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Causal Connectivity in Emerging Economies: Insights from Bangladesh's FDI, Financial Development, and Trade

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Abstract

Foreign Direct Investment (FDI) is considered to be a vital source of external finance for lower-middle-income countries, such as Bangladesh. Although the existing literature predominantly focuses on the causal relationship between FDI and economic growth, this study advances a discourse by examining the dynamic interdependencies among FDI, financial sector development, and trade openness within a cointegration and error-correction framework. Applying a Vector Error Correction Model (VECM) on data from 1972 to 2017, the analysis reveals a long-horizon relationship between the variables observed under the error correction mechanism, although no short-run causality is observed. The results show a positive association between the exchange rate and financial development, but a negative relationship between trade openness and FDI. These findings suggest that while a developed financial sector can enhance the benefits of FDI, trade openness alone may not be sufficient to attract FDI. The study offers valuable guidance for policymakers and investors by highlighting the strategic importance of macroeconomic factors in attracting FDI.

Keywords: *FDI · financial development · trade openness · VECM · Block Exogeneity*

JEL Classification: *F21 · G21 · P45*

1. Introduction

Bangladesh is regarded as one of the Next Eleven (N-11) economies, a classification introduced by Goldman Sachs to highlight countries with strong long-term growth prospects. This group comprises 11 nations: Bangladesh, Egypt, Indonesia, Iran, Mexico, Nigeria, Pakistan, the Philippines, South Korea, Turkey, and Vietnam (Energy Education, 2005). Over recent years, the country has posted notable economic progress, with several periods of solid single-digit GDP expansion. According to the World Bank, Bangladesh

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recorded a growth rate of 7.8% in 2019, marking one of its most significant economic performances in recent times (World Bank, 2026). Despite challenges, such as political instability, insufficient infrastructure, and energy shortages, the country has maintained a steady growth trajectory. However, the industrial sector remains underdeveloped, with limited specialization and a predominance of micro, small, and medium-sized enterprises (MSMEs), many of which lack access to credit, government support, and technical assistance.

Foreign Direct Investment (FDI) plays a crucial role in enhancing market efficiency, easing technology transfer, generating employment opportunities, and developing managerial capacity. In an increasingly competitive global economy, multinational corporations seek cost-effective production environments with accessible markets. Developing countries, such as Bangladesh, with relatively low labor and land costs, are attractive destinations for such investments.

Historically, Bangladesh's FDI inflows were minimal due to post-independence nationalization policies. Policy reforms during the 1980s, followed by the liberalization of key sectors such as telecommunications and energy in the 1990s, substantially increased foreign direct investment inflows. Despite these improvements, Bangladesh still lags behind its regional counterparts, such as India and Pakistan, in attracting foreign investment.

While several studies have examined the role of foreign direct investment (FDI) in Bangladesh's economic performance, most of this work has focused either on the direct FDI–growth relationship or on isolated macroeconomic variables, offering limited insight into the broader interaction among financial development, trade openness, and FDI. Existing research tends to analyze these factors separately, which leaves an important gap in understanding their combined long-run and short-run dynamics within a unified empirical framework. Moreover, although Bangladesh has undergone major structural and financial transformations over the past decades, relatively few studies apply advanced time-series techniques to evaluate how these changes shape the country's capacity to attract and benefit from FDI. The FDI–financial development–trade nexus thus remains underexplored, particularly with respect to causal direction and equilibrium adjustments specific to Bangladesh's economic context. Addressing this gap, the present study integrates FDI, financial development, trade openness, and exchange rate behavior into a comprehensive cointegration and error-correction model, providing new evidence on their long-run relationships and causal linkages. This approach offers a more complete understanding of how Bangladesh can strengthen its investment climate and economic integration.

2. Literature Review

Foreign Direct Investment (FDI) is widely recognized as a key driver of economic growth, particularly in developing economies. It contributes to increased total productivity, capital accumulation, and employment generation. Consequently, many countries actively pursue policies to attract FDI, aiming to harness its potential benefits for both host and home economies.

A substantial body of empirical research has investigated the nexus between foreign direct investment (FDI) and export performance. For instance, Athukorala & Menon (1995), Jongwanich & Kohpaiboon (2013), and Zhang & Felmingham (2001) emphasized the role of FDI in promoting exports in developing countries. However, the size and direction of this impact vary across nations. In many cases, the expected export-enhancing effects of FDI have not materialized due to limited technological advancement or weak absorptive capacities.

