KnE Social Sciences | The International Conference on Economic and Sustainable Development (ICESIDE) | KNE Publishing

Research Article

Backward and Forward Linkage Effects on Firm Survival: Evidence from East Java Large and Medium Manufacturing Survey

Rifai Afin*

Universitas Trunojoyo Madura, Indonesia

Abstract.

Firm survival in dynamic business environments is significantly influenced by the strength of a firm's intersectoral linkages. While the impact of backward linkages on firm performance has been widely studied, their effect on firm survival remains unclear, especially in emerging economies like Indonesia. This study investigates the effects of both backward and forward linkages on the survival of manufacturing firms in East Java, Indonesia, using a survival analysis approach coupled with Survival-time inverse-probability-weighted regression adjustment (STIPWRA). Analysis of enterprise-level large and medium industry survey data from 1995 to 2015 (published by the Central Bureau of Statistics (BPS)), complemented by Input-Output tables for 2000, 2005, 2010, and 2015, revealed that while backward linkages did not significantly impact survival, forward linkages had a positive and significant impact. Firms with strong forward linkages demonstrated greater resilience and longer survival times. These findings highlight the crucial role of forward-looking strategies, like cultivating strong customer relationships and market positioning, for the long-term sustainability of manufacturing firms. Policy implications center on fostering robust forward linkages through strategic investments in infrastructure, R&D, and workforce training to enhance the competitiveness of East Javan manufacturing enterprises.

Keywords: firm survival, backward linkages, forward linkages, survival analysis, Indonesia

Corresponding Author: Rifai Afin; email: rifaiafin22@gmail.com

Published: 19 February 2025

Publishing services provided by Knowledge E

Selection and Peer-review under the responsibility of the ICESIDE Conference Committee.

1. Introduction

dynamic and frequently unstable business environment, it is critical to comprehend the elements that support a firm's ability to survive. In this context, research on the idea of backward and forward links is essential. A firm's resilience and longevity are largely determined by these links, which stand for the ties and relationships a company has with its suppliers (backward linkages) and customers (forward linkages). Connections between industrial sectors can significantly impact productivity, as explored in several studies, including those by [NO_PRINTED_FORM] (1), [NO_PRINTED_FORM] (2), and [NO_PRINTED_FORM] (3). These studies examine how intersectoral ties function both backward and forward, emphasizing their role in facilitating productivity spillovers from

foreign to domestic companies. One important element that influences how well a company performs is its industrial relations with other sectors, both input-supporting sectors and pulling sectors, namely sectors that provide markets for the industry's output. Some of the benefits that can result from inter-sector relations include companies being able to increase their performance and survive longer in the market.

In June 2024, the S&P Global Indonesia Manufacturing PMI (Purchasing Manager's Index) fell from 52.1 in May to 50.7, marking the weakest performance since May 2023. This decline represented the third consecutive month of slowdown, despite factory activity increasing for the 34th straight month. Output growth was the slowest in 13 months while purchasing levels rose at the weakest pace since November 2022. New order growth also reached its lowest point in the current 13-month expansion sequence. Although job growth remained steady and backlogs of work decreased for the first time in seven months, overseas orders fell for the fourth consecutive month. Stable delivery times reflected the lack of demand pressure on supply systems. Input prices surged significantly due to higher costs for raw materials and diesel, compounded by a weak rupiah, yet overall inflation remained below the long-term average. Output prices continued to rise slightly. Despite a generally positive outlook, the level of optimism remained at its lowest point in the series' history, unchanged from May. (S&P Global).

This study aims to examine the impact of forward and backward linkages on the performance of manufacturing companies, specifically focusing on their survival. These linkages provide crucial support, significantly enhancing a company's ability to determine its market performance. Unlike previous studies, which have not explored the impact of these linkages on a company's survival, this research addresses this gap by offering several key contributions. First, this study investigates the effects of both forward and backward linkages on company survival, employing a survival analysis strategy. This approach contrasts with previous research that primarily examined the influence of inter-sectoral linkages on company performance without considering their direct impact on survival. By focusing on survival analysis, this study provides a more comprehensive understanding of how these linkages affect long-term viability. Second, the research treats backward and forward linkages between sectors as treatment variables within the context of impact evaluation. This innovative approach allows for a detailed analysis of how these linkages function as pivotal factors in the survival of manufacturing companies. The treatment variables are derived from meticulously tabulated input and output data, ensuring a robust and accurate evaluation. Overall, this study not only fills a significant gap in the existing literature but also offers practical

insights for manufacturing companies seeking to enhance their market performance and longevity through strategic linkages.

This paper is structured as follows: Chapter 2 reviews previous studies on the linkages between sectors and their impact on the performance of industrial sectors, both theoretically and empirically. Chapter 3 outlines the methodology, including a description of the data used and the estimation techniques or econometric models employed. Chapter 4 presents the estimation results and analysis, discussing the various implications. Finally, Chapter 5 offers the conclusions.

2. Literature Review

The results of studies related to the effects of backward and forward linkage on company performance have been widely conducted with various approaches and objects and the results are also diverse. Both backward and forward linkage have positive, negative, or no impact. The results of this study are summarized in Table 1.

3. Data and Methodology

3.1. Data

Some of the datasets used in this study include

a) Enterprise-level large and medium industry surveys from 1995 to 2015 (Published by the Central Bureau of Statistics (BPS)). This study uses individual company-level industry survey data of manufacturing companies. Every year BPS conducts a census of large and medium industries, and this makes it possible to find which companies are still there and which ones have left, and which companies are still operating in Indonesia so that survival analysis can be done properly. There are approximately more than 20,000-30,000 companies per year that are surveyed. These individual data per year are constructed into micro panel data that is used for analysis. There are about 600,000 observations in this study that will be used.

b) Input-Output (I-O) tables for 2000, 2005, 2010, and 2015 published by the Central Bureau of Statistics (BPS). I-O tables are needed to determine the interaction between economic sectors, especially sectors related to natural resources and industrial sectors. The target matrix classification used is 175 or more which includes a complete industrial sector of 2 digits or more. I-O Table updates between survey years are also considered

TABLE 1: Previous Studies of Backward and Forward Linkage Effects on Firm Performance.

