Trade Openness and Economic Growth in Ho Chi Minh City, Vietnam: Evidence from an Extended Solow ARDL Approach

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Article

Trade Openness and Economic Growth in Ho Chi Minh City, Vietnam: Evidence from an Extended Solow ARDL Approach

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Abstract

This study analyzes the relationship between trade openness, FDI, and economic growth in Ho Chi Minh City within the framework of an extended Solow model, using annual time series data from 2000 to 2024, and provides empirical evidence at the municipal level for Vietnam's leading economic and integration center. The trade openness is separated into the ratio of exports and imports to GRDP to reflect the different impacts of economic integration. The ARDL and ECM model are applied in order to instantaneously analyze both short-term and long-term effects. The results show that the variables have mixed integration orders. Capital is the factor with the most positive and stable impact in the long term. Meanwhile, relative exports and FDI have a positive impact in the short term but a negative one in the long term, implying that the benefits of integration depend on the quality of international trade, the ability to absorb technology, and domestic linkages. The negative and statistically significant error correction coefficient indicates the existence of an adjustment mechanism toward equilibrium. The robustness check with the COVID-19 dummy variable approves the stability of the main results. The study points out that the necessity of changing from extensive quantitative integration to enhance the quality of growth and the efficiency of resource allocation.

Keywords: ARDL; economic growth; extended Solow model; Ho Chi Minh City; trade openness

1. Introduction

After the implementation of the "Doi Moi" policy in 1986, Ho Chi Minh City (HCMC) has converted one of economic centers of Vietnam, where has been a major role in the fields of industry, trade, logistics, services, and attracting foreign investment. In the context of an open urban, HCMC is where production activities, import and export, and supply chains are highly connected to the global market, changes in the external environment can quickly transmit into local economic growth.

Basing on theory, the level of trade openness is considered an important factor in promoting a country's economic growth through international trade activities. In the neoclassical growth model, Solow (1956) emphasized the role of capital, labor, and technological progress in determining long-term output. Based on that, subsequent studies argue that international trade can complement the traditional growth framework through market expansion, promoting specialization, improving resource allocation efficiency, and accelerating technology diffusion (Frankel & Romer, 1999; Alcalá & Ciccone, 2004). Frankel and Romer's (1999) empirical evidences showed that trade has a positive impact on income, while Alcalá and Ciccone (2004) further asserted that trade openness has a positive and quite robust effect on productivity. In this approach, in a local economy oriented toward import and export like HCMC, trade openness has a clear theoretical basis to be considered a growth-driving factor.

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However, the benefits of trade openness do not always automatically promote economic growth for countries. The actual impact of trade also depends on the production structure, the degree of reliance on imported inputs, the quality of trade infrastructure, the capacity to absorb technology, and the institutional conditions of the economy (Rodrik, 1998; Frankel & Romer, 1999). In other words, the same level of openness can have significantly different growth effects between countries, as well as between economic spaces within the same country. This is particularly significant for HCMC, where the manufacturing and trade sectors have both benefited from integration and are constrained by logistics costs, input imports, and the uneven capacity to upgrade value chains across industries.

From worldwide empirical studies, the impact of trade openness on economic growth has yielded somewhat inconsistent results, such as many studies assert that international trade is an important driver of growth by promoting capital accumulation, technology transfer, and enhancing total productivity (Frankel & Romer, 1999; Alcalá & Ciccone, 2004). On the other hand, some studies argue that the impact of trade openness strongly depends on the quality of institutions, the level of development, the ability to diversify production, and the vulnerability to external shocks (Rodrik, 1998). This implies that the impact of international trade on growth is a contextual issue, especially for emerging economies and deeply integrated urban centers like HCMC.

In Vietnam, most previous studies primarily focused at the national level when examining the relationship between trade openness and economic growth. Some studies show that trade and international economic integration play a significant role in Vietnam's growth, but this impact varies by period, import-export structure, and macroeconomic management characteristics. However, empirical evidence at the local level, especially for HCMC, remains relatively limited. This is a notable gap, as HCMC is not only the region with the largest economic scale in the country but also an urban economic space with a very high degree of openness, where the effects of international trade can manifest more clearly, quickly, and complexly compared to the national level.

In addition, many local studies often examine trade from a descriptive or national-level analytical perspective, while there are not many studies integrating trade openness into a growth framework with a clear theoretical foundation at the city level. Meanwhile, for a large urban area like HCMC, growth analysis cannot be limited to traditional factors such as capital and labor; it must also consider external regional factors, among which trade openness is a particularly significant variable. Therefore, expanding the Solow model by incorporating trade openness as an additional explanatory variable is an approach that is both theoretically and empirically appropriate.

