



Analysis of Interregional Spillover Effects on Industrial Sector Growth in the Gerbangkertosusila - 4

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Abstract: This study examines spillover and reciprocal relationships of industrial sector growth among Sidoarjo, Gresik, Pasuruan, and Mojokerto. The Two-Stage Least Squares (TSLS) method was applied using industrial GRDP data from 2000–2024. The results show that: (1) Sidoarjo and Gresik have a positive and mutually reinforcing relationship; (2) Sidoarjo and Pasuruan exhibit a reciprocal but weak relationship; and (3) Sidoarjo and Mojokerto show a reciprocal but negative relationship, indicating spatial competition. These findings highlight that interregional industrial interactions vary and are shaped by agglomeration forces and regional industrial structures.

Keywords: Spillover, Reciprocal, Industry, TSLS

Introduction

Economic growth remains a primary indicator of development success in many developing countries, including Indonesia. However, this growth is influenced by various structural factors, such as regional inequality, infrastructure limitations, and the concentration of economic activities in certain areas. Therefore, development cannot merely aim to increase growth figures, but must also ensure a more equitable distribution of economic benefits so that development can take place in a fair and sustainable manner (Afif & Ciptawaty, 2020).

In East Java, relatively high economic growth rates do not necessarily reflect an even distribution of development across regions. Based on the Williamson Index, the level of interregional inequality in the province is still considered high, indicating significant disparities in the distribution of development outcomes. This condition supports the view that economic growth without equity may, in fact, widen social and economic gaps (Panzera & Postiglione, 2022).

The industrial sector is indeed a key engine of economic growth, as reflected in increased production capacity, productivity, and employment absorption (Novirin, 2021). Moreover, industrial growth does not occur in isolation, but generates spillover effects on surrounding regions. These effects can be positive, such as increased demand for labor and

logistics, but can also be negative in the form of competition that suppresses the growth of other regions (Hasna & Qibti, 2020; Ibrahim, 2017).

Based on these conditions, this study focuses on analyzing the reciprocal relationship in industrial sector growth between Sidoarjo Regency and three other major industrial areas, namely Gresik, Pasuruan, and Mojokerto. By employing the Two-Stage Least Squares (2SLS) method, this research seeks to reveal the dynamics of bidirectional interregional influence and to provide an empirical foundation for the formulation of more integrated and equitable industrial development policies.

Research Method

In this study, the relationship among variables is analyzed using a system of simultaneous equations, as there are indications of a reciprocal relationship among the endogenous variables. The specification of the simultaneous equations is based on relevant economic theories and findings from previous empirical studies, allowing each variable to be accurately classified as either endogenous or exogenous. Subsequently, the identification condition is tested through the order condition to ensure that each equation is either just-identified or over-identified, and therefore feasible for econometric estimation.

$$K - k \geq m - 1$$

Explanation;

M = the total number of endogenous variables in the system of simultaneous equations.

m = the number of endogenous variables in a specific equation.

K = the total number of exogenous variables in the system of simultaneous equations.

k = the number of exogenous variables in a specific equation.

The basis for determining the identification status of an equation in a simultaneous equation system is established through the following criteria. If $(K - k = m - 1)$, the equation is classified as just-identified and can be estimated using the Indirect Least Squares (ILS) technique. If $(K - k > m - 1)$, the equation is considered over-identified and is therefore estimated using the Two-Stage Least Squares (TSLS) method. Conversely, if $(K - k < m - 1)$, the equation is categorized as under-identified (unidentified) and cannot be estimated econometrically. In this study, equations that meet the over-identification condition are estimated using the TSLS approach.

The first equation

In the first equation, the simultaneous relationship model describes the reciprocal interaction between the industrial-sector GRDP at constant prices (ADHK) in Sidoarjo Regency and the industrial-sector GRDP at constant prices (ADHK) in Gresik Regency;

$$\begin{aligned} \text{KSDA} &= \alpha_0 + \alpha_1 \text{KGRS} + \alpha_2 \text{kpsr} + \alpha_3 \text{kmjk} + e_1 \\ \text{KGRS} &= \beta_0 + \beta_1 \text{kpsr} + \beta_2 \text{kmjk} + \beta_3 \text{klmn} + e_2 \end{aligned}$$

The second equation

In the second equation, the simultaneous relationship model describes the reciprocal interaction between the industrial-sector GRDP at constant prices (ADHK) in Sidoarjo Regency and the industrial-sector GRDP at constant prices (ADHK) in Pasuruan Regency;

$$\begin{aligned} \text{KSDA} &= \alpha_0 + \alpha_1 \text{KGRS} + \alpha_2 \text{kpsr} + \alpha_3 \text{kmjk} + e_1 \\ \text{KPSR} &= \beta_0 + \beta_1 \text{kpsr} + \beta_2 \text{kgrs} + \beta_3 \text{kmjk} + \beta_4 \text{kbkn} + e_2 \end{aligned}$$