Authors (s)	Country of Study	Backward Linkage Effect on Performance	Forward Linkage Effect on Firm Performance
[NO_PRINTED_FORM] (1)	Developing and emerging economies	+	Nothing
Suyanto & Sugiarti (2019)	Indonesia	+	+
[NO_PRINTED_FORM] (3)	Myanmar	+	+
Li & Tanna (2018)	China	+	+
[NO_PRINTED_FORM] (4)	French	+	+
Rahman & Sayeda (2016)	Bangladesh	+	+
[NO_PRINTED_FORM] (5)	Emerging Economies	+	Nothing
[NO_PRINTED_FORM] (6)	Urban West Africa	+	No
[NO_PRINTED_FORM] (7)	17 Transition Market Economies	+	No consistent
Ishengoma & Lokina (2013)	Tanzania	+	+
[NO_PRINTED_FORM] (8)	19 African countries	+	+
[NO_PRINTED_FORM] (9)	Vietnam	-	+
Vacek (2010)	Czech	+	Not stated
[NO_PRINTED_FORM] (10)	17 OECD countries	+	Nothing
Kadochnikov & Drapkin (2008)	Russia	+	Nothing
Girma & Pisu (2008)	UK	+	+
Tomohara & Yokota (2006)	Lithuania	+	Nothing
Thangavelu & Sanja (2006)	Indian	-	Nothing
Thangavelu & Pattnayak (2005)	Indian	-	+
Javorcik (2004)	Lithuania	+	Nothing
Alfaro & Clare (2004	Chile, Mexico, Venezuela and Brazil	+	nothing
Smarzynska (2002)	Lithuania	+	Nothing
[NO_PRINTED_FORM] (11)	Irish	+	Nothing
Sato (2000)	Indonesia	+	+
Matouschek, N. (1999)	Indonesia	+	Nothing
[NO_PRINTED_FORM] (12)	Ireland	+	Nothing
Martin (1986)	Finland	+	+
Lall (1978)	Least Developed Countries	+	+

for inclusion in the analysis. As the Input Output tabulation data is formed on a 5-yearly basis and the large and medium industry survey data is available on an annual basis, we have to interpolate the data between them to form annual input-output data.

c) World Development Indicators published by the World Bank. This data is used to complement the control variables of Indonesia's macroeconomic conditions as variables in the model estimation.

3.2. Empirical Design

To answer each of the previously mentioned research questions, several techniques were required:

3.2.1. Input Output Table Analysis

The purpose of using this technique is, first, to find out which sectors are directly related to the natural resources sector such as agriculture, plantations, marine, forestry, mining including oil and mining materials, and others. Classification for which industrial sector has the highest value with the natural resource sector. In addition, the use of this technique is to calculate Backward Linkage and Forward Linkage as the basis for selecting companies used for firm survival and productivity or efficiency analysis in the next stage. The BL and FL formulas can be written as follows:

$$BL_j = \frac{n \sum_{i=1}^{n} \alpha_{ij}}{\sum_{i=1}^{n} \sum_{j=1}^{n} \alpha_{ij}}$$

where αij is the Leontief inverse matrix element (I-A)-1 row i column j, Bj is the backward linkage (BL) index of sector j, and n is the number of sectors in the matrix. There are three categories of backward linkage indices, where BLj = 1 indicates that the backward linkage of sector j is equal to the average backward linkage of the whole economy; Bj > 1 indicates that the backward linkage of sector j is higher than the average backward linkage of the whole economy; and BLj < 1 indicates that the backward linkage of sector j is lower than the average backward linkage of the whole economy. However, Forward Linkage (FL), also known as forward linkage, can be formed as follows:

$$FL_i = \frac{n \sum_{j=1}^{n} \alpha_{ij}}{\sum_{i=1}^{n} \sum_{j=1}^{n} \alpha_{ij}}$$

where αij is the Leontief inverse matrix element (I-A)-1 row i column j, and n is the number of matrix sectors in the forward linkage index of sector i. There are three categories of forward linkage indices, where FLi = 1 indicates that the forward linkage of sector i is equal to the average forward linkage of all economic sectors; FLi > 1 indicates that the forward linkage of sector i is above the average forward linkage of all economic sectors;

and FLi < 1 indicates that the forward linkage of sector i is below the average forward linkage of all economic sectors. For forward linkages, the IO-F software accepts two types of estimates: the Rasmussen and Gosh approaches (13). From the calculation of BL and FL, we grouped (grouping or re-sampling) manufacturing companies that meet the criteria based on the amount of BL and FL with the primary sector (Natural Resource-Based Sector) for estimation in stage 2, namely estimation of company performance represented in efficiency/productivity and survival.

3.2.2. Evaluation Analysis of the Impact of Natural Resource Linkages on Firm Survival

This stage is conducted to see the effect of how natural resource linkages affect firm survival. The Quasi Experiment approach is used in this stage combined with survival analysis. Treatment effect of natural resource linkages formed from I-O analysis. The treatment effect of BL>1 and FL>1 is the focus even though the simulation will be carried out by the observed conditions and the grouping of companies in each sector that has been identified. The standard approach used in survival analysis is the Cox Proportional Hazard Model developed by(14,15) but in the case of this study where there are treatment variables analysed, a combination of survival analysis and treatment effect regression needs to be done and one of the techniques that are quite comprehensive in cases like this is Survival-time inverse-probability-weighted regression adjustment (STIPWRA) developed by [NO_PRINTED_FORM] (16). The Log-Likelihood function for the STIPWRA model can be written as follows:

$$L_{c,IPWRA}\left(t_i, w_i, \hat{\gamma}\right) = \overline{\omega}[c_i ln\left\{f_c\left(t_i|w_i, \hat{\gamma}\right)\right\} + \left(1 - c_i\right) ln\{1 - F_c\left(t_i|w_i, \hat{\gamma}\right\}]$$

Maximum Likelihood (ML) estimation of the parameter γ models the survival parameter for sensor time where $F_c(t_c|w, \gamma)$ is the distribution of sensor time. The contribution of each observation in ML is maximized by the following equation:

$$L_{p,ipwra}\left(\tau_i, z_i, \hat{\alpha}\right) = \overline{\omega}[\left(\tau_i == 1\right) ln\left\{p\left(z_i, \hat{\alpha}\right)\right\} + \left\{1 - \left(\tau_i == 1\right)\right\} ln\left\{1 - p\left(z_i, \hat{\alpha}\right)\right\}]$$

Where $p\left(z_i, \hat{\alpha}\right)$ is the probability model where observation i gets treatment level 1. Meanwhile, the steps for estimating the Average Treatment Effect (ATE) of natural resource linkages can be written generally as follows:

$$L_{ipwra}\left(t_i, x_i, \tau, \hat{\beta}_{ipwra,ate,\tau}\right) = \overline{\omega_i}\omega_{i,\tau} ln\{f\left(t_i|X_i, \tau, \hat{\beta}_{ipwra,ate,\tau}\right)\}$$