Based on the above context, this study aims to assess the impact of trade openness on economic growth in HCMC within the framework of the extended Solow model. Specifically, the study focuses on three main objectives. First of all, to examine whether trade openness has an impact on the economic growth of HCMC. Secondly, test the existence of a long-term equilibrium relationship between economic growth, capital, labor, and trade openness. Finally, separate the short-term and long-term impacts through the ARDL–ECM model to clarify the adjustment mechanism of local economic growth in response to changes in trade openness.

This study expects to contribute in four aspects. Primarily, the article provides empirical evidence at the local level for an urban economic center playing a strategic role in Vietnam's growth and integration. Secondly, the study extends the Solow model by incorporating trade openness as an external regional factor that can influence economic growth. Thirdly, the use of the ARDL model allows for the handling of small sample data, while also accommodating variables with mixed integration orders of I(0) and I(1), thereby distinguishing between the long-term relationship and short-term dynamics between the variables (Pesaran et al., 2001). Lastly, the research results can provide useful policy implications for urban growth strategies, enhancing the quality of trade integration, and improving the capacity to absorb benefits from international trade in HCMC.

The rest of the article is organized as follows. Section 2 presents a literature review and the development of the research hypothesis. Section 3 introduces the research model and research methods. Section 4 describes the data and data sources used in the article. Section 5 presents the

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experimental results and discussion. Finally, section 6 presents the conclusion and policy implications.

2. Theoretical Framework and Literature Review

2.1. Theoretical Framework

According to Solow model (1956), long-term output is primarily determined by the accumulation of capital, labor, and exogenous technological progress. Subsequent empirical extensions have shown that the Solow framework can be supplemented with variables reflecting modern development conditions, especially in open and deeply integrated economies, where growth not only depends on traditional production factors but is also significantly influenced by international trade and cross-border capital flows.

From a theoretical perspective, trade openness can promote growth thru four main channels. For instance, international trade expands market size and facilitates the exploitation of economies of scale. Secondly, international trade promotes specialization according to comparative advantage and enhances the efficiency of resource allocation. Thirdly, international competition creates pressure to enhance productivity and improve production organization. Lastly, international trade supports the economy access technology, machinery, and intermediate inputs from abroad. Influential studies show that trade has a positive impact on income and productivity, although the intensity of the impact may vary across different research contexts (Frankel & Romer, 1999; Alcalá & Ciccone, 2004).

However, recent researches showed that the impact of trade openness is not mechanical. For example, Nam, Kim, and Kim (2024) show that in developing countries, particularly in the context of ASEAN, higher trade volumes tend to support growth, but reducing trade barriers does not always create a corresponding growth effect. This implies that the benefits of trade liberalization depend on the production structure, absorptive capacity, and institutional conditions of the receiving economy.

More recent studies also emphasize the role of domestic market conditions and connectivity infrastructure in determining the growth effectiveness of trade. Yu (2025) shows that the positive impact of trade openness is stronger in areas with low domestic transportation costs and high market integration; conversely, high transportation costs weaken the growth benefits from trade. The implication of this argument is particularly relevant to Ho Chi Minh City, where international trade is closely tied to logistics quality, regional connectivity, and the capacity to engage in value chains.

At the side of international trade, FDI is considered an important channel that benefits the economy receive capital, technology, management skills, and international production networks. In expanded growth models, FDI is often used as an empirical representative for the external technology channel, especially when technological progress is difficult to measure directly at the local level. Yang (2024) showed that FDI inflows have a positive impact on productivity in both OECD and non-OECD countries, thereby contributing to economic growth. This result reinforces the view that FDI is not only a supplementary capital flow but also a mechanism for improving productivity in an open economy.

In terms of mechanisms, the impact of FDI on growth is mainly explained through technology transfer and knowledge spillover. Many previous studies consider FDI as a means for economies to absorb technology from abroad, but also emphasize that this effectiveness depends on the absorptive capacity of the domestic sector. In Vietnam, empirical evidence shows that FDI, the import of production materials, and exports can support long-term labor productivity growth. Therefore, in this study, the inclusion of FDI in the model not only aims to reflect the role of foreign capital but also has a clear theoretical basis to represent a technology channel within the extended Solow framework.

