Symmetric and Asymmetric Impact of Trade openness, financial development on Economic Growth in Ireland: New Evidence

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Abstract

This study aims to explore the symmetric and asymmetric impact of trade openness and financial development on Irish economic growth. Annual data covering the period 1981–2023 were used, using both linear autoregressive distributed lag ARDL and nonlinear autoregressive distributed lag NARDL. The results of the ARDL test for the symmetric impact in the long and short run showed that trade openness and financial development have a negative impact on economic growth. Regarding the asymmetric impact, the results of the NARDL test showed that the impact of positive and negative shocks in trade openness on economic growth in the long and short runs is asymmetric, positive shock has positive impact on economic growth in the long run, but negative impact in the shot run, while negative shock has negative impact in the long and short run. The positive and negative shocks in financial development in the long and short run are symmetric, meaning that positive shocks are equivalent to negative shocks.

Keywords: Financial development, Trade Openness, Economic growth, NARDL, Ireland
JEL classification : C10, F43, G21

Introduction

Trade openness and financial development represent two of the most important macroeconomic variables that have directly contributed to economic growth in recent years. Trade openness is defined as the level of a country's engagement in international trade through imports and exports. It has been identified as a crucial driver of economic growth, promoting competitiveness, innovation, and specialization (Krueger, 1978). Export-focused strategies have been essential for numerous developed and developing countries, as demonstrated by the economic successes of East Asian countries such as South Korea and Singapore (Rodrik, 1999). By integrating with global markets, these nations have benefited from economies of scale, access to new technologies, and improved productivity. Nonetheless, trade openness can also bring difficulties, such as heightened reliance on global demand and vulnerability to external shocks, illustrated during the global financial crisis (Baldwin, 1997). One of the earliest frameworks originates from Ricardian trade theory, which highlights the concept of comparative advantage. Ricardo (1817) argued that trade enables countries to focus on goods in which they possess relative efficiency, resulting in mutual benefits and economic growth. This idea was later elaborated by the Heckscher–Ohlin model, which underscores the influence of factor endowments on trade patterns and their impact on economic development (Ohlin, 1933). These theories established the groundwork for comprehending how trade openness stimulates growth by enhancing resource allocation, boosting efficiency, and facilitating technology transfer.

Current technological advancements, coupled with accelerated trade liberalization, have led to significant developments in the financial sector. Financial development and stability play a significant role in the economic growth of countries. Through financial development, the financial sector expands, economic liquidity has increased, financial innovations exhibit, and increased growth in the financial sector. The function of the financial sector is summarized as an intermediary that redistributes resources between savers and investors. The former invests their money with confidence, while the latter obtains the financial resources necessary for appropriate investment.

Schumpeter (1912), one of the initial pioneers, underscored the significance of finance in promoting growth. Similarly, Patrick (1966) introduced two new ideas that emphasize the conditions on both the demand and supply sides: the demand-following and supply-leading hypotheses. The former suggests that demand in the real sector drives the creation of financial services, while the latter posits that supply within the financial sector propels the advancement of the real sector. According to Rioja and Valev (2011), the financial sector (including banking and stock markets) has a positive effect on economic growth in middle and high-income countries, but a negative impact on lower-income nations. Demetriades and Hussein (1996) provide evidence that finance is a primary factor in the economic growth process. They also found that in most countries, the causality runs both ways, although, in some instances, financial development is a consequence of economic growth.

Despite the significant challenges faced by the Irish economy during the 1980s, the economic policy pursued by the Irish government during the 1990s focused on a knowledge-based economy, information and Communication Technology (ICT), smart industries, enhanced exports and development the transportation sector, these successes have been led to achieve remarkable economic growth. In 1981, GDP was $20.67 billion, and with noteworthy economic growth, it reached $551.39 billion in 2023.

Ireland is considered one of the most open countries in the field of international trade, with Irish trade accounting for approximately 237.21% of the GDP in 2023. Figure 1 shows the trend of growth rate of GDP and trade openness over the period 1982-2023. It is noted that there is an inverse trend between increasing trade openness and economic growth. This is primarily due to the significant increase in global competition, trade shocks, and the emergence new economic players such as China. The average means for both economic growth and trade openness were 0.09 and 0.02, confirming that trade openness has a modest impact on economic growth in Ireland.