Therefore, the formula for calculating ATE in this study follows the following function:

$$1/N \sum_{i=1}^{N} \overline{\omega}\{\hat{E}\left(t_i|X_i, \tau = 1, \hat{\beta}_{ipwra,ate,1}\right) - \hat{POM}_{ipwra,0} - \hat{ATE}_{ipwra}\} = 0$$

Where POM (Potential Outcomes Model). ATE estimation for each group was conducted to see the analyzed treatment variables grouped by the magnitude of Backward and Forward Linkage (BL and FL). The logic is multi-step but is implemented as a single step by solving the estimation equations that define each step simultaneously. This one-step estimation equation approach provides consistent point estimates and consistent variance-covariance estimators (VCE); some references can be found in [NO_PRINTED_FORM] (17), [NO_PRINTED_FORM] (18), and [NO_PRINTED_FORM] (19). In this step I explain how the observed survival time outcomes are generated from the random censoring time tc, the received treatment τ, and the survival times of potential outcomes t0 and t1 under the WAC (Weighted Adjusted-Censoring) assumption First, each potential outcome is either censored or not can be written simply as follows:

$$\tilde{t}_0 = t_c\left(t_0 \geq t_c\right) + t_0\{1 - \left(t_0 \geq t_c\right)\}$$

$$\tilde{t}_1 = t_c\left(t_1 \geq t_c\right) + t_1\{1 - \left(t_1 \geq t_c\right)\}$$

Under the WAC assumption, tc is a random variable from a known distribution, and tc does not vary by treatment level. Furthermore, the received treatment $\tau \in \{0, 1\}$ determines which potential outcomes, which may be censored, are observed as follows:

$$t = (1 - \tau)\tilde{t}_0 + \tau\tilde{t}_1$$

In addition to the relationship with natural resources, this study also looks at how GVC (Global Value Chain) affects the survival of the company where GVC is calculated from the proportion of imports and exports to total inputs and outputs respectively (20). As for productivity or efficiency, it is based on the calculation of the estimated production function with the ACF approach (2015) to avoid bias in the calculation of efficiency and production values due to the endogeneity of inputs and outputs in the production function. The output used in this study is the total value of production and the calculated inputs include the number of labor both production and non-production, the amount of capital owned in the form of vehicles, buildings, land, and machinery, and raw materials, as well as energy including fuel, lubricants, and electricity used. In addition to these main variables, several other variables become controls in the estimation of the model, including the level of competition calculated from the Herfindahl-Hirschman

Index (HHI), Price Cost Margin (PCM) calculated using the [NO_PRINTED_FORM] (21) approach, company size (Size) used is total assets, investment status which is a dummy variable whether it is government, private or foreign-owned, the number of ownership percentages (percentage), inventory, as well as several additional macroeconomic variables such as economic growth, inflation, interest rates, and the rupiah exchange rate with the US dollar.

The variables used in the estimation are summarized in Table 2 below

Table 2: Operational Variables.

No	Variable	Description	Expected Sign	Literature
		Production Function		
1	Backward Linkage	Dummy variable where the value 1 means that BL is more than one and 0 if the BL value is less than or equal to 1.	Positive	Girma & Pisu (2008), Gorodnichenko, et al (2014), Falk (2015)
2	Forward Linkage	Dummy variable where the value 1 means that FL is more than one and 0 if the FL value is less than or equal to 1.	Positive	Girma & Pisu (2008), Gorodnichenko, et al (2014), Falk (2015)
3	Linkage	Dummy variable where the value 1 means that BL and FL are more than one and 0 if the FL and BL value are less than or equal to 1.	Positive	Girma & Pisu (2008), Gorodnichenko, et al (2014), Falk (2015)
		Firm Survival Model (Effect Variables on Hazard Ratio)		
5	Technical efficiency (TE)	Both the production and cost frontier approaches were computed using Stochastic Frontier Analysis (SFA). Technical efficiency is measured by the production function, and allocative efficiency is measured by the cost function. The scores run from 0 to 1, with 1 representing the firm's level of efficiency. We utilize the average efficiency score for each category of enterprises at the overall level.	Negative	Buddelmeyer et al (2006), Dimara et al (2008), Jitsutthiphakorn (2021)
6	Competition	Measured by Cost Price Margin (PCM) developed by Domowitz et al (1986) which can be formalized as follows: $PCM = \frac{Value\ of\ Sales+\Delta Invetories-Payroll-Cost\ of\ Materials}{Value\ of\ Sales+\Delta Inventories}$	Ambiguous	(Lopez et al 2017, Audretsch and Mahmood, 1995), (Suarez,1995, Utterback (1993)
		Herfindahl–Hirschman-Index		
7	Size	Total Assets of firms	Ambiguous	Lopez et al, 2017, Buddelmeyer et al (2006), Naz et al (2023), Agarwal 2001, Rodeiro-Pazos et al, (2021)
8	Openness	It is the sum of the percentage of exported output and imported input	Ambiguous	Topalova (2004), Wagner (2013), Kao and Liu (2022)
9	Government Ownership (CGO)	Percentage of central government ownership	Ambiguous	Qu and Harris (2018), Kubo and Phan (2019), and Nguyen et al (2022)

TABLE 2: Continued.

No	Variable	Description	Expected Sign	Literature
10	Foreign Ownership (FO)	Percentage of foreign ownership	Negative	Shaver et al. (1997), Alfaro and Chen (2012), Wagner and Gelübcke (2012)
11	Domestic	Investment status of the firm (Domestic Investment), dummy variable where 1 if the firm is domestic investment, 0 otherwise	Ambiguous	Mata and Portugal (2002), Kokko and Thang (2014)
12	Foreign	Foreign Investment, a dummy variable where 1 if the firm is foreign investment, 0 otherwise	Ambiguous	Mata and Portugal (2002), Kokko and Thang (2014)
13	Capacity	Percentage of capacity used in the production process	Negative	Lecraw (1978), Lieberman (1989), Nikiforos (2012), Ray (2021)
14	Inventory	Change of inventory of the firm	Ambiguous	Basu and Wang (2011), Bao (2004), and Lin et al (2022)
16	Growth	Economic growth (percent)	Negative	Buddelmeyer et al (2006), Klapper and Richmond (2011)
17	Growthvar	Economic growth variability (Growth Uncertainty). Measured by $growth = \left(\frac{growth - mean\ growth}{N}\right)^2$	Positive	Ghosal (2003), Arza et al (2019), Kumar 2023
18	HDI	Human Development Index	Negative	Acs et al (2007), Huggins et al (2017)
19	Inflation	Inflation measured by consumer price index changes in percent	Ambiguous	Wu and Zang (2001), Tarcom and Ujah (2023), Kumar (2023)
20	Inflationvar	Inflation variability. Measured by the same equation for calculating growthvar	Positive	Ghosal (2003), Arza et al (2019), Kumar 2023, and Yotzov et al (2023)
21	Lending Rate	Lending rate (Egbunike, 2018)	Ambiguous	Audretsch and Mahmood (1995), Buddelmeyer et al (2006) Guariglia et al (2015), Hambur and Cava (2018), and Lee and Werner (2022)
22	Dummy Crisis	This is a dummy variable for 1998 Economic Crisis the value is 1 from 1995 to 1998 and 0 from 1999 to 2015	Positive	Muzi et al (2023), and Özşuca (2023),

TABLE 3: Descriptive Statistics.