In summary, expanding the Solow model by incorporating trade openness and FDI is appropriate both theoretically and in practical research. While trade openness reflects the level of integration of the local economy with the international market, FDI reflects the ability to absorb technology, management knowledge, and productivity incentives from abroad. For a deeply

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integrated urban area like Ho Chi Minh City, the extended Solow framework thus allows for a more comprehensive explanation of economic growth compared to the traditional model based solely on capital and labor.

2.2. Overview of Empirical Research on Trade Openness and Economic Growth

Empirical literature generally supports a positive relationship between trade openness and economic growth, but increasingly emphasizes that this relationship is conditional rather than universal. Classic studies showed that trade can raise income and productivity thru market expansion, specialization, and improved resource allocation efficiency (Frankel & Romer, 1999; Alcalá & Ciccone, 2004). However, recent evidences for developing countries showed that the impact of openness significantly depends on the measurement method. Nam and Ryu (2024) pointed out that higher trade volumes are often associated with better GDP growth, while excessive reduction of trade barriers does not necessarily create a similar growth effect in developing economies.

The main point of the new literature is the spatial heterogeneity. Yu (2025) showed that trade openness has a stronger positive impact in regions with low domestic transportation costs and high market integration; conversely, transportation barriers and market fragmentation weaken the growth benefits from trade. The implication is that national-level results cannot be automatically applied to all localities. In HCMC, this is particularly important because the effectiveness of trade integration is likely to depend on the quality of logistics, regional connectivity, and value chain integration capabilities.

In the case of Vietnam, Nguyen and Poczta-Wajda (2024) showed that per capita GDP growth has a long-term relationship with FDI, trade openness, and exchange rates. This result reinforces the argument that trade needs to be considered within a dynamic relationship system with other macroeconomic variables, rather than as an independent factor. Therefore, from an empirical standpoint, city-level studies are necessary to test whether a deeply integrated urban economy like Ho Chi Minh City transforms international trade benefits differently than at the national level.

2.3. Overview of Empirical Research on FDI and Economic Growth

The literature on FDI and growth also presents a positive but not one-dimensional picture. Recent studies are increasingly moving away from viewing FDI as merely a source of capital and emphasizing the role of FDI in productivity, technology transfer, and upgrading production structures. Yang (2024) showed that input FDI has a positive impact on productivity in both OECD and non-OECD countries, thereby contributing to economic growth. This result aligns with the argument that in open economies, the most significant contribution of FDI often lies in productivity effects rather than just in the scale of additional capital.

Recent studies also showed that the effects of FDI strongly depend on the spillover conditions in the host locality. Barboza et al. (2025) emphasize that FDI can create technology and knowledge spillovers through production linkages, industrial clusters, and business interactions, but the intensity of these effects depends on the industrial structure and absorptive capacity of the domestic region. This approach is very suitable for the study of HCMC, where the FDI sector coexists with a network of domestic enterprises, logistics operations, and large-scale manufacturing services.

Evidences demonstrated that Vietnam is also heading in this direction. Asada (2020) pointed out that FDI, the import of production materials, and exports all contribute positively to long-term labor productivity growth in Vietnam, although the short-term impact is still unclear. Therefore, incorporating FDI into the current model not only aims to reflect the role of foreign capital but also has empirical grounds to view FDI as a representative of the technology channel and productivity spillover within the framework of the extended Solow model.

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2.4. Research Gap

Although the existing literature is quite rich, there are still some significant gaps. Initially, most studies on trade, FDI, and growth in Vietnam are conducted at the national level, while evidence for a deeply integrated urban economy like Ho Chi Minh City is still limited. This is a significant gap because recent literature shows that the impact of trade and FDI strongly depends on market integration conditions, transportation costs, and local structures.

Secondly, many studies view trade openness and FDI as two relatively separate streams of literature. Meanwhile, recent studies show that trade and FDI often simultaneously impact productivity, innovation, and long-term growth. Therefore, an integrated framework would be more suitable for a city like Ho Chi Minh City, where trade, investment, and logistics channels operate simultaneously.

Thirdly, many recent studies stop at identifying statistical relationships without linking trade and FDI to a clear growth theory framework. The use of the extended Solow model in this study clearly identifies the role of each group of variables: capital and labor are traditional production factors; trade openness reflects the level of market integration; while FDI represents a channel for technology from abroad. Finally, with local-level time series data often having small samples and potentially including both I(0) and I(1) variables simultaneously, the ARDL approach is particularly suitable for testing both short-term and long-term relationships within the same experimental framework.

