

Does Economic Scale Strengthen Export Competitiveness? Evidence from Eastern Indonesia

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Abstract

This study examines the relationship between economic scale and non-oil export competitiveness in Eastern Indonesia using a simultaneous equation framework estimated using the three-stage least squares (3SLS) method. Economic scale is measured by labor productivity, while export competitiveness is measured using the revealed comparative advantage (RCA) index. The analysis covers capital accumulation, human capital, labor quality, and economic complexity across Eastern Indonesian provinces from 2000 to 2025. The results indicate an asymmetric relationship between the variables. Economic scale has a positive and significant effect on export competitiveness, whereas the latter does not significantly affect the former. Capital accumulation increases the economic scale but reduces export competitiveness, suggesting that investment has not been fully directed toward export-oriented and value-added activities. Labour quality improves the economic scale, although its direct effect on export competitiveness is insignificant. Human capital has a negative effect on the economic scale, indicating a possible mismatch with regional industrial needs. Economic complexity positively affects export competitiveness. These findings imply that export competitiveness in Eastern Indonesia depends primarily on labor productivity, productive capability, and economic complexity.

JEL Classification: F14; O18; R11; C30

1. Introduction

Non-oil and gas exports play an important role in Indonesia's trade performance and in generating foreign exchange earnings. However, the export performance remains uneven across regions. Eastern Indonesia, which includes Sulawesi, Nusa Tenggara, Maluku, and Papua, has abundant natural resources in fisheries, agriculture, and forestry, and resource-based industries. Despite this potential, the region contributes less to exports and captures lower value-added than major export centres in Java and Sumatra. This highlights the need for a regional analysis of non-oil export competitiveness, particularly in archipelagic areas that face logistics, infrastructure, and industrial capacity constraints (Amin et al., 2021).

Export competitiveness is not solely determined by natural resource endowment. It also depends on logistics efficiency, investment capacity, labor productivity, human capital, and sophistication of regional production structures. Better logistics performance can reduce trade costs, improve delivery reliability, and support export growth (Gani, 2017). Public policy, fiscal support, investment incentives, and institutional improvement can also improve export quality, particularly when supported by adequate infrastructure and skilled workers (Sui et al., 2023). Export-specific investments, including certification, export-oriented technology, workforce training, and international marketing, can strengthen export performance through efficiency gains and product differentiation (Ngo et al., 2024).

From a regional development perspective, economic scale and export competitiveness may influence each other. A higher economic scale, measured through labor productivity, can improve production efficiency and strengthen export competitiveness. Simultaneously, stronger export competitiveness can

increase market demand, attract investment, and stimulate industrial expansion. Previous studies have suggested that production scale, agglomeration, and local processing capacity can improve export competitiveness by reducing average costs and increasing value-added capture (Shabanov et al., 2021). However, empirical evidence on the relationship between economic scale and export competitiveness at the provincial level remains limited, particularly in Eastern Indonesia.

Several studies have used the revealed comparative advantage (RCA) and dynamic revealed comparative advantage (DRCA) indices to measure export competitiveness across products and regions (Leromain & Ore, 2014). However, most studies on Indonesia's non-oil export competitiveness have focused on national-level analyses or commodity-based approaches. They have paid less attention to regional structural factors such as labor productivity, capital accumulation, human capital, labor quality, and economic complexity. This study addresses this gap by examining the relationship between economic scale and non-oil export competitiveness in Eastern Indonesia using a simultaneous equation framework estimated using 3SLS.

2. Literature Review and Conceptual Framework

The relationship between economic scale (ES) and export competitiveness (XC) is an important issue in international trade and regional development. New trade theory explains that economies of scale enable firms and regions to reduce average production costs, improve their specialisation, and increase productivity. Krugman (2018) states that increasing returns to scale are a major foundation of international trade because larger production systems create efficiency advantages that support export performance. Therefore, regions with greater economic scale are expected to achieve stronger export competitiveness when production expansion is supported by productivity improvement, technological capabilities, and efficient resource allocation.

Capital accumulation is a key determinant of economic scale and export competitiveness. Capital enables regions to expand their production capacity, improve their infrastructure, adopt modern technology, and support export-oriented industries. Xie et al. (2025) found that financial agglomeration increases domestic value-added in exports by improving industrial efficiency and production scale. Ngo et al. (2024) also show that financial capability strengthens export performance through innovation, productivity, and market adaptation. These findings indicate that capital can support economic scale through industrial expansion and influence export competitiveness through investment capacity and technological upgrading.

Labour quality and human capital also play important roles in this framework. Labour quality supports economic scale by improving production efficiency, technical ability, and technological adaptation. Casagrande et al. (2024) found that export participation increases firm productivity and the demand for skilled labor. Human capital reflects education, health, knowledge, and capabilities within a region. Zhang et al. (2023) explain that human capital contributes to regional structural transformation because skilled and healthy workers improve productivity and technological capability. Thus, labor quality and

human capital are expected to strengthen regional productivity and support export-oriented developments.