Variable	Obs	Mean	Std. dev.	Min	Max
Backward Linkage	58,797	0.922445	0.267472	0	1
Forward Linkage	58,797	0.563906	0.495903	0	1
Linkage	58,797	0.555522	0.496912	0	1
Domestic Firm Status	58,797	0.17489	0.379876	0	1
Foreign Firm Status	58,797	0.032604	0.177599	0	1
Total Assets	58,797	1.436.954	1.998.917	3.465.736	242.781
Price Cost Margin	58,793	0.198933	2.932.011	-3.657.482	5.308.741
Herfindahl-Hirschman Index	58,780	0.25411	0.096443	0.2001777	0.962488
Openness	58,797	1.185.538	2.986.407	0	200
Capacity	58,797	6.230.056	3.880.702	0	950
Change Inventory	58,797	1.13E+07	1.20E+09	-6.42E+10	1.77E+11
Foreign Percentage Ownership	58,797	3.438.598	1.721.702	0	100
Government Percentage Ownership	58,797	1.400.642	115.752	0	100
Size	58,797	1.326.061	8.257.686	0	41374
HDI	58,797	0.666074	0.019802	0.632	0.695
Inflation	58,797	686.837	2.563.333	42.795	1.310.867
Inflation Variability	58,797	0.71124	0.095337	0.4858779	0.811977
Growth	58,797	5.634.572	0.565699	4.628.871	6.345.022
Growth Variability	58,797	0.741209	0.03254	0.7072928	0.818772

4. Results and Analysis

4.1. Estimation Results

The estimation results using the IPWRA estimation technique are summarized in Table 4 Estimation is done with 3 models, namely the Backward Linkage Model, Forward Linkage, and Linkage Model. The Backward linkage model estimates the effect of backward linkage as a treatment variable, while the Forward Linkage Model replaces the position of Backward with forward linkage as a treatment variable. while Model 3 uses the treatment linkage variable. The estimation results show that backward linkage has no significant effect on company survival. This is shown in the ATE (Average Treatment Effect) coefficient of 2.52 with a Robust standard error of 5.023 not showing significance at probabilities of 1, 5, and 10 percent. This means that the greater value of backward

linkage or backward industrial linkage does not have a significant role in increasing the likelihood of company survival. Several things can cause this to happen.

Relationships between a company and its suppliers or upstream industries (Backward Linkages). For a variety of reasons, the impact of backward linkages on business performance may not be substantial. First, suppliers' inputs can differ greatly in terms of both quality and price. Regardless of how strong the backward linkage is, low-quality or overpriced inputs might have a detrimental effect on the success of the company. High reliance on a small number of suppliers can also be dangerous. The business may have serious setbacks if suppliers experience problems like production delays, pricing increases, or supply chain interruptions. Furthermore, a corporation may not experience meaningful innovation if it has backward linkages. Instead of coming from suppliers, corporate R&D or partnerships with businesses in the same sector are frequently the source of innovation. The advantages of strong backward links may be outweighed by the competitive environment and general market dynamics in the firm's industry. The performance of a corporation is significantly influenced by market demand, competition, and client preferences. Furthermore, policies and regulations have a greater impact on a firm's success than do reverse relationships. Regardless of supplier ties, tariffs, trade regulations, and regulatory requirements can affect costs and operations.

Other strategic areas that a company may value more than backward links include forward linkages (relationships with customers), internal efficiencies, market expansion, and innovation. The effect of backward connections on performance may be lessened by this emphasis. In certain sectors of the economy, backward links may be less significant by nature. For example, supply chain management may not be as important in high-tech sectors as innovation and technological advancement. Finally, businesses in increasingly international environments frequently have diverse supply chains dispersed throughout various geographical areas. The influence of backward linkages from a single supplier or location can be lessened by this diversification. Backward links are crucial for maintaining a consistent flow of inputs, but they may have less of an immediate effect on a company's performance than other elements that promote efficiency, growth, and competitive advantage (22)

On the other hand, forward linkages have a significant influence on the survival of large and medium manufacturing companies in Indonesia. This is evidenced by a variable coefficient of 0.114 with a standard error of 0.049. It can be concluded that a forward linkage value above 1 indicates a positive impact on a company's survival. Therefore, the greater the forward linkage of a company, the higher the likelihood of its

continued survival.cox Forward links improve many parts of operations and the market, which greatly increases business survival. By building

TABLE 4:

Backward Linkage Effect			Forward Linkage Effect			Backward and Forward Linkage		
Survival Time	Coef.	Robust std. err.	Survival Time	Coef.	Robust std. err.	Survival Time	Coef.	Robust std. err.
ATE Backward Linkage (1 vs 0)	-2.521	5.023	ATE Forward Linkage (1 vs 0)	0,114**	0,049	ATE Linkage (1 vs 0)	0,086*	0,049
Pomean blt	16,06**	5.023	Pomean flt	13,45***	0,037	Pomean linkage	13,46***	0,037
OME0			OME0			OME0		
Domestic	0,181***	0,011	domestic	0,197***	0,006	domestic	0,196***	0,006
Percentage of Foreign Ownership	0,071*	0,037	foreign	0,151***	0,016	foreign	0,146***	0,015
Total Asset	0,018***	0,003	lva	0,016***	0,001	lva	0,016***	0,001
Price Cost Margin	-0,002***	0,001	pcm	-0,00009**	0,023	pcm	-0,00009***	0,00003
Herfindahl-Hirschman index	0,140	0,091	hhi5_output	-0,051**	0,023	hhi5_output	-0,044**	0,022
Openness	0,0002	0,0002	openness	0,0003***	7,19E-05	openness	0,0003***	0,00007
Capacity	0,0003**	0,0001	capasity	0,0009***	0,00008	capasity	0,0008***	0,00008
Change in Inventory	-2,81E-12***	8,04E-13	dinventory	-5,07E-13	7,77E-13	dinventory	-5,07E-13	7,72E-13
Foreign Status	0,0001	0,0003	dasing	-0,0005**	0,0001	dasing	-0,0005**	0,0001
Government Status	0,0011***	0,0003	dpusat	0,0006***	0,0001	dpusat	0,0006***	0,0001
Java	0	(omitted)	java	0	(omitted)	java	0	(omitted)
Size	0,00001**	3,75E-06	sizebig	0,00002***	4,07E-06	sizebig	1,69E-05***	3,92E-06
HDI	-5.434***	0,629	hdi	-4,628***	0,283	hdi	-4,537***	0,276
Inflation	0,364***	0,098	inflation	-0,056*	0,032	inflation	-0,059*	0,032
Inflation Variability	9.767***	2.623	inflationvar	-1,427*	0,842	inflationvar	-1,512*	0,841
Growth	-0,030**	0,013	growth	-0,049***	0,006	growth	-0,046***	0,006
Growth Variability	0	(omitted)	growthvar	0	(omitted)	growthvar	0	(omitted)
Lending Rate	-0,083***	0,015	lr	-0,020***	0,005	lr	-0,018***	0,005
Dummy Crisis	0	(omitted)	dcrisis	0	(omitted)	dcrisis	0	(omitted)
Constant	-2.178	2.184	_cons	7.412***	0,724	_cons	7,396***	0,721
OME0_lnshape			OME0_lnshape			OME0_lnshape		
_cons	0,934***	0,012	_cons	0,911***	0,005	_cons	0,914***	0,005
OME1			OME1			OME1		
domestic	0,180***	0,004	domestic	0,170***	0,005	domestic	0,170***	0,005
foreign	0,141***	0,009	foreign	0,129***	0,011	foreign	0,130***	0,011

TABLE 4: Continued.

Backward Linkage Effect			Forward Linkage Effect			Backward and Forward Linkage		
lva	0,019**	0,001	lva	0,023***	0,001	lva	0,023***	0,001
pcm	-0,00001	7,66E-05	pcm	8,17E-05	6,59E-05	pcm	0,00009	0,00006
hhi5_output	-0,062***	0,017	hhi5_output	-0,095**	0,024	hhi5_output	-0,100***	0,024
openness	0,0001**	4,94E-05	openness	6,42E-05	6,49E-05	openness	0,00007	0,00007
capasity	0,0009***	0,00006	capasity	0,0007***	7,77E-05	capasity	0,0007***	0,00008
dinventory	-5,36E-13	1,19E-12	dinventory	-3,25E-12**	9,72E-13	dinventory	-3,25E-12**	9,86E-13
dasing	-0,0005***	9,32E-05	dasing	-0,0005***	0,0001	dasing	-0,0005***	0,0001
dpusat	0,0009***	6,54E-05	dpusat	0,001***	7,99E-05	dpusat	0,001***	0,00008
java	0	(omitted)	java	0	(omitted)	java	0	(omitted)
sizebig	0,00001***	2,39E-06	sizebig	4,39E-06**	2,21E-06	sizebig	4,02E-06*	2,26E-06
hdi	-2,992***	0,194	hdi	-2,258***	0,247	hdi	-2,117***	0,253
inflation	-0,015	0,022	inflation	0,037	0,028	inflation	0,039	0,029
inflationvar	-0,325	0,573	inflationvar	1,116	0,747	inflationvar	1.169	0,750
growth	-0,024***	0,004	growth	-0,008	0,005	growth	-0,006	0,006
growthvar	0	(omitted)	growthvar	0	(omitted)	growthvar	0	(omitted)
lr	-0,015***	0,003	lr	-0,020***	0,004	lr	-0,019***	0,005
dcrisis	0	(omitted)	dcrisis	0	(omitted)	dcrisis	0	(omitted)
_cons	5,032***	0,508	_cons	3,114***	0,677	_cons	2,928***	0,680
OME1_lnshape			OME1_lnshape			OME1_lnshape		
_cons	0,884***	0,003	_cons	0,870***	0,005	_cons	0,868***	0,005
TME1			TME1			TME1		
domestic	-0,137**	0,044	domestic	0,148***	0,025	domestic	0,128***	0,025
foreign	0,238*	0,113	foreign	0,490***	0,067	foreign	0,455***	0,067
lva	-0,050***	0,010	lva	0,067***	0,005	lva	0,071***	0,005
pcm	-0,0001	0,0002	pcm	-0,0003	0,0002	pcm	-0,0003	0,0002
hhi5_output	1.825***	0,174	hhi5_output	0,256**	0,085	hhi5_output	0,208**	0,085
openness	0,004***	0,0006	openness	0,0001	0,0003	openness	0,0003	0,0003
capasity	-0,0004	0,0005	capasity	-0,001***	0,0002	capasity	-0,001***	0,0002
dinventory	-1,01E-11	7,55E-12	dinventory	-7,09E-12	7,34E-12	dinventory	-6,86E-12	7,30E-12
dasing	-0,0066***	0,001	dasing	-0,002**	0,0007	dasing	-0,002***	0,0007
dpusat	0,005**	0,002	dpusat	0,0007	0,0008	dpusat	0,0008	0,0008
java	0	(omitted)	java	0	(omitted)	java	0	(omitted)
sizebig	3,13E-06	1,64E-05	sizebig	-4E-05**	1,22E-05	sizebig	-0,00004 **	0,00001
_cons	2.758***	0,151	_cons	-0,720***	0,078	_cons	-0,791***	0,078

Simulations are also conducted to determine whether a company belongs to the leading sector, defined as a sector with backward and forward linkages greater than 1. The estimation results, presented in Table 4, indicate that companies in the leading sector have a higher likelihood of survival compared to those in non-leading sectors. This conclusion is supported by a coefficient of 0.08, with an average control period of 13.46 years. The leading sector's robust backward and forward linkages contribute to better access to high-quality inputs and stronger relationships with customers and distributors. These factors enhance operational efficiency, market responsiveness, and innovation capacity, thereby improving the overall resilience and longevity of firms. Additionally, firms in the leading sector benefit from diversified risk, stable revenue streams, and a stronger market position, further contributing to their higher survival rates. We find that the estimation results show that both forward and total effect linkages have a relative impact on the survival age of the firm. Trusting connections with distributors, retailers, and end users, they assist businesses in expanding their market reach and boosting sales and profits. Businesses can better satisfy market demands by adjusting their products and services based on direct feedback from customers via forward connections, which increases customer happiness and loyalty. Furthermore, forward links provide value addition using enhanced branding, packaging, and marketing tactics, which distinguish products in the marketplace and raise profit margins.