Balasubramanyam et al. (1996) demonstrated that foreign direct investment (FDI) positively influences economic growth across 46 countries during the period 1970–1985, with the effect particularly significant in economies implementing export-oriented trade policies. Conversely, countries with inward-looking trade strategies experienced limited or even adverse effects. Similar conclusions were drawn by Athukorala and Menon (1995), who highlighted the importance of trade regimes in shaping FDI outcomes.

Aitken et al. investigated the cross-sectoral impacts of FDI within the garment industry, observing that Korean multinational enterprises played a pivotal role in fostering the growth of local export-oriented firms. In China, (Hu & Khan, 1997) Attributed the country's rapid economic growth from 1952 to 1994 to market-driven reforms and the "open-door" policy, which significantly boosted FDI and trade.

(Kneller & Pisu, 2007), along with (Greenaway et al., 2002) Found that FDI can generate positive spillovers for domestic firms in similar industries, particularly in export-oriented sectors. However, contrasting evidence from Barrios et al. and Ruane and Sutherland (in the context of Spain and Ireland, respectively) suggests that such spillovers are not guaranteed and may depend on local conditions and firm capabilities.

Yeats highlighted that FDI has been particularly impactful in sectors involving complex manufacturing, such as electronics and engineering, with similar patterns seen in India.

The nexus between financial development and the capacity to harness the benefits of foreign direct investment (FDI) has long been a focal point of

scholarly inquiry. Alfaro et al. (2004) argue that well-developed financial markets are a critical prerequisite for optimizing the growth-enhancing effects of FDI, as they facilitate efficient capital allocation and strengthen absorptive capacity in host economies. They argued that in the absence of efficient financial institutions, the potential benefits of FDI, such as productivity gains and technology transfer, may not be fully realized. (Gmech, 2006) Further supporting this view, it suggests that capital market development eases entrepreneurial activity and the adoption of best-practice technologies.

From a theoretical standpoint, FDI is often analyzed through the lens of imperfect markets and asymmetric information.(Cho, 2003). (Eicher et al., 2012) have investigated the determinants of FDI inflows, including labor market conditions, market size, tax policies, and geographic proximity.

The exchange rate has appeared as a particularly contentious factor in determining FDI. While some studies(Dai, 2012; Froot & Stein, 1991; Kogut & Chang, 1996) report a direct association with currency movements between exchange rate appreciation and FDI inflows, others (Dees, 1998; Lily et al., 2014) Find a negative or insignificant effect. These discrepancies are often attributed to the dual role of exchange rates in influencing cost structures and investment motivations.

Moreover, (Combes et al., 2012; Jongwanich & Kohpaiboon, 2013) suggest that FDI inflows can themselves influence exchange rate movements by altering demand for the domestic currency. This bidirectional relationship complicates the analysis of the causal relationship between exchange rates and FDI.

Finally, the global financial crisis and subsequent tightening of external financial conditions have underscored the importance of financial development in sustaining FDI flows. The UNCTAD (2010, 2014) reports highlight that despite a surge in FDI between 2002 and 2015, inflows declined sharply in 2016–2017, partly due to constrained access to external capital. This underscores the need for robust domestic financial systems to support and attract sustainable FDI.

The paper is organized as follows: a brief introduction to Bangladesh's economy and FDI inflow is provided in Section 1, while selected studies on trade openness, FDI, and the relationship between exchange rate and financial development are reviewed in Section 2. The theoretical model is presented in Section 3. The data set and method are described in Section 4, and Section 5 presents the empirical results. Lastly, the discussion and conclusion are given in section 6.

3. Theoretical Foundation

This study employs a four-variable framework for analyzing the key factors influencing Foreign Direct Investment (FDI) in Bangladesh. The model hypothesizes that FDI is a function of trade openness (TO), exchange rate (ER), and financial development (FD), and is specified as follows:

$$FDI_t = f(TO_t, ER_t, FD_t)$$

Where FDI represents annual FDI inflow as a proportion of GDP, TO stands for trade openness as a proportion of $\frac{\text{Export+Import}}{\text{GDP}}$. ER represents the official exchange rate, and FD represents financial development. Financial development is measured by private credit (private), which is bank credits to the private sector as a share of GDP. All data were collected from the World Bank Data Bank to test the model. A total of 46 data points were collected from 1972 to 2017.