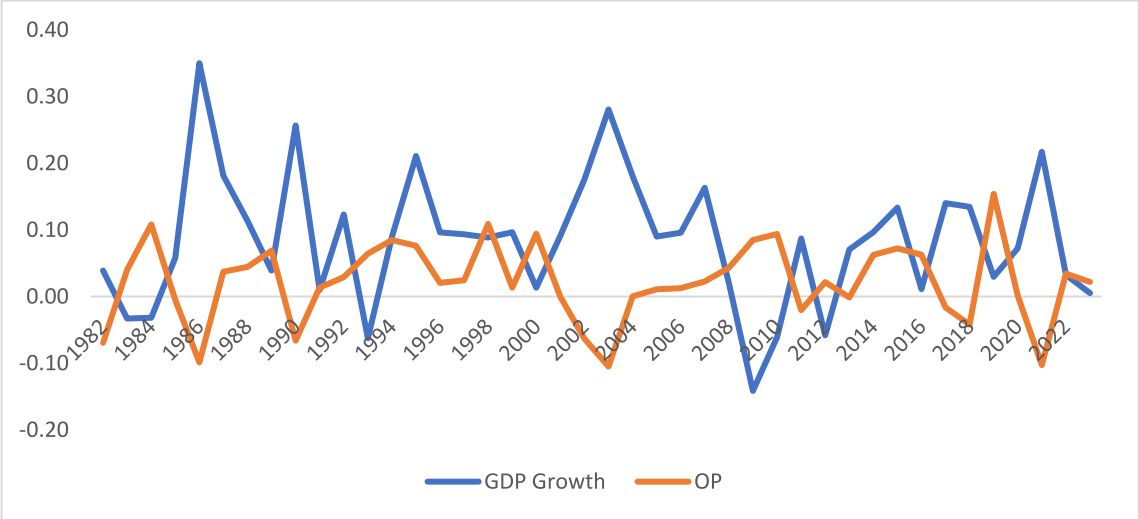

Figure 1. The growth rate in GDP and trade openness in Ireland (1982-2023)
Source: World Bank.

Figure 2 indicates that the growth rate of GDP and financial development in Ireland move in opposite directions. In the case where financial development decreases, it leads to an increase in economic growth, and vice versa. The average means of the growth rate of GDP and financial development during the period 1982-2023 is (0.09) and (-0.001) respectively, which confirms that financial development does not contribute to economic growth.

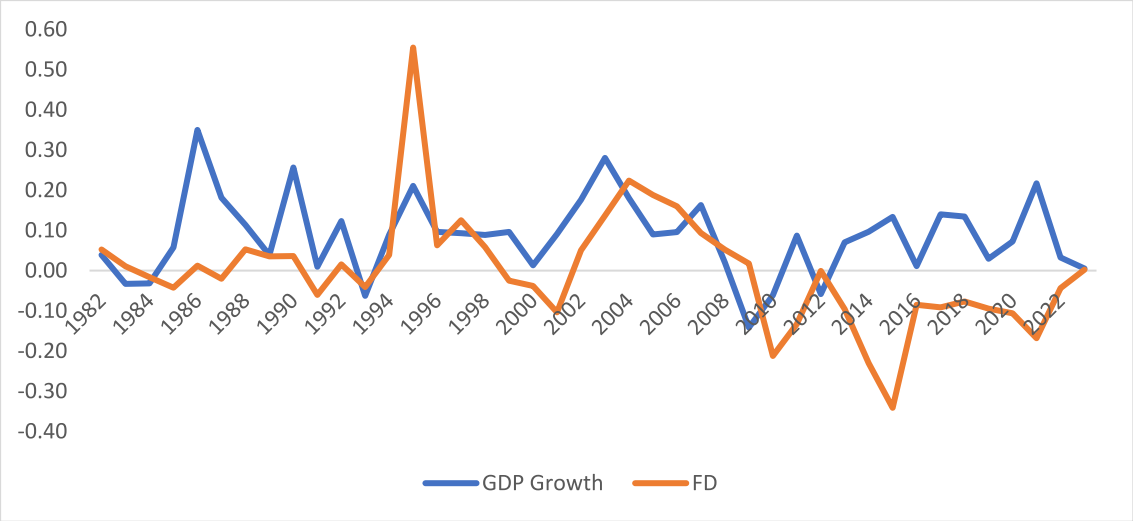

Figure 2. The growth rate in GDP and Financial development in Ireland (1982-2023)
Source: World Bank.

Literature review

Many scholars have studied the impact of both trade openness and financial development on economic growth in developing and developed countries, as unstable international economic conditions contribute to positive and negative shocks in macroeconomic variables, especially in the financial and external sectors.

Sriyana and Afandi (2020) explored the impact of trade openness alongside other economic factors such as foreign direct investment, gross capital formation, and human capital on economic growth in certain ASEAN countries. Annual time series data for the period of 1970–2017 were employed, the empirical NARDL models account for the asymmetric effects of trade openness on economic growth in Indonesia, the Philippines, Thailand, and Singapore. In contrast, Malaysia exhibits symmetric effects in both short- and long-run models, while the Philippines, Thailand, and Singapore present asymmetric effects in the long run and symmetric in the short run. In Indonesia, however, the influence of trade openness is asymmetric in the short term and symmetric over the long term. Moreover, the findings indicate that trade openness has a net positive effect on economic growth solely in the Philippines and Singapore.

Mallick and Behera (2020) examined the long-term equilibrium relationship between economic growth and trade openness in India from 1960 to 2018 using the asymmetric error-correction model with threshold cointegration. To assess the robustness of trade openness's impact on economic growth across different regimes, the full sample period was divided into two sub-periods, namely the pre-trade reforms phase from 1960 to 1990 and the post-trade reforms phase from 1991 to 2018. Their study confirms the presence of asymmetric cointegration between economic growth and trade openness in India throughout the evaluated period and across distinct sub-periods. The derived asymmetric error-correction model reveals varying adjustment speeds in trade openness in response to positive and negative economic growth shocks in the short term. Specifically, during the pre-reform period, deviations from the long-run equilibrium resulting from an increase in economic growth

exhibit a slower adjustment speed compared to deviations caused by a decrease in economic growth in India.