Strong forward links enable efficient supply chains that save costs and guarantee on-time product delivery, preserving competitive advantage and customer satisfaction. Working together with downstream partners helps businesses remain ahead of the competition and adapt to changing market conditions by fostering innovation in marketing tactics and product development. By reducing reliance on a single market and clientele, forward links also reduce risk by guarding against changes in the market and recessions. Robust forward connections and a strong brand reputation draw in additional partners, investors, and customers, which promotes long-term stability and growth. With forward linkages enabling them to create trends and have access to industry knowledge, businesses can anticipate changes in the market and make well-informed strategic decisions. Maintaining operations and funding future expansion plans require a steady flow of income, which is ensured by dependable and regular forward links. By utilizing these benefits, companies with strong forward links are more likely to survive and thrive in competitive markets.

4.2. Assumption Test

The regression treatment effect estimate has 2 underlying assumptions, including balance (Because treatment assignment is independent of covariates due to study design, covariates are balanced in experimental data. On the other hand, since treatment assignment is connected to the covariates that also influence the outcome of interest, variables in observational data need to be balanced through weighing or matching) and overlap (It asserts that there is a positive probability that every person will receive every level of treatment.). Therefore, this study also includes the results of these two tests for each model used. The estimated density of the predicted probabilities that a firm with more than one backward linkage is a firm with more than one backward linkage, as well as the estimated density of the predicted probabilities that a firm with less than or equal to one backward linkage is a firm with those values of backward linkage, are shown in the graph. This also pertains to linkage variables and forward linkage. In addition, the two estimated densities have the majority of their respective masses in places where they overlap, and neither figure shows an excessive amount of probability mass near 0 or 1. Therefore, there is no proof that the overlap assumption is not being met.

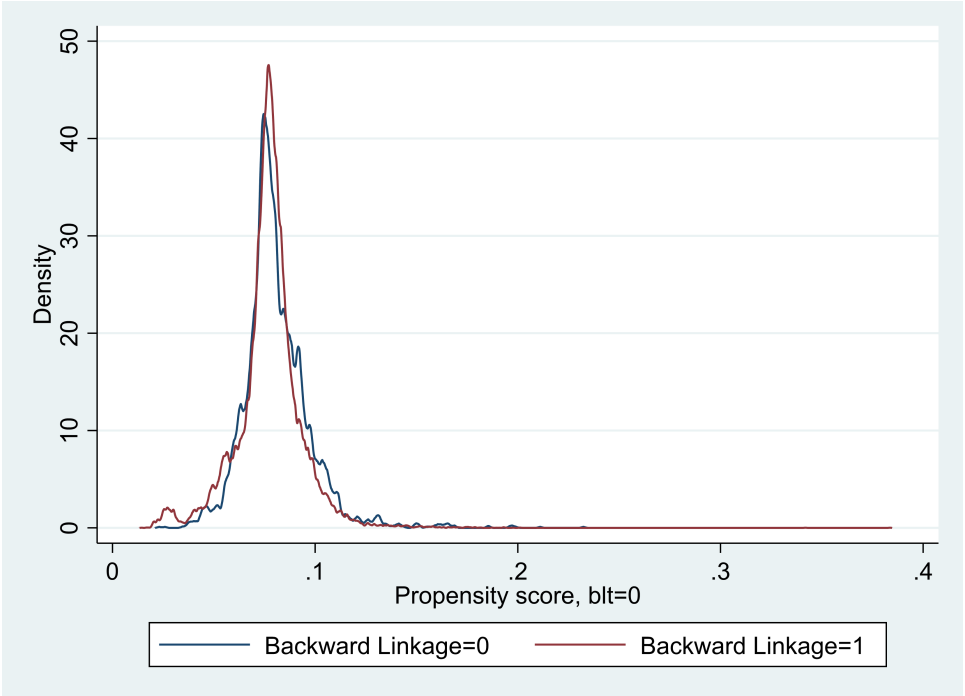

Figure 1: Overlap Test for Backward Linkage Model.

The second test is the balance test in this test, A perfectly balanced covariate has a standardized difference of zero and variance ratio of one. The results in table 5 show that

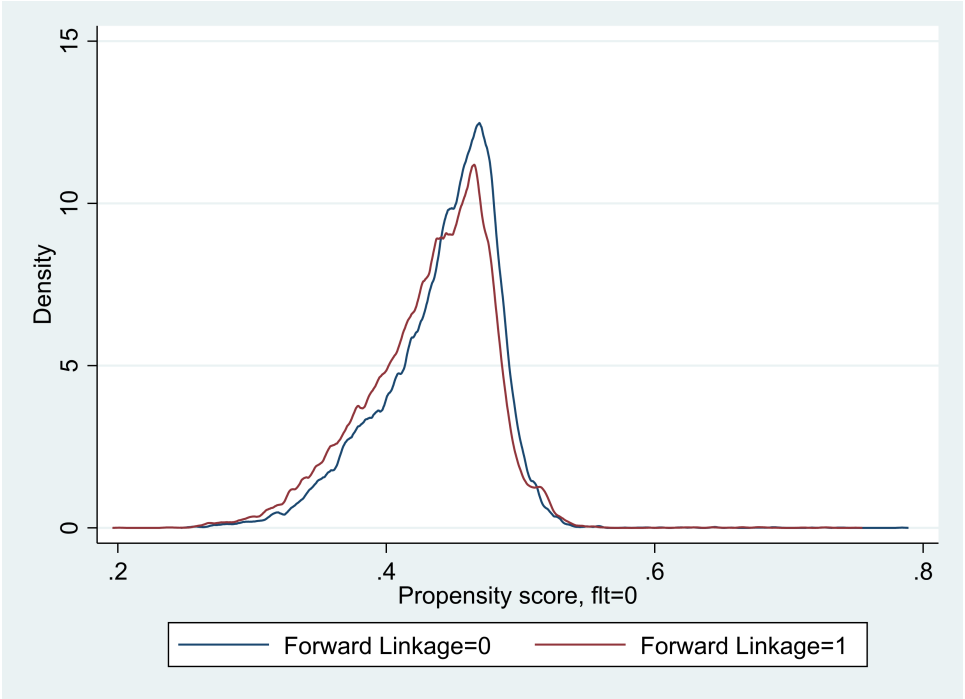

Figure 2: Overlap Test for Forward Linkage Model.