4. Estimation Techniques and Model Specification

Stationarity may occur if the order of integration is the same. The series are cointegrated, as all variables are stationary linear combinations, indicating a long-run relationship (Engle & Granger, 1987). The autoregressive distributed lag model is most widely used to check for cointegration. This test estimates the number of cointegration equations using two likelihood-ratio (LR) tests (Johansen & Juselius, 1990; Johansen, 1988). At the same time, trace statistics perform in the first and second tests based on the largest eigenvalue. The Cointegration test does not reveal the direction of the causal relationship, but it does indicate the presence of a causal relationship between the two series. The Vector Error Correction Model (VECM) is used to determine the causality relationship. The VECM offers advantages over Granger Causality tests, as it can detect both short-term and long-term dynamics among variables. The long-run cointegration relationship is obtained from the VECM. This result is used to examine the dynamic Granger causality (Engle & Granger, 1987).

The following VECM is applied.

$$\Delta FDI_t = \alpha_1 + \sum \beta_{1i} \Delta FDI_{t-i} + \sum \gamma_{1i} \Delta TO_{t-i} + \sum \gamma_{2i} \Delta ER_{t-i} + \sum \gamma_{3i} \Delta FD_{t-i} + ECT_{t-1} + u_{1t}$$

Where Δ is the difference operator, ECT is the error-correlation term. Johansen's maximum likelihood method is used to obtain the ECTs from the long-run cointegrating relationships, denoted as us (i = 1, 2, 3, ...). This refers to error terms that exhibit no serial correlation and maintain an average value of zero. The relationships between FDI, trade openness, exchange rates, and financial development are examined using Equation 1. Equation 1 illustrates that ECTt1, which is a lagged function, affects exchange rates, trade openness,

FDI, and financial development, or a combination of any two of these. Through the ECT, the ECM opened an additional channel for Granger causality. The statistical significance of the following tests can use to determine Granger Causality; (i) The t-test is applied to assess the significance of the lagged error-correction terms, (ii) a joint test assessing the significance of the combined lags of each explanatory variable $s\gamma(')$, with the aid of a joint F or Wald χ^2 test, (iii) a combined test of all the terms in (i) and (ii) using a joint F or Wald χ^2 test (i.e., considering each of the parenthesized terms independently; the $s\,\gamma 1(')$ in equation 1). The dependent variables are econometrically exogenous when the F, t, or Wald χ^2 test in the VECM is insignificant. (Masih & Masih, 1996).

The VECM helps to illustrate the relationship between variables and distinguish between short-run and long-run Granger causality. Suppose the variables are cointegrated and keep a long-run equilibrium. That changed in the dependent variable for the short run. FDI responds to the long-run relationship if cointegration errors drive it. Otherwise, it responds only to the short-run component of the stochastic process. Short-term causal relationships are identified using F-tests for the explanatory variables.

In contrast, the "t" test(s) are used to figure out the long-run causal relationship. Cointegrating relationships are used to derive the long-run relation by employing lagged numbers in the error-correction term. The significance of the error-correction term coefficient, often referred to as the speed of adjustment (ξ), serves as a key indicator for testing long-run causality. A significant ξ indicates that the long-run equilibrium has a direct influence on the dependent variable.

The error correction term and the lagged first differences of the endogenous variables are included in the ECM. EC records the degree of deviation from the long-run equilibrium relationships in the earlier period. The ECT coefficient represents the speed of adjustment and indicates the level of disequilibrium in the next period.

5. Empirical Results

5.1 Unit Root Test

The unit root test is the first step in assessing the stationarity of a dataset. The Augmented Dickey-Fuller (Dickey & Fuller, 1979) is used to test unit roots. The Dickey-Fuller test derives from the regression equation:

$$Y_t = \gamma_0 + \gamma_1 t + \delta Y_{t-1} + \epsilon_t \qquad -1 \leq \delta \leq 1 \tag{2}$$

Here, Yt follows a random walk with drift and a stochastic trend, while ϵ_t denotes a white noise error term assumed to be uncorrelated with other components. If δ=1, Yt is not stationary.