The third equation

In the third, the simultaneous relationship model describes the reciprocal interaction between the industrial-sector GRDP at constant prices (ADHK) in Sidoarjo Regency and the industrial-sector GRDP at constant prices (ADHK) in Mojokerto Regency;

$$\begin{aligned} \text{KSDA} &= \alpha_0 + \alpha_1 \text{KGRS} + \alpha_2 \text{kpsr} + \alpha_3 \text{kmjk} + e_1 \\ \text{KMJK} &= \beta_0 + \beta_1 \text{kpsr} + \beta_2 \text{kgrs} + \beta_3 \text{kpsr} + \beta_4 \text{klmn} + e_2 \end{aligned}$$

Explantion;

KSDA	: GDRP industrial-sector Kabupaten Sidoarjo
KGRS	: GDRP industrial-sector Kabupaten Gresik
KPSR	: GDRP industrial-sector Kabupaten Pasuruan
KPMJK	: GDRP industrial-sector Kabupaten Mojokerto
KLMN	: GDRP industrial-sector Kabupaten Lamongan
KMJK	: GDRP industrial-sector Kabupaten Mojokerto
<i>e</i>	: Standar error
<i>t</i>	: Time
β_0	: Intersep
$\beta_1, \beta_2, \beta_3, \beta_4$: Coefisien regression partial

The model is estimated using EViews software through the Two-Stage Least Squares (TSLS) method. In the first stage, the endogenous variables are regressed on all exogenous variables and instruments to obtain predicted values that are free from endogeneity problems. In the second stage, these predicted values are then included in the structural equations as substitutes for the original endogenous variables, resulting in coefficient estimates that are more consistent and unbiased.

Before interpreting the estimation results, the model is tested using classical assumption tests, including tests for normality, heteroskedasticity, and autocorrelation. These tests aim to ensure that the model satisfies the BLUE (Best Linear Unbiased Estimator)

criteria and is suitable as a basis for drawing conclusions. With the support of EViews 13, all data processing stages are carried out in a systematic, accurate, and efficient manner.

Results and Discussion

Results

Based on the identification rules of simultaneous equation models, the TSLS method is applied when a model falls into the over-identified category. Referring to Table 1, the first, second, and third equations are all classified as over-identified. Therefore, these three simultaneous equations meet the requirements and are appropriate to be estimated using the TSLS method.

Table 1. Results of simultaneous model identification through order conditions

Equation	K-k	m-1	Identification
1	5-2	2-1	Overidentified
	5-3	2-1	Overidentified
2	5-2	2-1	Overidentified
	5-3	2-1	Overidentified
3	5-2	2-1	Overidentified
	5-3	2-1	Overidentified

Source: Processed Data, 2025

After all equations are confirmed to be over-identified based on the order condition, each equation is further subjected to classical assumption tests to ensure that the model meets the required econometric criteria. Once these assumptions are satisfied, the equations can be properly analyzed and estimated in the next stage using the Two-Stage Least Squares (TSLS) method. The following are the regression results obtained through the TSLS estimation.

Table 2. The estimation results of the Two-Stage Least square model

Equation	Dependent Variable	Independent Variable	Coefficient	Prob.
1	KSDA	KGRS	0.797250	0.0563**
	KGRS	KSDA	1.108810	0.0086*
2	KSDA	KPSR	1.281524	0.0103*
	KPSR	KSDA	0.446400	0.0906**
3	KSDA	KMJK	-0.263918	0.0236*
	KMJK	KSDA	-1.540616	0.0001*

Source: Processed data from Eviews 13, 2025

Note: *Sig on α 0.05; **Sig on α 0.10

The TSLS estimation results above show that:

Results of the first model:

The first model examines the simultaneous relationship between the industrial-sector GRDP (ADHK) of Sidoarjo (KSDA) and Gresik (KGRS). The results indicate a reciprocal relationship, where KGRS significantly affects KSDA at the 10% level (coefficient 0.7972) and KSDA significantly influences KGRS at the 5% level (coefficient 1.1088) over the period 2000–2024.

Results of the second model:

The second model examines the simultaneous relationship between the industrial-sector GRDP (ADHK) of Sidoarjo (KSDA) and Pasuruan (KPSR). The results indicate a reciprocal relationship, where KPSR significantly affects KSDA at the 5% level (coefficient 1.2815) and KSDA also influences KPSR at the 10% level (coefficient 0.4464).

Results of the Third model:

The third model examines the simultaneous relationship between the industrial-sector GRDP (ADHK) of Sidoarjo (KSDA) and Mojokerto (KMJK). The results indicate a reciprocal but negative relationship, where KMJK significantly affects KSDA with a coefficient of -0.2639 , and KSDA also significantly influences KMJK with a coefficient of -1.5406 .