Kaushal and Pathak (2015) indicated that there exists a short-term connection between GDP, trade openness, and financial development in India from 1991 to 2013. Their empirical findings suggest that financial development does not have an impact on GDP, as indicated by the causality test and VAR analysis. Adamopoulos (2013) investigated the connection between financial development and economic growth in Ireland from 1965 to 2011. A vector error correction model was applied, based on Johansen cointegration analysis and stationarity testing. The Granger causality method was subsequently utilized to determine the direction of causality among the variables studied. The empirical results revealed a bilateral causal relationship between economic growth and industrial production, while a unidirectional causality from economic growth to credit market development was observed. Additionally, development in the stock market was found to cause economic growth and industrial production.

Rahman et al. (2015) explored the connection between financial development, international trade, and economic growth in Australia from 1965 to 2010. They utilized the autoregressive distributed lag (ARDL) bounds testing method to analyze the long-term relationship among the variables. The findings indicate a long-run relationship among these factors. Financial development, international trade, and capital are identified as key contributors to economic growth in both the short and long terms.

Ductor and Grechvna (2015) explored the relationship between real sector output and financial development, focusing on how GDP influences this relationship by analyzing panel data from a variety of developed and developing nations. The findings indicate that the impact of financial development on GDP is significantly influenced by net credit to key industries, and this effect turns negative without a corresponding increase in real output. Isik et al. (2017) identified both unidirectional and bidirectional relationships between financial development, international trade, and GDP in Greece over the period from 1970 to 2017, utilizing an unrestricted error correction model for the ARDL approach.

Shahbaz et al. (2020) explored the influence of financial development on economic growth, highlighting asymmetric effects and financial efficiency among the top 10 financially developed countries. They utilized annual data spanning from 1971 to 2016. A three-regime threshold autoregressive distributed lags (TARDL) model was created to accommodate their analysis. The empirical results indicated the presence of threshold asymmetric co-integration between the variables. Specifically, in the upper regime, financial development promotes economic growth in Singapore but negatively affects economic growth in Finland. In the middle regime, financial development enhances economic growth in both Australia and Singapore. Conversely, in the lower regime, financial development negatively impacts economic growth in the US, Malaysia, and Singapore. Additionally, trade openness has a favorable long-term effect on economic growth in Canada, South Africa, Australia, Malaysia, New Zealand, Singapore, Finland, and Norway.

Asteriou et al. (2023) investigated the relationship between finance and economic growth, as well as the performance of the financial system, which was measured through financial depth, accessibility, and efficiency across both financial institutions and stock markets. The analysis utilized data from a panel of 26 European Union countries covering the period from 1990 to 2020, employing GMM panel estimation. The findings indicate that during normal circumstances, the relationship between finance and growth, alongside the stock market's

role, is significantly important, whereas during periods of stress, this relationship loses its significance. Alexiou et al. (2018) discovered that from 1998 to 2014, a rise in credit flows had a negative impact on the economies of 34 European and Commonwealth of Independent States countries, while the previously observed positive influence of money supply on growth before the Global Financial Crisis was not supported in advanced economies, unlike in developing nations. Seti et al. (2025) analyzed the effects of financial and trade openness on economic growth in ten emerging and developing countries from 1970 to 2023. Their study utilized a dynamic panel generalized method of moments (GMM) model, and the results showed that both financial and trade openness have a positive effect on economic growth.

Ho et al. (2021) investigated the causal relationship between financial development and economic growth through trade openness in six leading ASEAN countries (Indonesia, the Philippines, Malaysia, Singapore, Thailand, and Vietnam). This research utilized panel data spanning 25 years from 1995 to 2019 for these nations, employing both the fixed effect model (FEM) and the random effect model (REM). The results revealed that trade openness is positively correlated with growth, while financial development showed a positive but insignificant relationship with growth. Liu and Hsu (2006) investigated the connection between financial development and growth sources for three Asian economies: Taiwan, Korea, and Japan. The data analyzed for these countries consists of quarterly information from 1981:1 to 2001:3. The selection of 1981:1 as the starting point was influenced by the commencement of market liberalization in Korea and Taiwan that year, as well as data availability constraints. Using the generalized method of moments (GMM) and principal component analysis, the result indicated that the financial aggregate had a beneficial impact on Taiwan's economy but adversely affected the other two countries; stock market development positively influenced Taiwan's economic growth.

Ahfer and Inoue (2014) explored the long-term relationship between financial development, stock market growth, and economic advancement in Japan. Quarterly data for the Japanese economy for the period 1957 to 2011. Johansen Co-integration Technique and Vector Error Correction Model were employed to assess these relationships. Their findings indicate that there exists a long-run equilibrium relationship between financial development, stock market growth, and economic growth in Japan, confirming that both financial and stock market developments foster economic growth, but no causal relationship from economic growth to financial or stock market development was found. Additional analyses revealed that although bank-based financial development and stock market growth promote economic growth, stock market development has been particularly significant for Japan's economic progress since 1974.