Economic complexity is included because export competitiveness is shaped by the sophistication and diversity of regional productive capacity. This reflects the knowledge, capabilities, and productive know-how embedded in the economy. Regions with higher economic complexity are more likely to produce higher value-added and diversified export products. Leromain and Ore (2014) explained that revealed comparative advantage can identify export competitiveness across products and regions. However, the RCA should be complemented by an understanding of the productive structure because a region may have a comparative advantage in certain commodities without a diversified industrial base.

The framework assumes a potential reciprocal relationship between economic scale and export competitiveness. The economic scale, measured through labor productivity, can improve export competitiveness by reducing unit costs and increasing production efficiency. Agglomeration theory explains that industrial concentration creates knowledge spillovers, labor pooling, and supply chain integration. Fujita et al. (1999) and Porter (1990) argue that industrial clusters improve export performance through innovation diffusion and production efficiency. Conversely, export competitiveness may stimulate economic growth through higher international demand, investment growth, and industrial expansion. Melitz (2003) explains that exporting firms tend to increase productivity and output, while Rodrik (2006) argues that export-oriented industrialisation supports structural transformation through learning by exporting and technology diffusion.

Source: Authors' conceptualisation.

3. Data and Methodology

3.1 Data and variables

This study uses provincial panel data from Eastern Indonesia. The observation period covers 2000 to 2025 using five-year intervals, resulting in 84 province-period observations. The empirical framework consists of two endogenous variables, economic scale and export competitiveness, and four explanatory variables: capital accumulation, human capital, labor quality, and economic complexity. The use of five-year interval data helps capture medium-term changes in regional production capacity and export competitiveness.

Table 1
Variable definitions and measurements

Variable	Definition	Indicator	Expected role
Capital accumulation (KA)	Growth of productive capital stock through investment and reinvestment.	Capital accumulation, US dollars	Affects ES and XC through production capacity and technology adoption.
Human capital (HK)	Knowledge, education, health, and capability are embedded within the population.	Human Development Index, HDI	Affects the ES through labor productivity and capability formation.
Labour quality (LK)	Share of skilled or educated labor in the total labor.	Proportion of skilled labour, percent	This affects ES and may indirectly support XC.
Economic complexity (EC)	Productive capability and sophistication are embedded in the regional export structures.	Lagged non-oil export capacity, t-1, logged	Affects XC through diversification and export sophistication.
Economic scale (ES)	Efficiency of regional economic activities in generating output from labor	GRDP divided by employed labour	Endogenous variable.
Export competitiveness (XC)	Ability of a province to compete in non-oil export markets	RCA index with Indonesia as benchmark	Endogenous variable.
Note: ES = economic scale; XC = export competitiveness. The lagged export capacity measure is used as a proxy for economic complexity because consistent province-level economic complexity indicators are scarce.			

3.2 Measurement of economic scale and export competitiveness

Economic scale is measured using a labor productivity approach. Labour productivity reflects a region's ability to generate economic output from each unit of employed labor. A higher value indicates that a province can produce greater output with its available labor force.

$$ES_{it} = \frac{Y_{it}}{L_{it}} \quad (2.1)$$

where ES_{it} denotes the economic scale in province i during period t , Y_{it} denotes the gross regional domestic product, and L_{it} denotes the employed labor. Export competitiveness is measured using the Revealed Comparative Advantage index. The RCA formula was adapted to compare the share of provincial non-oil and gas exports with the corresponding national export structure.

$$RCA_{it} = \frac{\frac{X_{NO_{it}}}{X_{T_{it}}}}{\frac{X_{NO_{t}}}{X_{T_{t}}}} ; RCA_{it} >, =, < 1 \quad (2.2)$$

where XNO_it denotes non-oil and gas exports of province i in period t, XT_it denotes total exports of province i, XNO_t denotes national non-oil and gas exports, and XT_t denotes total national exports. RCA values greater than one indicate that a province has relatively strong non-oil export competitiveness compared to the national benchmark value. RCA values equal to one indicate average competitiveness, whereas values below one indicate relatively weak competitiveness.

3.3 Empirical strategy

This study examines the reciprocal relationship between economic scale and export competitiveness across Eastern Indonesian provinces. The empirical strategy follows a panel simultaneous equation framework because the economic scale and export competitiveness may influence each other contemporaneously. A larger economic scale can improve export competitiveness through higher production capacity, economies of scale, and stronger market access. Simultaneously, stronger export competitiveness can expand regional economic activity through higher demand, productivity gains, and wider integration into external markets.

To address this simultaneity problem, this study estimates a panel simultaneous equation model using the three-stage least squares method. The 3SLS approach is appropriate because it addresses endogeneity between the two dependent variables and accounts for cross-equation correlations in the error terms. Unlike the fixed-effects specification, this study does not include province-specific fixed effects. This choice allows the model to retain cross-provincial variation, which is important for explaining structural differences in the economic scale and export competitiveness across Eastern Indonesian provinces. Therefore, the estimation focuses on the simultaneous relationships between the observed variables in the system.