Discussion**Spillover of Industrial Sector Growth between Sidoarjo Regency and Gresik Regency**

The Two-Stage Least Squares (TSLS) estimation results indicate a strong industrial linkage between Sidoarjo Regency and Gresik Regency. Industrial growth in Gresik has a significant impact on Sidoarjo, with a coefficient of 0.797250 at the 10% significance level, while Sidoarjo's industrial sector also exerts a significant influence on Gresik, with a coefficient of 1.108810 at the 5% significance level. These findings confirm a reciprocal relationship that reflects the economic integration of the Gerbangkertosusila region through interconnected supply chains, distribution networks, and interregional flows of raw materials.

This relationship is consistent with Hirschman's Linkage Effect theory (1984), where backward linkages are evident in Sidoarjo's reliance on raw material inputs from Gresik, and forward linkages appear through the absorption and further processing of Gresik's industrial output by Sidoarjo's manufacturing sector. The results also align with previous studies highlighting East Java's interregional economic integration through production and logistics networks (Fitriani et al., 2021), reinforcing the view that Sidoarjo and Gresik develop within a single, interconnected regional industrial growth system.

Spillover of Industrial Sector Growth between Sidoarjo Regency and Pasuruan Regency

The Two-Stage Least Squares (TSLS) estimation results indicate a significant linkage between the industrial sectors of Sidoarjo Regency and Pasuruan Regency. Industrial growth in Pasuruan has a positive effect on Sidoarjo, with a coefficient of 1.281524 at the 5% significance level, while industrial growth in Sidoarjo also influences Pasuruan, with a coefficient of 0.446400 at the 10% significance level. This reflects a reciprocal relationship in the industrial dynamics of the two regions.

This reciprocal interdependence is consistent with the concept of the Linkage Effect (Hirschman, 1984), which highlights the presence of both backward and forward linkages across sectors and regions. The findings also support previous studies on spatial linkages and growth interactions in East Java, particularly within the Gerbangkertosusila economic network, confirming that Sidoarjo and Pasuruan develop within a shared and interconnected regional industrial system.

Spillover of Industrial Sector Growth between Sidoarjo Regency and Mojokerto Regency

Based on the Two Stage Least Squares (TSLS) estimation, the industrial growth relationship between Sidoarjo Regency and Mojokerto Regency does not exhibit a mutually reinforcing pattern; instead, it is competitive in nature. Industrial growth in Mojokerto has a negative and significant effect on Sidoarjo (coefficient -0.263918 ; $\alpha = 5\%$), and conversely, industrial growth in Sidoarjo also has a negative and significant effect on Mojokerto (coefficient -1.540616 ; $\alpha = 5\%$). This indicates competition in attracting investment, labor, and the use of industrial space within the Surabaya hinterland.

This phenomenon can be explained through Hirschman's (1984) Linkage Effect theory; however, the relationship reflects a backwash effect rather than mutually beneficial integration. Regions with stronger industrial capacity, infrastructure, and market access such as Sidoarjo tend to dominate investment flows, diverting potential growth from weaker neighboring areas (Wibisono & Kuncoro, 2015). Thus, the Sidoarjo–Mojokerto linkage is characterized more by spatial competition than by industrial synergy.

Conclusion

Based on the Two-Stage Least Squares (TSLS) estimation, the industrial spillover relationships between Sidoarjo Regency and Gresik Regency, Pasuruan Regency, and Mojokerto Regency exhibit different characteristics in terms of both direction and strength. Overall, Sidoarjo shows a reciprocal relationship with all three regions, although the pattern and magnitude of the spillover effects are not uniform.

The relationships between Sidoarjo and Gresik, as well as between Sidoarjo and Pasuruan, tend to be mutually supportive. Industrial growth in one region stimulates

industrial activity in the other through shared supply chains, sectoral proximity, and linkages in labor and production networks. This condition suggests strong potential for regional industrial synergy between these areas.

In contrast, the relationship between Sidoarjo and Mojokerto appears weaker and more competitive. Differences in industrial structure, unequal business scale, and limited market integration mean that industrial growth in one region does not significantly stimulate growth in the other. This indicates that the economic linkage between Sidoarjo and Mojokerto is relatively limited and less synergistic.

Suggestion

Based on the research findings, the positive and reciprocal spillover between Sidoarjo and Gresik should be strengthened through supply chain integration, improved logistics connectivity, and collaborative industrial zoning and planning. Meanwhile, the reciprocal but still weak relationship between Sidoarjo and Pasuruan calls for enhanced inter-industrial cooperation, better distribution infrastructure, and value chain integration to maximize the spillover benefits for both regions.

The negative reciprocal spillover observed between Sidoarjo and Mojokerto reflects spatial competition. Therefore, an industrial differentiation strategy, labor market integration, and more balanced industrial infrastructure development are needed to reduce unhealthy competition and minimize crowding-out effects, allowing both regions to grow without weakening each other.

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