Jaberi et al. (2015) investigated how financial development and symmetric information influence economic growth across all European Union members. A Pooled Data approach was utilized from 2000 to 2012. The results indicate that financial development alongside symmetric information contributes to a higher rate of economic growth within the European Union. Akinci et al. (2014) examined the relationship between financial development and economic growth in OECD countries using unbalanced panel cointegration and causality analysis from 1980 to 2011. The findings of the Pedroni and Kao Cointegration Analysis confirm a long-term relationship between financial development and economic growth. The Granger Causality Analysis results suggest a unidirectional causal relationship running from economic growth to the three financial development proxy variables, while a bidirectional relationship is identified between the broad money measure and economic growth. Therefore, the demand-following phenomenon appears to be prevailing.

Chung et al. (2016) analyzed the causal interactions between financial development, liberalization, and economic growth through the channel of technological innovation in five Southeast Asian countries from 1980 to 2012, utilizing a fully modified ordinary least squares estimation technique. They discovered that advancements in technology are primarily driven by the strengthening of the financial system and financial liberalization, rather than by fluctuations in a country's market capitalization. Additionally, they observed a negative impact from financial openness and a positive effect from financial deregulation.

Currently, many developed countries face numerous challenges, particularly due to US trade policies, which can lead to significant shocks to economic growth. This study attempts to explore the symmetric and asymmetric impact of trade openness and financial development on Irish economic growth.

Model specification and methodology

3.1 Model specification

This study examines the relations between economic growth and trade openness, financial development. Following King and Levine (1993), Asghar and Hussain (2014), Belazreg and Mtar (2019), Shahbaz et al. (2020), Rafindadi and Ozturk (2017), and Menyah *et al*. (2014). The study model is based on extended traditional production function as follows:

$$GDP = Af(K, L) \quad (1)$$

By extended equation (1) through insert Trade openness (OP) and financial development (FD).

$$GDP = f(K, L, OP, FD) \quad (2)$$

Where, *GDP*: proxy of Economic growth; *K*; gross fixed capital formation (real domestic investment); *L*: Labor force; FD : financial development (Domestic credit to private sector), *OP*: trade openness.
By taking natural logarithm of equation (2), it becomes as:

$$LGDP_t = \beta_0 + \beta_1 LOP_t + \beta_2 LFD_t + \beta_3 LK_t + \beta_4 LL_t + \varepsilon_t \quad (3)$$

In this study, empirical specification is an econometric representation of the linear and non-linear relationship between *OP, FD, K, L* and *GDP* in the context of short-run and long-run dynamics.

3.2 Methodology

To test the symmetric and asymmetric relationship between trade openness, financial development and economic growth, linear autoregressive distributed lag (ARDL) which was developed by Pesaran *et al.* (2001), and nonlinear autoregressive distributed lag NARDL which was advanced by Shin *et al.* (2014). In this context, ARDL bounds test approach was used to estimate the symmetric the long-run and short-run relationship between *OP, FD , K , L* and *GDP*. Based on Equation (3), the ARDL model estimates the effect of independent variables on the GDP growth within the framework of short-run and long-run dynamics as follows:

$$\Delta LGDP_t = \beta_0 + \beta_1 GDP_{t-1} + \beta_2 LOP_{t-1} + \beta_3 LFD_{t-1} + \beta_4 LK_{t-1} + \beta_5 LL_{t-1} + \sum_{i=1}^{q} \gamma_1 \Delta GDP_{t-i} + \sum_{i=1}^{q} \gamma_2 \Delta LOP_{t-i} + \sum_{i=1}^{q} \gamma_3 \Delta LFD_{t-i} + \sum_{i=1}^{q} \gamma_4 L\Delta K_{t-i} + \sum_{i=1}^{q} \gamma_5 \Delta LL_{t-i} + \theta ECM_{i-1} + \varepsilon_t \quad (4)$$

Where q representing the lag length of the series, Δ as the first difference operator, and θ as the coefficient of the ECM. $\beta_1 - \beta_5$ represent the long run coefficients, $\gamma_1 - \gamma_5$ represent the short run coefficients.

To investigate the positive and negative shock in trade openness, financial development and its impacts on economic growth, the nonlinear autoregressive distributed lag (NARDL) methodology is considered a brilliant econometric estimation technique for discovering the asymmetric impacts. Several reasons support employing the NARDL method, specifically its usefulness in capturing the intricate dynamics that define these economic connections. The main validation for utilizing the NARDL method lies in its ability to discover asymmetric relationships that traditional linear models may struggle to adequately illustrate, as these conventional models assume uniform responses to changes in independent variables. In contrast, the NARDL method simplifies separate estimation of both positive and negative shocks, allowing for a more nuanced understanding of how economic variables respond to both increases and decreases in growth interventions. Furthermore, a notable advantage of employing the NARDL framework is its ability to model short-term dynamics alongside long-term associations within a single framework. This feature allows for a comprehensive examination of both immediate and enduring effects, providing a holistic view of the temporal dynamics of economic growth. Furthermore, the NARDL approach excels at addressing the nonlinearities found in economic relationships. Given the observed nonlinear effects, a modeling technique capable of accommodating the complexities in the interactions among trade openness, financial development, and economic growth is essential. The NARDL model's capacity to integrate nonlinear changes confirms a more accurate and realistic portrayal of these relationships, thereby filling a gap often neglected in linear analyses. Lastly, the NARDL method's significance is further improved by its robustness to the integration properties of variables. As noted by Shin et al. (2014). According to Boehlke et al. (2017), the nonlinear growth pattern of Irish GDP was more plausible based on empirical evaluations than the linear alternative. Equation (2) can be reformulated within the NARDL framework as follows:

$$LnGDP_t = a_0 + a_1 LnOP_t^{+} + a_2 LnOP_t^{-} + a_3 LnFD_t^{+} + a_4 LnFD_t^{-} + a_5 LnK_t + \\ + a_6 LnL_t + \varepsilon_t \qquad (5)$$