The structural model consists of two equations: The first equation explains economic scale as a function of capital accumulation, labour quality, human capital, and export competitiveness. The second equation explains export competitiveness as a function of capital accumulation, labor quality, economic complexity, and economic scale. The structural equations are specified as follows:

$$ES_{1it} = \alpha_0 + \alpha_1 \ln KA_{it} + \alpha_2 LK_{it} + \alpha_3 HK_{it} + \alpha_4 XC_{it} + \varepsilon_{1it} \quad (3.1)$$

$$XC_{1it} = \beta_0 + \beta_1 \ln KA_{it} + \beta_2 LK_{it} + \beta_3 \ln EC_{it-1} + \beta_4 ES_{it} + \varepsilon_{2it} \quad (3.2)$$

where ES_it denotes the economic scale in province i at time t, and XC_it represents export competitiveness. $\ln KA_{it}$ refers to the natural logarithm of capital accumulation, LK_{it} refers to labor quality, HK_{it} represents human capital, and $\ln EC_{it-1}$ denotes the lagged economic complexity. The error terms ε_{1it} and ε_{2it} capture the unobserved shocks in the two structural equations.

The inclusion of XC in the economic scale equation and ES in the export competitiveness equation creates a simultaneity problem. Therefore, both ES and XC were considered endogenous variables. Direct estimation using ordinary least squares produces biased and inconsistent estimates because endogenous regressors are likely to be correlated with error terms.

To identify the model, the study excluded exogenous variables within the system. Human capital is included in the economic scale equation but excluded from the structural export competitiveness equation. Lagged economic complexity is included in the export competitiveness equation but excluded from the structural economic scale equation. This identification strategy allows human capital to serve as an instrument for the economic scale in the export competitiveness equation, while lagged economic complexity serves as an instrument for export competitiveness in the economic scale equation.

Before estimating the structural system, reduced-form equations are specified using all the exogenous variables in the system. These equations provide the predicted values of the endogenous variables and form the basis of the instrumental variable estimation procedure. The reduced-form equations are as follows.:

$$ES_{2it} = \gamma_0 + \gamma_1 \ln KA_{it} + \gamma_2 \ln K_{it} + \gamma_3 \ln HK_{it} + \varepsilon_{3it} \quad (3.3)$$

$$XC_{2it} = \delta_0 + \delta_1 \ln KA_{it} + \delta_2 \ln K_{it} + \delta_3 \ln EC_{it-1} + \varepsilon_{4it} \quad (3.4)$$

The reduced-form specification uses all predetermined and exogenous variables in the system because each endogenous variable must be predicted using a complete set of valid instruments. This step is important to ensure that the endogenous components of economic scale and export competitiveness are removed before estimating their reciprocal effects on the export performance.

The 3SLS estimation was conducted in three stages. In the first stage, the endogenous variables were estimated using reduced form equations. In the second stage, the fitted values of the endogenous variables were used to estimate each structural equation using instrumental variable estimation. In the third stage, the system is estimated jointly by accounting for the contemporaneous correlation between the error terms across the equations. This procedure improves efficiency relative to the single-Eq. 2SLS because it uses information from all systems.

The direct effects are obtained from the structural coefficients of the 3SLS model. In the economic scale equation, α_1 , α_2 , and α_3 measure the direct effects of capital accumulation, labor quality, and human capital on the economic scale, while α_4 measures the direct effect of export competitiveness on the economic scale. In the export competitiveness equation, β_1 , β_2 , and β_3 measure the direct effects of capital accumulation, labor quality, and lagged economic complexity on export competitiveness, whereas β_4 captures the direct effect of the economic scale on export competitiveness.

Indirect effects are derived from the reciprocal links between the economic scale and export competitiveness of the industry. For example, capital accumulation may directly affect the economic scale through α_1 and indirectly through export competitiveness. Similarly, human capital may indirectly affect export competitiveness through its effect on the economy. These indirect effects were calculated as the product of the relevant structural coefficients.

The total effect on the economic scale combines the direct effect of each explanatory variable with the indirect effect transmitted through the export competitiveness. Conceptually, the total effect equation for the economic scale is expressed as follows:

$$ES_{1it} = \ln \phi_0 + \phi_1 \ln KA_{it} + \phi_2 LK_{it} + \phi_3 HK_{it} + \phi_4 \ln EC_{it-1} + \varepsilon_{5it} \quad (3.5)$$

Meanwhile, the total effect on export competitiveness combines the direct effects of the explanatory variables with the indirect effects transmitted through the economic scale. The total effect equation for export competitiveness is as follows:

$$XC_{1it} = \ln \theta_0 + \theta_1 \ln KA_{it} + \theta_2 LK_{it} + \theta_3 HK_{it} + \theta_4 \ln EC_{it-1} + \varepsilon_{6it} \quad (3.6)$$

These total effect equations are not substitutes for the structural 3SLS model. Instead, they are used as complementary specifications that summarise the combined direct and indirect channels through which production inputs and economic complexity influence economic scale and export competitiveness. The main causal interpretation remains based on the structural simultaneous equation model estimated using the 3SLS.