An alternative approach involves estimating the model as follows:

$$\Delta Y_t = \gamma_0 + \gamma_1 t + \varphi Y_{t-1} + \epsilon_t \quad (3)$$

φ=(δ−1), where Δ denotes the first-difference operator. The null hypothesis is φ = 0, which implies δ = 1 and the presence of a unit root, indicating non-stationarity. The ADF test addresses this by including lagged differences of Yt when error terms are correlated. Subsequently, the accompanying repetition assesses unit root testing:

$$\Delta Y_t = \gamma_0 + \gamma_1 t + \varphi Y_{t-1} + \alpha_i \sum_{j=1}^{q} \Delta Y_{t-j} + \mu_t \quad (4)$$

In equation (4), Y_t follows a random walk with a stochastic trend, while μt denotes a white noise error term. Δ represents the first-difference operator, and q is the number of lags in the dependent variable. Under the null hypothesis of a unit root, the coefficient of Y_{t-1} equals zero; rejecting this hypothesis indicates stationarity. It is not necessary to see the difference in the series to check for stationarity. This study employs unit root tests to assess stationarity in the log-transformed series and their first differences. The Augmented Dickey–Fuller (ADF) test is used to determine the integration properties of the variables. Although the narrative suggests all variables are I (1), Appendix Table 1 indicates that ER (exchange rate) and TO (trade openness) reject the unit-root null at level (p = 0.0160 and p = 0.0063), implying they are I(0) with trend and intercept. In contrast, FDI and FD do not appear stationary at the level but are stationary in first differences, i.e., I (1). So FDI and FD are treated as first differences in the VEC model to capture the VECM presumption. The next step involved using the Final Prediction Error (FPE), the sequential modified LR test statistic (LR), the Schwartz Information Criterion (SIC), the Akaike Information Criterion (AIC), and the Hannan-Quinn information criterion (HQ) to estimate the proper lag length. The number of lags in the dependent variable is four based on the Akaike Information Criterion (AIC). Table 2 holds the VAR results, which are given below:

Table 2. Lag Length Selection Criteria

VAR Lag Order Selection Criteria						
Lag	LogL	LR	FPE	AIC	SC	HQ
1	79.94591	NA	5.61e-07	-3.045043	-2.383074*	-2.802405*
2	98.66169	30.30173*	5.01e-07	-3.174366	-1.850427	-2.689090
3	115.7316	24.38559	4.99e-07	-3.225314	-1.239406	-2.497400
4	135.9247	25.00095	4.50e-07*	-3.424985*	-0.777107	-2.454433

* Indicates lag order selected by the criterion.
FPE: Final Prediction Error
LR: Sequential modified LR test statistic (each test at 5% level)
SC: Schwarz Information Criterion
HQ: Hannan-Quinn Information Criterion
AIC: Akaike Information Criterion

5.2. Test for Cointegration

All variables have the same integration properties. A cointegration test is conducted to determine whether the variables exhibit a long-run relationship. A cointegration test (see Table 3) is conducted to assess the existence of a long-run relationship among the variables. Johansen (1988) suggested that the likelihood ratio (LR) trace test be applied to determine the order of r in this test.

$$\lambda_{trace}\,(q,n) = -T\,\sum_{i=q+1}^{k} \ln(1-\hat{\lambda}i\,) \quad (5)$$

From the above equation, r 0,1, 2,..., k-1, T is the number of observations used for estimation. The largest estimated i^{th} eigenvalue is λ_i. The maximum eigenvalue likelihood ratio (LR) test statistic, as proposed by Johansen, is defined as follows:

$$\lambda_{max}\,(q, q+1) = -T\,ln\{1-\lambda\_(q+1)\} \quad (6)$$

Suppose the test statistic fails to reject the null hypothesis. Therefore, a cointegrating relation exists between the variables ($r \leq 1$). Alternatively, the test statistics reject the null hypothesis of cointegration among the variables (r=0).

The Unrestricted Cointegration Rank Test (Trace and Maximum Eigenvalue) is used to detect cointegration relationships. The test statistics used to determine the maximum number of cointegrating equations are presented in Table 3, which examines the relationship among exchange rates, Financial Development, and international trade. Eigenvalue and trace tests reveal two cointegrating vectors in both models.