In order to examine the positive and negative shock impact of trade openness and financial development on economic growth, the changes in the partial sum can be portrayed as follow:

$$OP^{+}{}_t = \sum_{i=1}^{t} \Delta OP_i^{+} = \sum_{i=1}^{t} \max(\Delta OP_{i,}\ 0) \qquad \text{Positive shock} \qquad (6)$$

$$OP^{-}{}_t = \sum_{i=1}^{t} \Delta AOP_i^{-} = \sum_{i=1}^{t} \min(\Delta OP_{i,}\ 0) \qquad \text{negative shock} \qquad (7)$$

$$FD_t^{+} = \sum_{i=1}^{t} \Delta FD_i^{+} = \sum_{i=1}^{t} \max(\Delta FD_{i,}\ 0) \qquad \text{positive shock} \qquad (8)$$

$$FD_t^{-} = \sum_{i=1}^{t} \Delta FD_i^{-} = \sum_{i=1}^{t} \min(\Delta FD_{i,}\ 0) \qquad \text{negative shock} \qquad (9)$$

The NARDL model is utilized to explore how fluctuations in shocks, including both positive and negative changes in independent variables, impact time-series dependent variables (Neog and Yadava, 2020). Due to its accurate and reliable outcomes when the variables are in level I(0), the first difference I(1), or a combination of I(0) and I(1), NARDL is a commonly applied technique. It also differentiates between the short-run and long-run impacts of independent variables on the dependent variable. According to the critical bounds established by Pesaran *et al.* (2001), a long-term relationship among the variables is identified when the calculated F-statistics exceed the upper bound's critical value at a 5% significance level. By integrating

equations 6, 7, 8, and 9 adhering to the econometric methodology of Shin *et al.* (2014) and Villanthenkodath *et al.* (2021), NARDL model estimation for both long-run and short-run effects as outlined:

$$\Delta lnGDP_t = \beta_0 + \beta_1 lnGDP_{t-1} + \beta_2 lnOP^+{}_{t-1} + \beta_3 lnOP^-{}_{t-1} + \beta_4 lnFD^+{}_{t-1} + \beta_5 lnFD^-{}_{t-1} + \beta_6 lnK_{t-1} + \beta_7 lnL_{t-1} + \sum_{i=1}^{j} \delta_1 \Delta lnGDP_{t-i} + \sum_{i=0}^{k} (\delta_2^+ \Delta lnOP_i{}^+ + \delta_3^- \Delta lnOP_i{}^-) + \sum_{i=0}^{m} (\delta_4^+ \Delta lnFD_i{}^+ + \delta_5^- \Delta lnFD_i{}^-) + \sum_{i=0}^{n} \delta_6 \Delta lnK_{t-i} + \sum_{i=0}^{L} \delta_7 \Delta lnL_{t-i} + \varphi ECM_{t-1} + \varepsilon_t \quad (9)$$

Where, $\beta_1 - \beta_7$ long run impacts, $\alpha_1 - \alpha_6$ long run impacts as mentioned in equation 5, $\alpha_1 = -\beta_2/\beta_1$; $\alpha_2 = -\beta_3/\beta_1$ displays the long run impacts of positive and negative shock in the trade openness on economic growth, $\alpha_4 = -\beta_4/\beta_1$; $\alpha_5 = -\beta_5/\beta_1$ presents the long run impacts of positive and negative shoch in the financial development on economic growth, $j, k, m, n, l, are\ lag$ orders, $\delta_1 - \delta_6$ short run impacts, $\sum_{i=0}^{k} \delta_2^+$ measure the impact of an increase in trade openness on economic growth in the short term, $\sum_{i=0}^{k} \delta_3^-$ measure the impact of a decrease in trade openness on economic growth in the short term. $\sum_{i=0}^{m} \delta_4^+$ measure the impact of an increase in financial development on economic growth in the short term, $\sum_{i=0}^{m} \delta_5^-$ measure the impact of a decrease in financial development on economic growth in the short term. Δdenotes difference operator; and ε_t is the white noise term.

The impact of dynamic asymmetric multiplier on the variables can be stated as follows:

$$m(OP)_h^+ = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{OP_{t-1}^+} = m(OP)_h^- = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{OP_{t-1}^-}, h = 0,1,2 \ldots \quad (10)$$

$$m(FD)_h^+ = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{FD_{t-1}^+} = m(FD)_h^- = \sum_{j=0}^{h} \frac{\partial y_{t+j}}{FD_{t-1}^-}, h = 0,1,2 \ldots \quad (11)$$

Kowing that, as $h \to \infty, m(OP)_h^+ \to a_1,\ and\ m(OP)_h^- \to a_2$.

$$m(FD)_h^+ \to a_3,\ and\ m(FD)_h^- \to a_4.$$

By utilizing these dynamic multipliers, the endogenous variable reacts differently to positive and negative changes in the exogenous variable. When there is a change to the model, the estimated multipliers enable us to track the dynamic adjustment between the variables from the initial equilibrium to their new equilibrium following the change.