In this framework, capital accumulation and labor quality are treated as common production inputs that may influence both economic scale and export competitiveness. Human capital is expected to strengthen the economic scale by improving labor productivity and regional production capacity. Economic complexity is included with a one-period lag to reduce reverse causality and capture the delayed effect of productive knowledge, technological capability, and export diversification on export competitiveness.

Overall, this empirical strategy allows us to examine three relationships. First, it estimates the direct effects of capital accumulation, labor quality, human capital, and economic complexity on the two main outcomes. Second, it captures the reciprocal relationship between the economic scale and export competitiveness. Third, it identifies the total effects of the explanatory variables by considering both the direct and indirect transmission channels. Therefore, the model provides a systematic framework for analysing how regional production capacity and export competitiveness reinforce each other across Indonesian provinces in Eastern Indonesia.

4. Results

4.1 Descriptive statistics and bivariate patterns

Non-oil export competitiveness in Eastern Indonesia varies substantially among provinces. Papua Barat, Sulawesi Tenggara, and Sulawesi Utara recorded relatively stronger RCA values than other provinces, while several provinces showed lower and less stable competitiveness. This pattern indicates uneven productive capability, infrastructure readiness, and export specialisation across regions.

Table 2
Descriptive statistics

Statistic	Capital accumulation	Human capital	Labour quality	Economic complexity	Economic scale	Export competitiveness
Mean	448.1548	66.8088	6.0750	1,737.9400	49.3674	1.5004
Median	250.0000	67.0000	5.7000	148.8000	39.1050	1.2720
Maximum	3,224.0000	79.3900	11.2000	25,225.2000	188.4400	3.0430
Minimum	10.0000	54.2000	3.5000	0.1000	14.8800	0.4970
Std. dev.	552.4525	5.2765	1.6437	4,217.0940	34.7008	0.7278
Jarque-Bera	387.3582	0.6880	12.0015	871.7509	86.8832	7.2073
Probability	0.0000	0.7089	0.0025	0.0000	0.0000	0.0272
<i>Note: Statistics are based on 84 province-period observations.</i>						

Source: Authors' calculation based on provincial panel data.

The scatterplots indicate a positive relationship between economic scale and export competitiveness, suggesting that labor productivity supports efficiency, specialisation, and export performance. However, several observations deviate from the trend line, indicating that scale expansion must be supported by productivity improvement, technological upgrading, export diversification, and stronger capabilities. Other bivariate patterns show that capital accumulation is positively related to the economic scale but has a weaker and slightly negative relationship with export competitiveness. Labour quality contributes to economic scale, whereas economic complexity reflects the productive sophistication needed to strengthen export competitiveness.

Table 3
Correlation matrix

Variable	Capital accumulation	Economic complexity	Human capital	Labour quality
Capital accumulation	1.000	0.724	0.601	0.646
Economic complexity	0.724	1.000	0.517	0.606
Human capital	0.601	0.517	1.000	0.779
Labour quality	0.646	0.606	0.779	1.000
<i>Note: The matrix is used to evaluate preliminary multicollinearity among explanatory variables.</i>				

4.2 Simultaneous equation results

Table 4 presents the main 3SLS estimation results for the full sample. The findings show that economic scale and export competitiveness have an asymmetric relationship. Economic scale has a positive and significant effect on export competitiveness, whereas export competitiveness does not significantly affect economic scale. This finding indicates that regional labor productivity is more important for strengthening non-oil export competitiveness than export expansion alone.

Table 4
Main simultaneous-equation estimates using 3SLS

Equation / variable	Coefficient	Std. error	p-value	Inference
Panel A. Dependent variable: Economic scale (ES)				
Export competitiveness	-7.5077	9.5136	0.4312	Not significant
ln Capital accumulation	14.2617	3.3337	0.0000	Positive, significant
Human capital	-2.7083	0.9020	0.0031	Negative, significant
Labour quality	17.1634	4.3775	0.0001	Positive, significant
Panel B. Dependent variable: Export competitiveness (XC)				
Economic scale	0.0218	0.0078	0.0056	Positive, significant
ln Capital accumulation	-0.5392	0.1188	0.0000	Negative, significant
Labour quality	-0.0735	0.1021	0.4731	Not significant
ln Economic complexity	0.1474	0.0296	0.0000	Positive, significant
<i>Note: Estimates are based on 84 observations. Instruments: lnKA, HK, LK, lnEC, and constant. Significance is interpreted at conventional 1 percent, 5 percent, and 10 percent levels.</i>				

Table 5
Total Effects Based on the Reduced Form

Variable	Total effect on ES	Total effect on XC
In Capital accumulation	18.3099	-0.2283
Labour quality	17.7152	0.3007
Human capital	-2.7083	-0.0590
In Economic complexity	-1.1066	0.1474
Note: Total effects were calculated from the reduced-form transformation of the simultaneous equation estimates. The values summarise the combined direct and indirect effects, but their statistical significance is not reported because the standard errors and p-values for the total effects were not estimated separately.		