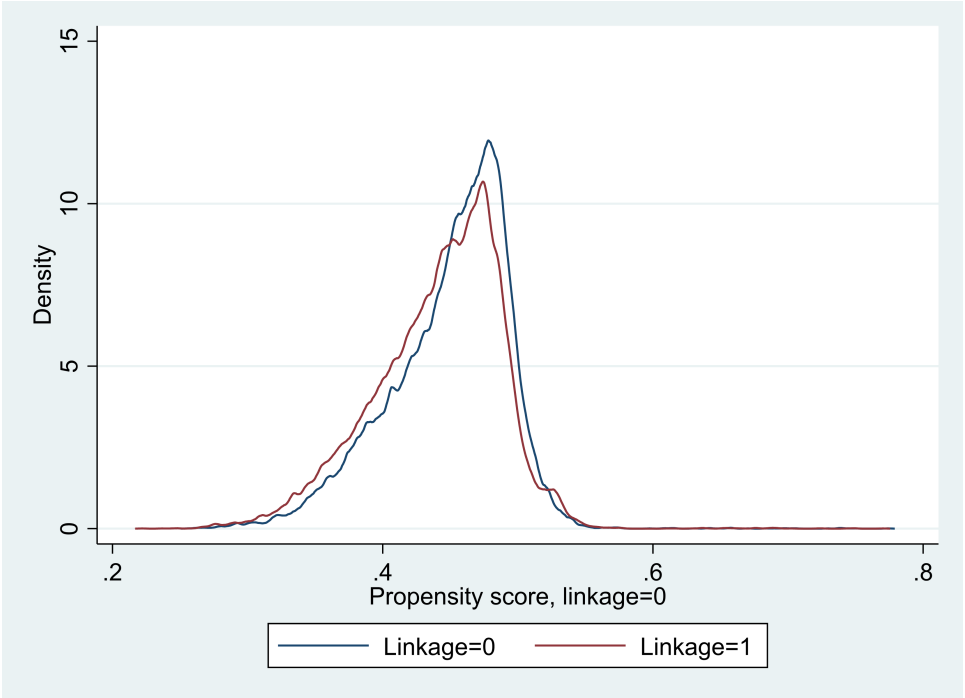

Figure 3: Overlap Test for Linkage Model.

several variables in the backward and forward linkage models are likely not balanced because they have a value of less than 1.

TABLE 5: Balance Test Results.

Variable	Standardized Differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
Backward Linkage				
Domestic Status	-0.0691462	-0.0026292	0.8941577	0.99552
Foreign Status	-0.0150369	-0.0075481	0.9250571	0.961479
Total Asset	-0.0970858	0.0099204	0.8033264	0.867357
Price Cost Margin	-0.0042303	-0.0062879	8.525.659	7.249.045
Herfindahl Hirschman Index	0.1691182	0.0667557	2.948.665	2.177.364
Openness	0.056071	-0.0031296	1.119.481	0.913976
Capacity	-0.0002803	0.0019296	0.5881448	0.656323
Inventory Change	-0.021643	-0.0050826	0.4782983	1.716.139
Percentage of Foreign Ownership	-0.0690572	-0.0050253	0.7269632	0.975942
Percentage of Government Ownership	0.0423769	0.0007066	1.571.352	1.044.458
Size	-0.0314741	0.0013557	0.7438108	1.127.799
Forward Linkage				
Domestic Status	0.096646	-0.000231	1.183.091	0.999605
Foreign Status	0.0785049	-0.0004554	15.314	0.997608
Total Asset	0.1563667	-0.0016606	1.039.895	0.955666
Price Cost Margin	-0.0079436	-0.0028436	0.530602	0.715452
Herfindahl Hirschman Index	0.0170888	0.0027697	1.095.776	1.061.039
Openness	0.0630619	-0.0011169	1.070.972	0.910448
Capacity	-0.0659153	0.0026189	1.112.817	1.417.144
Inventory Change	-0.0061703	-0.0008756	0.6286873	1.238.525
Percentage of Foreign Ownership	0.0463636	-0.0012779	1.233.223	0.982424
Percentage of Government Ownership	0.0345911	-1.25E-03	1.345.658	0.999558
Size	0.0199767	-2.07E-06	1.234.756	2.028.258
Linkage Model				
Domestic Status	0.0930974	-0.000297	1.175.376	0.999492
Foreign Status	0.0748925	-0.0003108	1.499.171	0.998366
Total Asset	0.1610853	-0.0016441	104.458	0.959585
Price Cost Margin	-0.007533	-0.002582	0.5486005	0.722879
Herfindahl Hirschman Index	0.0123883	0.0023153	1.112.847	1.095.687
Openness	0.0658856	-0.0010228	1.083.352	0.915208
Capacity	-0.0674872	0.0027254	1.084.404	1.386.311
Inventory Change	-0.0059129	-0.0008986	0.6504437	1.230.479
Percentage of Foreign Ownership	0.0437716	-0.0010854	1.217.012	0.983832
Percentage of Government Ownership	0.0353852	-0.0011578	1.360.046	100.469
Size	0.0198817	0.0009055	1.234.013	2.126.399

Table 6:

Variable	Standardized Differences		Variance ratio	
	Raw	Weighted	Raw	Weighted
Domestic	0.096646	-0.000231	1.183.091	0.999605
Foreign	0.0785049	-0.0004554	15.314	0.997608
Total Asset	0.1563667	-0.0016606	1.039.895	0.955666
Price Cost Margin	-0.0079436	-0.0028436	0.530602	0.715452
Herfindahl Hirschman Index	0.0170888	0.0027697	1.095.776	1.061.039
Openness	0.0630619	-0.0011169	1.070.972	0.910448
Capacity	-0.0659153	0.0026189	1.112.817	1.417.144
Inventory Change	-0.0061703	-0.0008756	0.6286873	1.238.525
Percentage of Foreign Ownership	0.0463636	-0.0012779	1.233.223	0.982424
Percentage of Government Ownership	0.0345911	-1.25E-03	1.345.658	0.999558
Size	0.0199767	-2.07E-06	1.234.756	2.028.258

5. Conclusion

This study aims to see how the impact of backward and forward linkages in influencing the survival of manufacturing companies in Indonesia, especially in East Java. The results show that backward linkage does not affect the survival of the company. However, forward linkages significantly affect the leading sector. The study's conclusions have important policy ramifications for Indonesia's industrial and economic plans, especially in East Java. Strengthening forward linkages should be a top priority for policymakers as they have been shown to have a major impact on the survival of leading sectors. This could entail making investments in infrastructure, technology, and logistics to ensure that industries that provide goods and services to important manufacturing sectors are well-integrated into the supply chain. Subsidies, tax breaks, or grants for research and development could be used as targeted support for businesses that have strong forward connections in order to encourage economic growth and stability. Furthermore, it is critical to create a trained labor force through higher education and vocational training programs that is suited to the demands of these industries. Promote research and development (R&D) and innovation to assist these sectors in maintaining their competitiveness through partnerships, investment, and the establishment of innovation hubs. Growth prospects can be further improved by policies that seek to increase market access through trade agreements, export incentives, and involvement

in international commerce. These policies will be continuously observed and assessed to make sure they are working and to help with any necessary revisions. Even while the study suggests that backward links may not have a direct effect on a company's ability to survive, they should nevertheless be encouraged in order to upstream industry development and sustain a stable supply chain, which would strengthen the industrial ecosystem as a whole. By improving the competitiveness and survival of East Javan manufacturing enterprises, this strategic emphasis on forward connections can lead to wider economic gains.