3.3 Data

To achieve econometric analysis, Annual time series data from 1981 to 2023 was used. Data regarding GDP, trade openness, financial development, gross fixed capital formation, and labor forces obtained from the World Development Indicators (WDI). The descriptive statistics variables are shown in Table 1. All of the series' standard deviations were found to be relatively low, demonstrating little data variability. Furthermore, all series had a normal distribution, according to the Jarque-Bera coefficient.

Table 1. Descriptive statistics

	LGDP	LOP	LFD	LK	LL
Mean	25.48946	5.026987	4.119238	24.00528	7.545582

Median	25.57994	5.033028	3.880945	24.13573	7.600713
Maximum	27.03572	5.521895	5.131377	26.10169	7.937194
Minimum	23.72432	4.542972	3.264232	22.10976	7.148031
Std. Dev.	1.038956	0.303342	0.529578	1.178706	0.239517
Skewness	-0.266028	-0.011796	0.367592	-0.062971	-0.371733
Kurtosis	1.809650	1.764280	2.022638	1.728064	1.820815
Jarque-Bera	3.045863	2.736878	2.679851	2.927013	3.481601
Probability	0.218072	0.254504	0.261865	0.231423	0.175380

Empirical results

In Table 2, the findings of the optimal lag selection are displayed. Identifying the best lag in the ARDL model aims to address the issue of autocorrelation within the model system by treating the lag in endogenous variables as an exogenous variable. The optimal lag determination is based on the likelihood ratio (LR), final prediction error (FPE), AIC, Schwarz information criterion (SIC), and Hannan–Quin criterion (HQ) values. As indicated in Table 2, the chosen lag is lag 1, as the optimal lag implies that all variables not only influence each other in the same period but also in the preceding one period.

Table 2. Lag selection

Lag	**LogL**	**LR**	**FPE**	**AIC**	**SC**	**HQ**
0	35.07037	NA	1.53e-07	-1.503519	-1.292409	-1.427188
1	263.6567	388.5968*	5.87e-12*	-11.68283*	-10.41618*	-11.22485*
2	281.6500	26.09022	8.86e-12	-11.33250	-9.010289	-10.49286
3	293.3315	14.01789	2.03e-11	-10.66658	-7.288818	-9.445285

Before engaging in a cointegration test, it is essential to perform unit root tests to assess the stationarity characteristics of the parameters. This step is vital as it aids in selecting an appropriate test for the subsequent phase of the study and identifies the type of stationarity of the parameters being analyzed. Two-unit root testing methods were implemented in this study: Augmented Dickey-Fuller (Dickey and Fuller. 1979), and Phillips-Perron (Perron, 1989). As shown in Table 3, all parameters evaluated displayed stability at the level I(0) or after the first difference I(1). This indicates that cointegration and the ARDL estimator can be utilized with the data.

Table 3. The results of unit root tests

	ADF		PP	
Variables	**At level**	**First difference**	**At level**	**First difference**
L(GDP)	-0.823206	-4.907232***	-0.801525	-4.817488***
L (OP)	-0.511877	-5.846246***	-0.456710	-5.918830***
L (FD)	-1.206503	-3.387977**	-0.971635	-3.363599**
L (L)	-0.483313	-5.693476***	-0.446975	-5.693476***
L (K)	-0.448339	-4.830611***	-0.527135	-4.779780***

*, ** and ***, 1%, 5% and 10%

symmetric ARDL estimation

The dataset's stationarity can be assessed based on the results from the unit root tests. An ARDL bounds test was conducted to evaluate whether a cointegration relationship exists among the parameters utilized. The results of the cointegration analysis are presented in Table 4. The computed F-statistic for cointegration (11.237) exceeds the maximum upper bounds.

Table 4. ARDL bounds test results

Null hypothesis: No degree of relationship			
	Sig.	I(0	I(1)
F- value (11.237)	10%	2.2	3.09
K 4	5%	2.56	3.49
	2.5%	2.88	3.87
	1%	3.29	4.37

*, ** and ***, 1%, 5% and 10%

The results of the test of the symmetric effect of trade openness and financial development in the long and short term on economic growth shown in Table 5, indicate that economic growth is negatively affected by the increase in trade openness and financial development, while the labor force and fixed capital formation have a positive effect.

The ECM value mirrors the speed at which the system moves from a temporary balance to a state of permanent stability. Both the coefficient and the derived ECM are negative at the 1% significance level. According to the ECM value, short-term deviations from the long-term equilibrium path are generally adjusted by an average of 6.44 %. The significantly negative

ECM coefficient indicates that any long-term disparities among the model variables will adjust or align with the long-term equilibrium.

Table 5. ARDL long and short run results

Independent Variables	Long run		Short run	
	coefficients	Prob.	coefficients	Prob.
LOP	-0.392256	0.8222	-0.970599	0.000
LFD	-0.153839	0.6814	-0.009917	0.6528
LL	2.053883	0.5285	0.132396	0.6627
LK	0.469512	0.4390	0.238680	0.000
C	2.535416	0.8319		
ECM			-0.064462	0.000

*, ** and ***, 1%, 5% and 10%.