5.3. Vector Error-Correction Model and Granger Causality

The variables exhibit a cointegrated relationship, and according to the Granger representation theorem (Engle & Granger, 1987), this can be modeled using a Vector Error Correction Model (VECM). The VECM framework ensures that short-term fluctuations and future adjustments converge toward the long-run equilibrium. Equation 1 shows the specified VEC function. The estimated FDI model report is in Table 5 (Appendix). The table reports both long-run and short-run dynamics, including the significance of each estimated parameter and its associated test statistic. The VECM specification indicates that the structure of FDI flow is significantly affected by the exchange rate, financial development, and trade openness.

Moreover, the explanatory variables and the lag of FDI have a significant role in explaining the relationship. The VECM provides insights essential for short-term forecasting, as the short-term analysis process includes a mechanism to

adjust toward long-term equilibrium. The error correction term is negative and significant, implying that trade openness, exchange rate, and financial development have a long-term impact on FDI. The coefficient of error correction (-0.1695) is significant at the 5% level under the VECM. These findings reflect the long-run adjustment speeds of the independent variables, as identified through Granger causality tests. Table 4 presents the results of the Granger Causality Test.

Table 4. Block Exogeneity Wald Tests

Dependent Variable: ΔFDI			
Excluded	Chi-sq	Df	Prob.
ΔER	0.565228	1	0.4522
ΔFD	0.487628	1	0.4850
ΔTO	1.417845	1	0.2338
All	1.723079	3	0.6318

The Wald test results (see Table 4) indicate that the exchange rate, trade openness, and financial development do not have a short-run relationship with FDI. There is no Heteroscedasticity (see Table 6) and Autocorrelation (see Table 7) in the FDI VECM. The VECM residuals do not follow a perfect normal distribution, mainly due to component 2(see Table 8). However, VEC models often remain reliable even when normality is not fully satisfied (Lee et al., 2015).

6. Conclusion and Policy Implications

Foreign direct investment influences exchange rates at both short- and long-term horizons, especially within the context of trade openness in Bangladesh. It is examined in this study. This study employs a Vector Error Correction Model (VECM) to examine the short-term and long-term interrelationships among foreign direct investment (FDI), the exchange rate, financial development, and trade openness. The findings reveal no short-run causality between FDI and the other variables, while demonstrating significant long-run relationships with the exchange rate, financial development, and trade openness. Moreover, FDI has a notable long-term influence on financial development, consistent with recent empirical studies that underscore its importance. A valuable policy implication is that FDI can play a significant role in economic growth, primarily through efficiency improvements rather than capital accumulation.

Notwithstanding, the economic impact of FDI also varies across countries. The importance of offering incentives to multinational companies seems unjustified. Better policies should be formulated to improve local firms' relationships. Foreign companies increase their access to finance, inputs, and

technology, and simplify the processes involved in selling inputs. Domestic conditions should also improve, as it has the dual ability to attract foreign investment. (Alfaro et al., 2004) Moreover, allow host economies to fully benefit from such foreign investment.

Furthermore, Table 5 indicates that trade openness is negatively associated with FDI inflows. The statistical significance of the trade openness coefficient at the 10% level suggests that trade openness, by itself, is insufficient to attract FDI inflows in developing economies. However, trade opening alone can reduce a country's FDI inflows.

This study highlights the influence of exchange rate movements on Bangladesh's markets, noting that currency appreciation affects FDI inflows in two distinct ways, depending on cost considerations and the underlying investment objectives. When the host country's currency appreciates, it increases its FDI inflows if the objective of the FDI is to support the local market. Otherwise, it reduces the country's FDI inflows if the FDI objective is based on cost reduction or re-export.

Farrell et al. (2004) highlight a relationship between FDI and exchange rates, noting that exchange rate movements exert no short-term impact on FDI inflows, despite their potential influence. Given the variability in exchange rate effects across countries, these findings raise questions about the role of exchange rates in attracting FDI. Although this study identifies an insignificant short-term relationship, exchange rates may still influence FDI over the long term. The analysis focuses on aggregate FDI flows, leaving sector-specific dynamics unexplored, which could yield differing responses to exchange rate changes. Furthermore, government intervention in foreign exchange rate management introduces uncertainty about the currency's actual value, which may affect the long-run FDI–exchange rate nexus. Future research should investigate the composition of foreign investment inflows to provide deeper insights into sectoral dynamics. Given the long-term implications of investment decisions, this study further recommends that monetary policies incorporate exchange rate considerations to strengthen FDI inflows and promote sustained economic growth.