References

[1] Jordaan JA, Douw W, Qiang Z. Multinational Corporation Affiliates, Backward Linkages, and Productivity Spillovers in Developing and Emerging Economies: Evidence and Policy Making. In: Policy Research working paper [Internet]. 2020 [cited 2025 Jan 4]. Available from: https://documents.worldbank.org/pt/publication/documents-reports/documentdetail/302481598274482747/multinational-corporation-affiliates-backward-linkages-and-productivity-spillovers-in-developing-and-emerging-economies-evidence-and-policy-making

[2] Takii S, Narjoko D. FDI forward linkage effect and local input procurement: Evidence from Indonesian manufacturing. The Effects of Globalisation on Firm and Labour Performance [Internet]. 2020 Nov 30 [cited 2025 Jan 4];62–80. Available from: https://www.taylorfrancis.com/chapters/edit/10.4324/9781003050902-4/fdi-forward-linkage-effect-local-input-procurement-sadayuki-takii-dionisius-narjoko

[3] Win MMK, Kakinaka M. Firm performance and backward and forward linkages: the case of the garment sector in Myanmar. Asia-Pacific Journal of Accounting & Economics [Internet]. 2022 Mar 4 [cited 2025 Jan 4];29(2):523–46. Available from: https://www.tandfonline.com/doi/abs/10.1080/16081625.2019.1600415

[4] Ben Hassine H, Boudier F, Mathieu C. The two ways of FDI R&D spillovers: evidence from the French manufacturing industry. Appl Econ [Internet]. 2017 May 28 [cited 2025 Jan 4];49(25):2395–408. Available from: https://www.tandfonline.com/doi/abs/10.1080/00036846.2016.1240345

[5] Falk M. The Relationship Between FDI Through Backward Linkages and Technological Innovations of Local Firms: Evidence for Emerging Economies. East Europ Econ [Internet]. 2015 Sep 3 [cited 2025 Jan 4];53(5):424–38. Available from: https://www.tandfonline.com/doi/abs/10.1080/00128775.2015.1065507

[6] Böhme MH, Thiele R. Informal-formal linkages and informal enterprise performance in urban West Africa. European Journal of Development Research [Internet]. 2014 Aug 7 [cited 2025 Jan 4];26(4):473–89. Available from: https://link.springer.com/article/10.1057/ejdr.2014.26

[7] Gorodnichenko Y, Svejnar J, Terrell K. When does FDI have positive spillovers? Evidence from 17 transition market economies. J Comp Econ. 2014 Dec 1;42(4):954–69.

[8] Görg H, Ruane F, Görg H, Ruane F. An Analysis of Backward Linkages in the Irish Electronics Sector. Econ Soc Rev (Irel) [Internet]. 2000 [cited 2025 Jan 4];31(3):215–35. Available from: https://EconPapers.repec.org/RePEc:eso:journl:v:31:y:2000:i:3:p:215-235

[9] Anwar S, Nguyen LP. Foreign direct investment and export spillovers: Evidence from Vietnam. International Business Review. 2011 Apr 1;20(2):177–93.

[10] Bitzer J, Geishecker I, Görg H. Productivity spillovers through vertical linkages: Evidence from 17 OECD countries. Econ Lett. 2008 May 1;99(2):328–31.

[11] Görg H, Ruane F. Multinational Companies and Linkages: Panel-Data Evidence for the Irish Electronics Sector. Int J Econ Bus [Internet]. 2001 [cited 2025 Jan 4];8(1):1–18. Available from: https://www.tandfonline.com/doi/abs/10.1080/13571510151075215

[12] Görg H, Ruane F. Linkages between Multinationals and Indigenous Firms: Evidence for the Electronics Sector in Ireland. 1998;

[13] Miller RE, Blair PD. Input-Output Analysis Foundations and Extensions Second Edition. Second Edition. CAMBRIDGE UNIVERSITY PRESS; 2009.

[14] Cox DR. Regression Models and Life-Tables. J R Stat Soc Series B Stat Methodol [Internet]. 1972 Jan 1 [cited 2025 Jan 4];34(2):187–202. Available from: https://dx.doi.org/10.1111/j.2517-6161.1972.tb00899.x

[15] Cox DR. Partial likelihood. Biometrika [Internet]. 1975 Aug 1 [cited 2025 Jan 4];62(2):269–76. Available from: https://dx.doi.org/10.1093/biomet/62.2.269

[16] Wooldridge JM. Inverse probability weighted estimation for general missing data problems. J Econom. 2007 Dec 1;141(2):1281–301.

[17] Newey WK. A method of moments interpretation of sequential estimators. Econ Lett. 1984 Jan 1;14(2–3):201–6.

[18] Wooldridge JM. Econometric Analysis of Cross Section and Panel Data, Second Edition. 2010;

[19] Drukker DM. Using gmm to solve two-step estimation problems [Internet]. 2014 [cited 2025 Jan 4]. Available from: https://blog.stata.com/2014/12/08/using-gmm-to-solve-two-step-estimation-problems/

[20] Korwatanasakul U, Paweenawat S. Trade, Global Value Chains, and Small and Medium-Sized Enterprises in Thailand: A Firm-Level Panel Analysis. 2020 May 11 [cited 2025 Jan 4];(1130). Available from: https://www.adb.org/publications/trade-global-value-chains-and-sme-thailand-firm-level-panel-analysis

[21] Domowitz I, Hubbard RG, Petersen BC. Business Cycles and the Relationship between Concentration and Price-Cost Margins. Rand J Econ. 1986 Spring;17(1):1.

[22] Rodríguez-Clare A. Multinationals, Linkages, and Economic Development. Am Econ Rev [Internet]. 1996 [cited 2025 Jan 4];86(4):852–73. Available from: https://www.jstor.org/stable/2118308