5. Discussion

The 3SLS results show that economic scale and export competitiveness in Eastern Indonesia are asymmetrically related. Economic scale, measured through labour productivity, strengthens non-oil export competitiveness, whereas export competitiveness does not significantly expand the economic scale. This finding supports the core argument of the new trade theory that productivity and efficiency improve competitiveness. It also shows that export expansion alone is insufficient when regional exports have weak backward linkages and limited value-added spillovers. The reduced-form total effects strengthen this interpretation by showing that indirect channels change the magnitude and direction of several variables, particularly capital accumulation and labour quality. Kim (2021) argues that economies of scale do not always generate stronger international performance when expansion creates inefficiencies or resource misallocations. Nourira and Saafi (2022) also show that export upgrading supports growth only when countries meet the threshold conditions related to human capital, institutional quality, and development capacity. Therefore, the asymmetric result in this study is theoretically plausible for Eastern Indonesia, where exports remain concentrated in resource-based sectors and industrial linkages are unevenly distributed.

The positive effect of economic scale on export competitiveness indicates that labour productivity is a key foundation of regional competitiveness. Higher productivity enables provinces to produce more output with available labour, reduce unit costs, and improve efficiency in meeting export demand. This finding is consistent with Casagrande et al. (2024), who show that export participation is closely associated with productivity improvement and capital intensity at the firm level. It also aligns with the economic fitness perspective proposed by Cervantes-Martínez and Villaseñor-Becerra (2023), which emphasises that competitiveness should be understood not only from gross export value but also from the domestic value-added capability embedded in production. The total-effect estimates also support this interpretation because the effect of labour quality on export competitiveness becomes positive after the indirect channel through economic scale is considered. For Eastern Indonesia, this implies that

export competitiveness will be stronger when production efficiency, local processing, and domestic value-added capture increase together.

Capital accumulation has a positive effect on the economic scale, confirming that investment remains important for expanding productive capacity. Capital allows firms and regions to improve infrastructure, adopt technology, increase production capacity, and reduce operational constraints. The total effect of capital accumulation on the economic scale is 18.3099, which is larger than its direct effect of 14.2617. This indicates that capital accumulation supports the economic scale both directly and indirectly through the export competitiveness channel. This result is in line with Xie et al. (2025), who found that financial agglomeration improves domestic value-added in exports by supporting industrial efficiency. This also supports Ngo et al. (2024), who argue that financial capability enables export-oriented firms to invest in innovation and market adaptation. He and Zeng (2024) further show that productive services and alleviation of financial constraints can improve export technological complexity. These studies support the finding that capital can strengthen the productive bases of regional economies.

However, capital accumulation has a negative relationship with export competitiveness. This result suggests that the problem is not the availability of capital itself, but rather the direction and quality of capital allocation. Investment may increase the production scale, but it may not improve RCA-based competitiveness if it flows mainly into extractive sectors, domestic-oriented activities, or low-complexity production. The total effect of capital accumulation on export competitiveness remains negative at -0.2283, although its magnitude is smaller than the direct effect of -0.5392. This means that the positive indirect effect through economic scale partly offsets the negative direct effect of capital accumulation on export competitiveness. Ferraz et al. (2021) emphasise that diversification and industrial policy are crucial for converting economic complexity into sustainable development. Mealy and Teytelboym (2022) show that advanced productive capabilities matter for moving into future-oriented sectors, while Cakir et al. (2021) argue that economic complexity must capture internal productive resilience, not only export volume. These arguments explain why capital expansion in Eastern Indonesia may enlarge production capacity without directly improving export competitiveness.

Labour quality improves the economic scale but does not directly strengthen the export competitiveness. This finding indicates that skilled labour contributes to labour productivity and regional production efficiency, but its effect on export performance remains limited when export structures are dominated by primary commodities and resource-based products. However, the total effect showed a more complete pattern. The total effect of labour quality on the economic scale increases from 17.1634 to 17.7152, while its total effect on export competitiveness changes from a negative direct coefficient of -0.0735 to a positive total effect of 0.3007. This suggests that labour quality can indirectly improve export competitiveness by strengthening the economy. Zhang et al. (2023) showed that human capital quality supports regional economic growth through productivity and structural changes. Casagrande et al. (2024) also highlighted that export-oriented firms require skilled labour to sustain productivity improvements. However, Ul-Haq et al. (2025) show that human capital improves export product diversification only when combined with technological innovation, foreign direct investment (FDI), and an

open trade policy. This supports the interpretation that labour quality in Eastern Indonesia requires stronger links with export diversification and industrial upgrading.