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Appendix

Table 1. Summary of Unit Root Test Results

ADF Test at Level with trend and intercept			ADF Test at first difference with trend and intercept		
Variable	T-Statistics	P-Value	Variable	T-Statistics	P-Value
FDI	-3.115637	0.1151	ΔlnFDI	-6.965724***	0.0000
ER	-4.002431**	0.0160	ΔlnER	-6.859986***	0.0000
FD	-2.906602	0.1702	ΔlnFD	-7.892468***	0.0000
TO	-4.350774***	0.0063	ΔlnTO	-6.629253***	0.0000

Note: ***P < 0.01 denotes significant at 1% level, **P < 0.05 denotes significant at 5% level, *P < 0.10 denotes significant at 10% level

Table 3. Summary of Johansen and Juselius (1990) Cointegration Test

Hypothesized No. of CE(s)	Trace Rank test		Maximum Eigenvalue	
	Eigen value	Trace statistic	Eigen value	Max-Eigen Statistic
r* = 0	0.551876	69.20255	0.551876	35.31811
r* ≤ 1	0.408209	33.88445	0.408209	23.08247
r ≤2	0.182813	10.80198	0.182813	8.883031
r ≤ 3	0.042675	1.918953	0.042675	1.918953

Trace test indicates 2 co-integrating equation(s) at the 0.05 level
* denotes rejection of the hypothesis at the MacKinno-Haug-Michelis (1999) p- 0.05 level **

Table 5. Vector Error Correction Estimates
Table 5.1. Long run Estimates

Cointegrating Eq:	$ECM_{1,t-1}$	$ECM_{2,t-1}$
LFD_{t-1}	14.14721** (6.09872)	-0.064157 (-0.58802)
LTO_{t-1}	-28.02165 ** (-4.95944)	-1.134908** (-4.27053)
C	-84.39509	-5.381620

Notes: The numbers in parentheses refer to t-statistics. The numbers in brackets indicate p-values following the chi-squared distribution. *Significant at the 5% level of significance.

Table 5.2. Short-run Estimates

Error Correction:	D(LFDI)	D(LER)	D(LFD)	D(LTO)
ECM_1	-0.169520 (-1.82027)	0.015762 (3.53504)	-0.026866 (-2.91388)	0.006203 (0.50305)
ECM_2	4.125293 (1.96254)	-0.402181 (-3.99625)	0.505501 (2.42905)	0.143213 (0.51460)
$D(LFDI_{t-1})$	-0.136275 (-0.95017)	-0.010470 (-1.52470)	0.014404 (1.01439)	0.010648 (0.56076)
$D(LER_{t-1})$	-2.119794 (-0.75182)	0.598339 (4.43234)	0.428209 (1.53400)	1.630645 (4.36816)
$D(LFD_{t-1})$	1.147998 (0.69830)	-0.040411 (-0.51342)	-0.110746 (-0.68043)	-0.004171 (-0.01916)
$D(LTO_{t-1})$	-1.132400 (-1.19073)	-0.106698 (-2.34335)	0.079031 (0.83939)	0.060398 (0.47969)
C	0.124590 (0.48178)	0.026540 (2.14357)	0.056907 (2.22272)	-0.080928 (-2.36368)

Table 6. VEC Residual Heteroscedasticity Test

Chi-sq	Df	Prob.
289.7670	270	0.1951

Table 7: VEC Residual Serial Correlation LM Tests

Null Hypothesis: No Serial correlation at lag h

Lag	LRE* stat	Df	Prob.	Rao F-stat	df	Prob.
1	20.69384	16	0.1906	1.336637	(16,92.3)	0.1925
2	18.27320	16	0.3081	1.165521	(16,92.3)	0.3104

Null Hypothesis: No Serial correlation at lag 1 to h

Lag	LRE* stat	Df	Prob.	Rao F-stat	df	Prob.
1	20.69384	16	0.1906	1.336637	(16,92.3)	0.1925
2	48.09758	32	0.0337	1.625444	(32,97.5)	0.0366

* Edgeworth expansion corrected likelihood ratio statistic.

Table 8: VEC Residual Normality Tests

Component	Jarque-Bera	df	Prob.
1	2.408913	2	0.2999
2	24.94562	2	0.000
3	0.119198	2	0.9421
4	1.338161	2	0.5122
Joint	28.81189	8	0.0003