Asymmetric NARDL estimation

To achieve the NARDL estimation, the bound test for cointegration was made. The F-statistic value is 3.417, these values exceeded the upper bound I(1), as shown in Table 6. Consequently, rejecting the null hypothesis of no level relationship. This established the existence of a long-run asymmetric relationship between economic growth and explanatory variables.

Table 6. NARDL bounds test results

Null hypothesis: No degree of relationship			
	Sig.	I(0	I(1)
F-value (3.417) K 6	10%	1.99	2.94
	5%	2.27	3.28
	2.5%	2.55	3.61
	1%	2.88	3.99

*, ** and ***, 1%, 5% and 10%

Regarding the asymmetric effect of positive and negative shocks in trade openness and financial development in the long run, the result reveals that in positive shock a 1% increase in openness contributes to economic growth by 0.61%, but insignificantly. In negative shock a 1% decrease in trade openness leads to a negative effect, reducing economic growth by 2.53%, and insignificantly. Moreover, the NARDL results show that a positive shock in financial

development decreases economic growth by 0.11%. A negative shock in financial development contributes to a 0.16% increase in economic growth. The results also show that the labor force and fixed capital formation have a positive effect on Irish economic growth.

Concerning the impact of positive and negative shocks in trade openness and financial development on economic growth in the short term, the results show that a 1% increase in trade openness resulting from a positive shock leads to a 0.63% decrease in economic growth, while a 1% decrease in trade openness accompanied by a negative shock leads to a 1.48% decrease in economic growth. A 1% positive shock in financial development leads to a 0.24% increase in economic growth, while a 1% decrease in financial development resulting from a negative shock leads to a 0.23% decrease in economic growth. Finally, it was also shown that the labor force and fixed capital formation have a positive impact on economic growth.

Concerning the error correction coefficient (ECM), the test results showed that the error correction coefficient value is 28.24, and is statistically significant, meaning that short-term deviations from the long-term equilibrium path are generally adjusted by an average of 28.24% each year, respectively. The significantly negative ECM coefficient indicates that any long-term disparities among the model variables will adjust or align with the long-term equilibrium.

Table 7. NARDL long and short run results

Independent Variables	Long run		Short run	
	coefficients	**Prob.**	**coefficients**	**Prob.**
LOP_POS	0.613424	0.2141	-0.638650	0.0007***
LOP_NEG	-2.538795	0.0027***	-1.481472	0.0000***
LFD_POS	-0.112366	0.6111	0.241672	0.0116**
LFD_NEG	0.161762	0.2564	-0.231704	0.0041***
LK	0.395581	0.0163**	0.204921	0.0000***
LL	0.115271	0.8951	0.032559	0.8977
C	14.19475	0.0132		
ECM			-0.282452	0.0000***

*, ** and ***, 1%, 5% and 10%.

The asymmetry Wald test essentially represents a test of whether the coefficients are equal or not, a test of whether the positive and negative shocks of trade openness on economic growth have different magnitudes of effect in the long and short run, however, financial development on economic growth have the same magnitude of effect in the long and short run. The results are shown in Table 8.

Table 8. Asymmetry tests

	W_{LR}			W_{SR}		
	F-statistic	Prob.	Result	F-statistic	Prob.	Result
OP	9.804813	0.0040	asymmetric	49.68068	0.000	asymmetric
FD	0.791465	0.3812	symmetric	0.004351	0.9479	symmetric

Where, W_{LR} (Wald long-run result), W_{SR} (Wald short-run result).

Figure 3 illustrates the existence of a negative relationship between trade openness and economic growth. The solid black line shows the positive impact of trade openness on GDP. The effect of a negative shock in trade openness is found to dominate that of a positive shock. The NARDL multiplier effects figure demonstrates the asymmetries between the positive and negative shocks in trade openness and economic growth.

