the mismatch between labor force skills and manufacturing industry needs will reduce the absorption rate of labor force. This finding is consistent with study conducted by Ehrl (2013) who found that labor can drive agglomeration economies when there is a skills match between labor force and industry needs, while Abbritti & Consolo (2024) found that unemployment occurs due to a skills mismatch between labor skills and industry needs, resulting in unskilled labor having low bargaining power to secure employment. Furthermore, Steijn et al. (2022) found that the role of labor in agglomeration economies is declining as routine jobs are increasingly replaced by advanced technology. Duguet et al. (2023) also found that higher labor availability reduces the chances of unemployed groups in France return to work due to high competition among job seekers.

Labor productivity has a significant negative effect on manufacturing industry agglomeration. Increased labor productivity by 1% will reduce manufacturing industry agglomeration by 0.77% in western Indonesia and 0.65% in eastern Indonesia, *ceteris paribus*. Increased labor productivity should improve agglomeration economies because it can reduce production costs and increase profits, thereby attracting new firms to join the manufacturing industry agglomeration area. However, there are several reasons why labor productivity has a significant negative effect on manufacturing industry agglomeration in Indonesia. First, high labor productivity tends to be found only in large firms that have advanced technology and large production capacities, thereby creating economies of scale. Economies of scale lower production costs and increase profits. However, the average investment in physical capital is significantly higher in Western Indonesia than in Eastern Indonesia. In Western Indonesia, the average investment is IDR 165.44 trillion, whereas in Eastern Indonesia, it is only IDR 39.02 trillion. Consequently, Western Indonesia, particularly Java, is better able to attract production factors from other regions, which hinders the development of manufacturing industry agglomeration outside Java. Second, labor tend to demand wage increases in line with the increase in labor productivity provided. This condition may encourage firms to relocate to regions that offer labor with the same productivity level at lower wages, thus enabling them to maintain high profits. Third, labor productivity may also experience diminishing returns to scale at some point, such that higher labor productivity actually increases marginal costs. Diseconomies of scale will result in lower savings from agglomeration than increased production costs, causing firms to relocate. This finding is consistent

with study conducted by Cruz (2023) who found that increased labor productivity through advanced technology increase efficiency, but may trigger increased real wages in OECD countries, thereby raising production costs. Brault & Khan (2024) found that large firms in the US experience diminishing returns to scale in productivity when they need to hire more labor to increase marginal output. Meanwhile, Wu et al. (2024) found that the use of robots in production within the manufacturing industry will have a spillover effect, increasing labor productivity in China.

Average years of schooling has a significant positive effect on manufacturing industry agglomeration. Increased average years of schooling by 1% will increase manufacturing industry agglomeration by 1.26% in western Indonesia, *ceteris paribus*. More skilled labor will find it easier to operate advanced physical capital. Skilled labor who interact with each other can also enhance knowledge spillover, thereby increasing productivity. Furthermore, more skilled labor can add value to manufacturing industry, which can boost economic growth. This finding is consistent with study conducted by Benos & Karagiannis (2016) who found that higher levels of education increase labor productivity, resulting in a spillover effect that reduces the productivity gap among labor in Greece. Sugiharti et al. (2021) found that labor productivity in Indonesia is not solely determined by average years of schooling, but is more significantly affected by work experience. Grieser et al. (2022) found that knowledge spillovers encourage new investment in the region, creating agglomeration economies. Nevertheless, Yao (2019) found that the uneven distribution of education across regions may reduce labor productivity in China, as labor operates solely on the basis of their abilities without guidance from the government.

Road infrastructure has a significant positive effect on manufacturing industry agglomeration. Increased road infrastructure by 1% will increase manufacturing industry agglomeration in eastern Indonesia by 0.65%, *ceteris paribus*. Well-maintained road infrastructure will facilitate distribution of goods, thereby reducing transportation costs. The ease with which firms can carry out distribution activities will expand the market, thereby increasing demand for goods and boosting economic growth. In addition, good road infrastructure conditions will facilitate labor migration and employment in agglomeration economies areas. This finding is consistent with study conducted by Hörcher et al. (2020) who found that agglomeration economies can reduce public transportation costs through higher frequency of use. Tan et al. (2022) found that transportation infrastructure can promote agglomeration economies, thereby increasing economic growth in China. Meanwhile, Zhang et al. (2023) found that public transportation can expand labor activity, thereby promoting manufacturing industry agglomeration in China.