The negative relationship between human capital and economic scale indicates a possible mismatch between human development improvements and productive industrial needs. Human capital, as reflected by HDI, may improve education and health conditions; however, these improvements do not automatically generate higher labour productivity if regional industries are unable to absorb skilled workers or if production remains concentrated in low-technology sectors. The total-effect estimates show that human capital retains a negative effect on economic scale(-2.7083) and also has a negative total effect on export competitiveness(-0.0590) through the economic scale channel. This result does not imply that human capital weakens development in general. Instead, it suggests that human capital has not yet been fully absorbed into productive and export-oriented activities in Eastern Indonesia. Liu (2024) shows that FDI can accelerate human capital accumulation when it creates demand for skilled labour and higher returns to education. Ha (2023) also shows that digital business is linked to economic complexity, suggesting that human capital becomes more productive when it is connected to digital transformation and knowledge-based activities. Thus, the finding does not imply that human capital is unimportant. It indicates that human capital policy must be aligned with industrial structure, vocational skills, technology adoption, and export-oriented production systems.

Economic complexity positively affects export competitiveness, confirming that competitiveness depends on the sophistication and diversity of productive capabilities. The total effect of economic complexity on export competitiveness remains positive at 0.1474, confirming its central role in strengthening non-oil export competitiveness. However, the total effect of economic complexity on the economic scale is negative at -1.1066 through the export competitiveness channel. This result should be interpreted carefully because the direct effect of export competitiveness on the economic scale is statistically insignificant. Olasehinde-Williams and Oshodi (2021) show that economic complexity is a determinant of export competitiveness because it reflects the quality and capability of the products that a country can export. Török (2022) demonstrates that subnational economic complexity can be measured through the diversity and ubiquity of export products, making it relevant for regional-level analyses. Lădaru et al. (2024) also show that technical complexity helps explain export competitiveness in agri-food product markets. These studies support the finding that Eastern Indonesian provinces with stronger productive capabilities and more sophisticated export structures are more likely to achieve higher non-oil export competitiveness.

The role of economic complexity is especially important because Eastern Indonesia has abundant natural resources but relatively limited industrial diversification in the region. RCA may show that a province has a comparative advantage in specific commodities, but it does not necessarily show whether that advantage comes from a sophisticated productive capability or dependence on raw commodities. Leromain and Ore (2014) emphasised the importance of RCA in identifying revealed competitiveness, while Cervantes-Martínez and Villaseñor-Becerra (2023) showed that value-added-based approaches can provide deeper insights into international competitiveness. Wang et al. (2023)

further argued that trade diversification and economic complexity support green growth, whereas Yang et al. (2024) showed that digital trade strengthens export competitiveness through product quality and market access. These findings suggest that Eastern Indonesia must shift from commodity-based to capability-based competitiveness.

The discussion also shows that export competitiveness does not significantly increase economic scale because export activities may not generate strong local spillovers. This condition may occur when export sectors operate as enclaves, rely on raw commodity extraction, or have limited integration with local suppliers and small firms. The reduced-form results support this point because several total effects on economic scale are driven mainly by capital accumulation and labour quality, not by export competitiveness itself. Shabanov et al. (2021) argue that export-oriented regional development requires local processing capacity, innovation, and open regional systems. Ferraz et al. (2021) also emphasise that industrial policy must connect diversification with productive transformation. For Eastern Indonesia, export growth will contribute more strongly to economic scale when export industries are linked to local value chains, processing industries, logistics services, and technology-based supplier networks.

Overall, the findings suggest that regional export competitiveness in Eastern Indonesia is shaped mainly by labour productivity and economic complexity. Capital accumulation and labour quality strengthen the economic scale, but they do not automatically improve export competitiveness when investment allocation, industrial structure, and export sophistication remain weak. The total effect estimates refine this conclusion. Capital accumulation has a stronger total effect on the economic scale, but its total effect on export competitiveness remains negative. Labour quality becomes positive for export competitiveness after considering the indirect economic scale channel. Human capital also requires stronger integration with productive transformation because its total effect remains negative. Therefore, the main development challenge is not only to increase investment, labour quality, or export volume, but also to transform these factors into higher productivity, diversified export products, stronger domestic value chains, and more complex, productive capabilities. This interpretation is consistent with recent international literature that places economic complexity, digital capability, export upgrading, and productive diversification at the centre of sustainable export competitiveness.

The total-effect results should be interpreted as reduced-form calculations derived from simultaneous-equation estimates. They help explain the direct and indirect channels among variables but should not be treated as separate significance tests because standard errors and p-values for the total effects were not estimated separately.

6. Conclusion and Policy Implications

This study examines the relationship between economic scale and export competitiveness in Eastern Indonesia using a simultaneous equation framework estimated through 3SLS. Economic scale was measured using labour productivity, while export competitiveness was measured using RCA. The findings show an asymmetric relationship between the variables. Economic scale has a positive and

significant effect on export competitiveness, but export competitiveness does not significantly affect the economic scale. This indicates that higher labour productivity strengthens non-oil export competitiveness, whereas export performance alone does not automatically expand the regional economic scale.