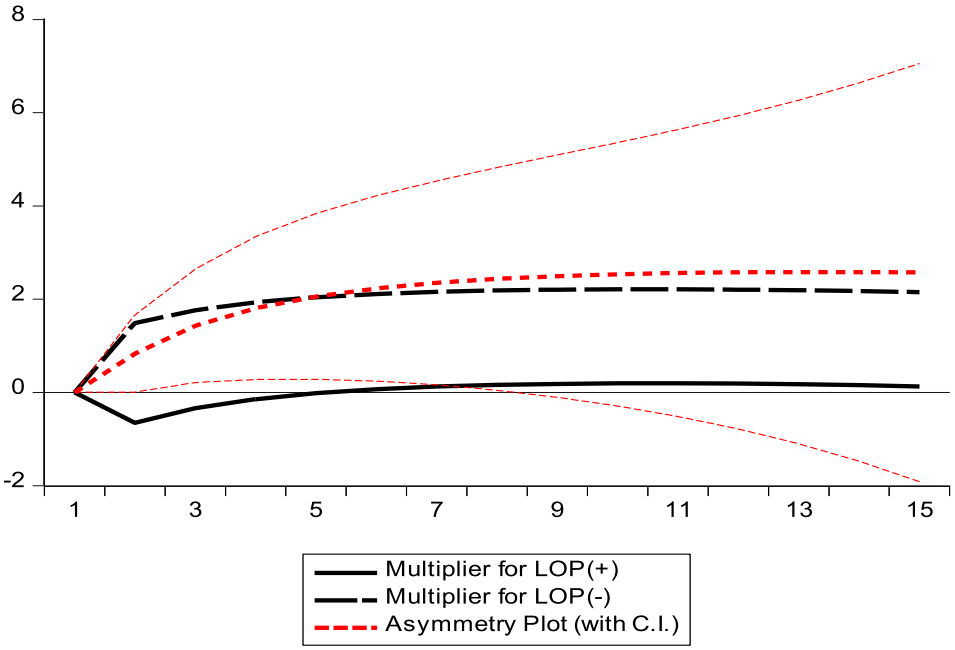

Figure 3. NARDL multiplier of trade openness and response of economic growth

Figure 4 shows the asymmetric NARDL dynamic multiplier effects, which highlight the impact of both positive and negative shocks in financial development on economic growth. The solid black line shows the positive impact of financial development on GDP, whereas the dotted black line shows the negative effect of financial development on Irish economic growth.

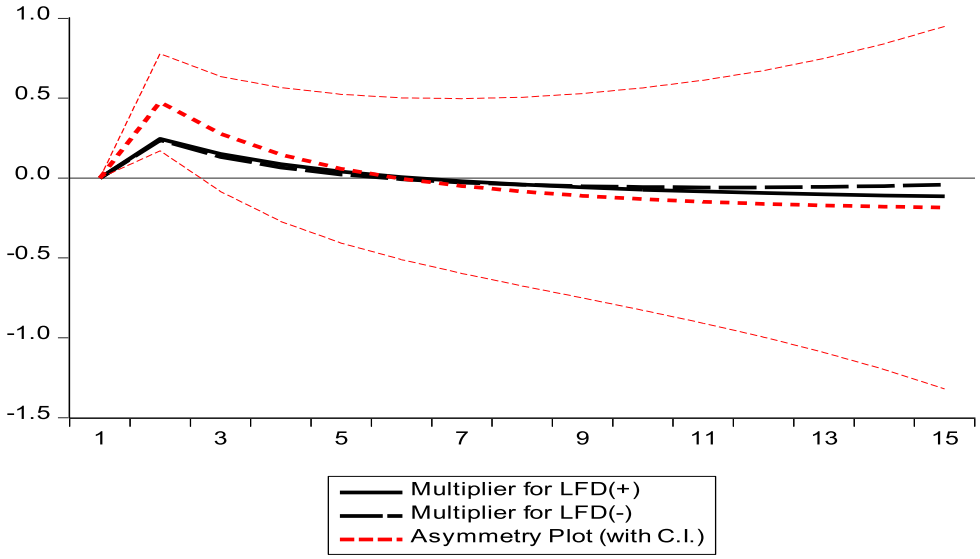

Figure 4. NARDL multiplier of financial development and response of economic growth

Diagnostic tests

According to Table 9, the model is not affected by any problems as indicated by several diagnostic tests performed before the final implementation of the asymmetric ARDL model. The p-values for the Jarque-Bera test, LM test, Heteroskedasticity Test, and Ramsey Reset test. The results of the Jarque–Bera test confirm that the residuals are normally distributed, and our model does not exhibit problems with serial correlation or heteroscedasticity. Furthermore, the Ramsey RESET value is also statistically insignificant, which indicates that our model is appropriately specified.

Table 9: ARDL and NARDL results of diagnostic tests

	ARDL		**NARDL**		
Diagnostic tests	Coefficient	Prob.	Coefficient	Prob.	Decision
Jarque-Bera test	0.091	0.955	0.799	0.670	Residuals are normally distributed
Breusch-Godfrey Serial Correlation LM Test:	1.632	0.2115	0.354	0.705	No serial correlation exists
Heteroskedasticity Test: Breusch-Pagan-Godfrey	0.110	0.9973	1.105	0.394	No heteroscedasticity exists
Ramsey Reset test	2.534	0.1210	2.915	0.100	The model is properly specified

Conclusion

Economic growth is significantly affected by internal and external shocks of international trade and financial sector. Today, many countries are attempting to understand the impact of positive and negative shocks of the economic variables on economic growth. This study attempts to shed light on the symmetric and asymmetric impact of trade openness and financial development on Irish economic growth. To achieve the study's objective, annual data spanning the period 1981-2023 were used. The symmetry results showed that trade openness and financial development have a negative impact on Irish economic growth in both the long and short term. Limited trade openness policy may reduce imports, thus preserving cash flows within the domestic economy, as well as, rationing credit to the private sector contributes to stimulating investments toward productive sectors, thus achieving economic growth. Regarding the asymmetric effect of trade openness and financial development, the results of the NARDL test showed that the positive and negative impact of shocks in trade openness on economic growth are asymmetric and that negative shocks outweigh positive shocks in the long and short runs.

Concerning the positive and negative shocks in financial development in the long and short run the results show that the impact on economic growth is symmetric. These results are of great importance to Irish trade policymakers.

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