Minimum wage has a significant positive effect on manufacturing industry agglomeration. Increased minimum wage by 1% will increase manufacturing industry agglomeration in eastern Indonesia by 0.46%, *ceteris paribus*. Minimum wage should have a negative impact on agglomeration economies because firms would be more inclined to choose industrial locations with lower-wage labor. However, the relatively limited availability of low-skilled labor in eastern Indonesia will encourage firms to raise wages to attract a labor force from other regions to migrate and work in the manufacturing industry agglomeration in eastern Indonesia. Labor in eastern Indonesia also has relatively higher wages due to higher cost of living. In addition, lower labor supply and high labor demand will increase competition among similar firms to obtain skilled labor, thereby increasing wages. This finding is consistent with study conducted by Fafchamps & Hamine (2017) who found that lower wages increase manufacturing industry agglomeration in Morocco because large firms have no competitors to set low wages. Bosker et al. (2021) found that manufacturing industry

agglomeration in Java and Bali provides higher wages for labor. Ridhwan (2021) found that the skills of labor force relative to industry needs determine wage differentials between regions of manufacturing industry agglomeration in Indonesia. Meanwhile, Ma et al. (2024) found that rising wages encourage job seekers to migrate to other cities in China that offer higher wages. Labor will migrate to regions that offer higher wages when there is an increase in real wages.

Per capita income has a significant positive effect on manufacturing industry agglomeration. Increased per capita income by 1% will increase manufacturing industry agglomeration in eastern Indonesia by 1.66%, *ceteris paribus*. Increased per capita income will increase purchasing power, thereby encouraging greater consumption activities. Increased per capita income will also encourage new investments for market-oriented firms in the agglomerated economic regions. Moreover, firms that focus more on the domestic market than on exporting to the global market will also prefer to be located close to the market. This finding is consistent with study conducted by Huang & Dennis Wei (2016) who found that ease of market access will enhance foreign investment, thereby increasing manufacturing industry agglomeration in China. Meanwhile, (Tokunaga, 2024) found that market potential will increase manufacturing industry agglomeration in Japan due to increased demand for output.

Labor force and labor productivity, which have a significant negative effect, indicate that there has been a diseconomies of agglomeration in Indonesia, where firms are relocating and spreading from agglomeration economies areas to other regions. This condition is caused by the economic savings of agglomeration that are no longer proportional to increased production costs from other variable costs in the agglomeration economies area. Manufacturing industry agglomeration can have a positive impact if a spillover effect occurs that enhances economic growth of surrounding areas, thereby reducing the economic development gap between regions.

Conclusions

This study aims to identify determinants of manufacturing industry agglomeration in Indonesia. Panel dataset consists of secondary data from 34 provinces during the period 2015-2023, which is analyzed using panel data regression. This study found that average years of schooling, road infrastructure, minimum wage, and per capita income have a significant positive effect, labor force and labor productivity have a significant negative effect, while FDI has no significant effect on manufacturing industry agglomeration in Indonesia.

This study also found that significant negative effect of labor force and labor productivity indicates that diseconomies of agglomeration have occurred in the manufacturing industry in Indonesia. Several firms have started to relocate and spread out from agglomeration economies areas in order to achieve lower production costs. In addition, some new investments also choose to establish new enterprises outside agglomeration economies areas. This finding contributes to the literature by indicating that uneven physical capital investment across regions results in a backwash effect. This effect is characterized by the withdrawal of production factors, particularly skilled labor, from underdeveloped regions. This condition widens economic development disparities and may lead to premature deindustrialization. Policymakers are expected to improve the allocation of FDI value and project to manufacturing industry and reduce skill mismatch to improve labor absorption and labor productivity. Furthermore, to attract private sector investment and create

manufacturing industry agglomeration, the government needs to accelerate infrastructure development outside of Java.

This study has limitations as it only identifies determinants of manufacturing industry agglomeration based on production, distribution, and consumption activities. This study did not measure diseconomies of agglomeration determinants. In addition, spatial analysis was not used to measure the impact of agglomeration economies on economic development disparities with the surrounding regions.

Further studies can be conducted to identify other potential determinants of manufacturing industry agglomeration such as technology, trade openness, migration, and institutions. The more determinants of manufacturing industry agglomeration are identified, the more it will drive appropriate policy recommendations. In addition, threshold or turning point from agglomeration economies to diseconomies of agglomeration need to be identified. When the manufacturing industry agglomeration has reached a saturation point, stakeholders will receive an early warning. They can then formulate policies to prevent diseconomies of scale and promote equitable economic development.

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