The results also show that capital accumulation and labour quality improve economic scale. However, capital accumulation has a negative effect on export competitiveness, while labour quality does not have a significant direct effect on export competitiveness. This suggests that investment and skilled labour can increase regional productivity; however, they do not automatically improve export performance when regional economies remain concentrated in primary commodities, extractive sectors, and low-value-added activities. Human capital also shows a negative relationship with economic scale, indicating a possible mismatch between improvements in education and health indicators and the actual needs of regional industries.

Economic complexity has a positive effect on export competitiveness, showing that export performance depends on the sophistication, diversity, and value-added capacity of the regional production. Therefore, sustainable export competitiveness in Eastern Indonesia requires improved labour productivity, better capital allocation, technological upgrading, export diversification, downstream industrialisation, greater economic complexity, and closer alignment between human capital development and regional industrial requirements.

Policy strategies in Eastern Indonesia should focus on improving the quality and allocation of capital accumulation. Investment policy should direct capital toward productive and export-oriented sectors, such as value-added processing industries, export-oriented manufacturing, logistics facilities, cold-chain systems, product certification, and technology adoption. This direction is important to ensure that investment expansion improves labour productivity and supports stronger non-oil export competitiveness.

Labour productivity should be the main foundation of regional export competitiveness. Regional policy should strengthen production efficiency, reduce logistics costs, improve industrial infrastructure, and support technology-based production systems. Labour development also needs to be aligned with industrial needs through vocational education, technical training, digital skills, and industry-based certification. Skilled labour can improve the economic scale, but its contribution to export competitiveness will remain limited when export sectors are still dominated by primary commodities and low-value-added activities.

Human capital and export policies should be connected more directly to regional productive transformation. Human capital development should strengthen applied skills, technical capability, entrepreneurship, industrial research, and innovation capacity. At the same time, export policy should increase economic complexity through downstream industrialization, product upgrading, domestic value-chain development, and stronger linkages with local suppliers and small and medium-sized enterprises. Future research should include infrastructure quality, institutional quality, technological

innovation, foreign direct investment, logistics performance, industrial diversification, and spatial linkages to explain the relationship between economic scale and export competitiveness more comprehensively.

Declarations

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Authors' contributions

Djuanda Hatta was responsible for developing the study design, collecting the data, preparing the methodology, conducting the empirical analysis, and drafting the initial manuscript. Hamid Paddu provided guidance on the conceptual framework, supervised the research process, and reviewed the manuscript critically. Dwiana Sari Saudi contributed to the literature review, supported the interpretation of the findings, and helped refine the manuscript. Amanus Khalifah Fil'ardy Yunus reviewed the methodological aspects, contributed to the discussion section, and assisted with the final editing of the manuscript. All authors reviewed and approved the final version of the manuscript.

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Availability of data and materials

The data used in this study were obtained from publicly available provincial-level statistical and export data sources. The processed datasets and supporting materials are available from the corresponding author upon reasonable request.

Competing interests

The authors declare that they have no competing interests.

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Appendix A. Preliminary Estimates

Table A1
Reduced-form and 2SLS estimates

Model	Dependent variable	Variable	Coefficient	p-value
OLS reduced form	ES	In Capital accumulation	15.1215	0.0000
OLS reduced form	ES	Human capital	-2.3242	0.0018
OLS reduced form	ES	Labour quality	14.2448	0.0000
OLS reduced form	XC	In Capital accumulation	-0.2738	0.0004
OLS reduced form	XC	Labour quality	0.1695	0.0031
OLS reduced form	XC	In Economic complexity	0.1269	0.0000
2SLS	ES	Export competitiveness	-7.5077	0.4464
2SLS	ES	In Capital accumulation	14.2617	0.0001
2SLS	ES	Human capital	-2.7083	0.0047
2SLS	ES	Labour quality	17.1634	0.0003
2SLS	XC	Economic scale	0.0218	0.0079
2SLS	XC	In Capital accumulation	-0.5392	0.0000
2SLS	XC	Labour quality	-0.0735	0.4875
2SLS	XC	In Economic complexity	0.1474	0.0000

Note: Reduced-form and 2SLS estimates are reported as preliminary evidence supporting the main 3SLS results.

Figures

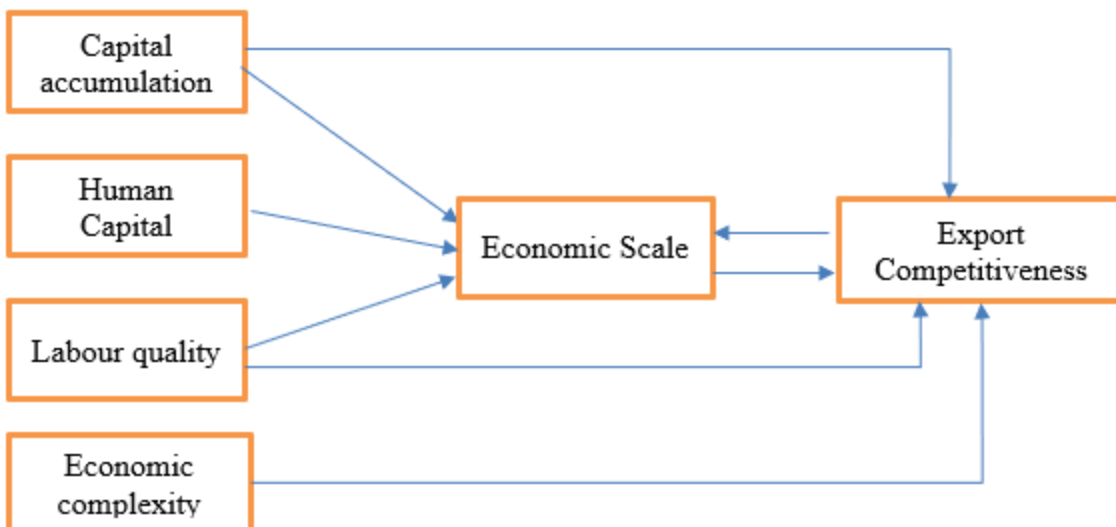


Figure 1

Conceptual framework

Source: Authors' conceptualisation.



Figure 2

Study Area, Eastern Indonesia

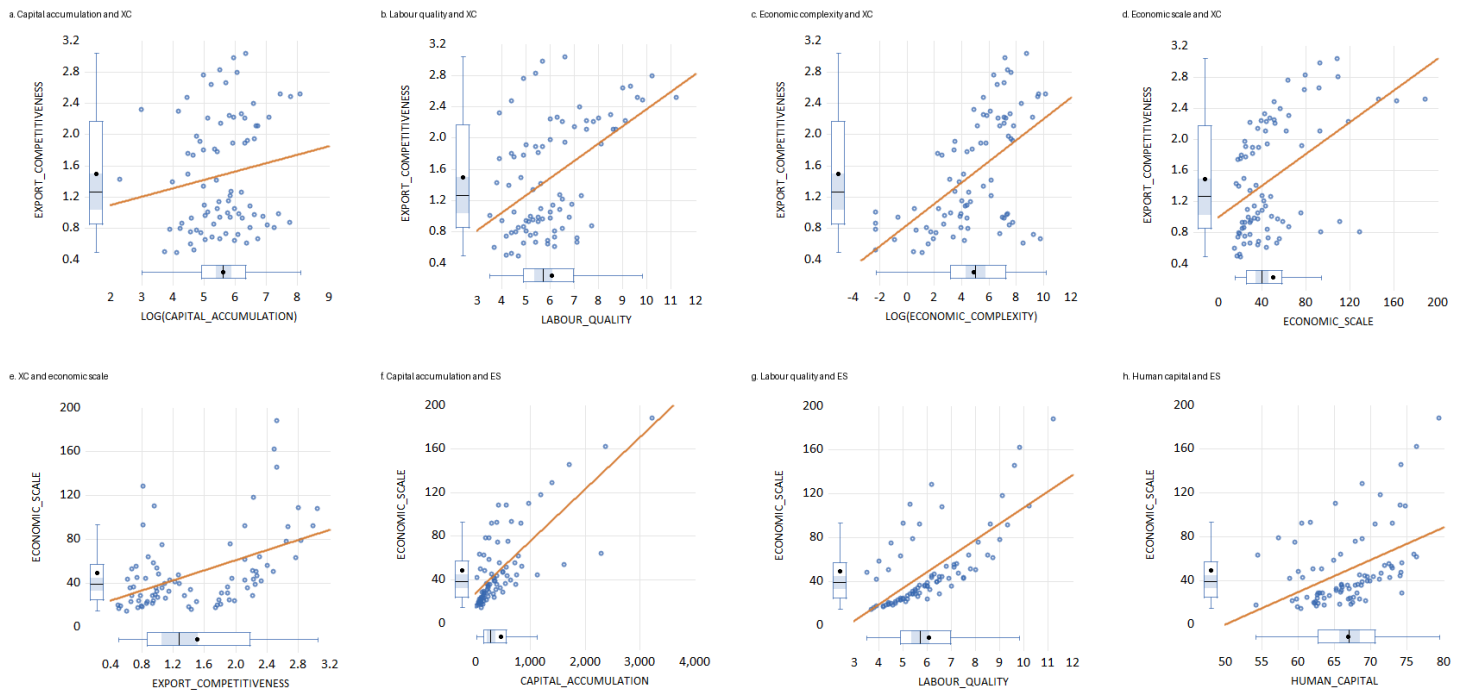


Figure 3

Bivariate relationships among core variables

Source: Authors' calculation based on provincial panel data.

Supplementary Files

This is a list of supplementary files associated with this preprint. Click to download.

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