2.5. Development of Research Hypotheses

Based on the extended Solow model and recent empirical studies, this research constructs three main hypotheses:

First of all, trade openness is expected to have a positive impact on economic growth because it helps to expand market size, improve resource allocation efficiency, and facilitate access to external technology. Although recent studies showed that the impact of openness depends on the measurement method and development context, the general expectation for a highly integrated urban area like Ho Chi Minh City remains positive. Therefore, the first hypothesis is stated as follows:

H1. The trade openness has a positive impact on economic growth in HCMC

Secondly, FDI is expected to contribute positively to growth by supplementing capital, improving productivity, and transferring technology and management skills from abroad. Recent literature generally supports the view that FDI can stimulate growth when the host economy has sufficient absorptive capacity and appropriate domestic linkages. With its role as the largest FDI attraction center in the country, HCMC has both theoretical and empirical grounds to expect a positive contribution of FDI to growth. Therefore, the second hypothesis is proposed as follows:

H2. FDI has a positive impact on economic growth in HCMC.

Finally, if the economic growth of Ho Chi Minh City is simultaneously determined by traditional production factors and external integration factors, then there is a high likelihood that a long-term equilibrium relationship exists between these variables. Recent studies in Vietnam and developing economies provided a basis for expecting the existence of a long-term relationship between growth, trade openness, and FDI. Therefore, the third hypothesis is constructed as follows:

H3. There exists a long-term equilibrium relationship between economic growth, capital, labor, trade openness, and FDI in HCMC.

3. Research Model and Research Methods

3.1. Analytical Framework

This study uses the extended Solow model as the foundation for analyzing the economic growth of Ho Chi Minh City. In the original Solow model, long-term output growth is determined by the accumulation of capital, labor, and exogenous technological progress. However, for an open and

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deeply integrated urban economy like HCMC, growth is also significantly influenced by external regional factors, particularly international trade and foreign direct investment. Therefore, the study expands the Solow framework by incorporating variables that reflect trade integration and FDI into the growth function. This approach aligns with the literature suggesting that trade can improve income and productivity, while FDI can serve as a channel for technology transfer and enhancing production efficiency.

Based on that, local economic growth is seen as the result of the interaction between traditional production factors and international integration factors. Specifically, capital represents the capacity for accumulation and production expansion; labor reflects the input resources of the economy; exports on GRDP and imports on GRDP reflect the two dimensions of trade integration; while FDI is used as a variable reflecting the technology channel and productivity spillover from abroad. With this specification, the model not only tests the role of trade in general but also allows for distinguishing the impact of exports and imports on growth.

3.2. Specification of the Research Model

To ensure consistency between the theoretical framework and the empirical analysis, this study specifies the research model based on the autoregressive distributed lag (ARDL) approach. The ARDL model is suitable for examining both the short-run dynamics and the long-run relationship between trade openness and economic growth.

Basing on the ARDL model equation:

$$y_t=\alpha_0+\sum_{i=1}^{p}\phi_i y_{t-i}+\sum_{j=0}^{q}\beta_j x_{t-j}+u_t$$

$$\Delta y_t=\alpha_0+\lambda_1 y_{t-1}+\lambda_2 x_{t-1}+\sum_{i=1}^{p-1}\psi_i \Delta y_{t-i}+\sum_{j=0}^{q-1}\theta_j \Delta x_{t-j}+\varepsilon_t \quad (1)$$

The study's equation is:

$$\ln grdp_t=\alpha_0+\sum_{i=1}^{p}\alpha_i \ln grdp_{t-i}+\sum_{j=0}^{q1}\beta_j \ln cap_{t-j}+\sum_{k=0}^{q2}\gamma_k \ln lab_{t-k}+\sum_{l=0}^{q3}\delta_l \ln exgrdp_{t-l}$$
$$+\sum_{m=0}^{q4}\phi_m \ln impgrdp_{t-m}+\sum_{n=0}^{q5}\theta_n \ln fdi_{t-n}+\varepsilon_t \quad (2)$$

Where:

$\ln grdp_t$: the natural logarithm of the real GRDP.

$\ln cap_t$: the natural logarithm of development investment capital;

$\ln lab_t$: the natural logarithm of labor.

$\ln exgrdp_t$: the natural logarithm of the export ratio on GRDP;

$\ln impgrdp_t$: the natural logarithm of the import ratio on GRDP;

$\ln fdi_t$: the natural logarithm of actual or disbursed FDI in the area.

The random error is denoted as εt.

p,q1,q2,q3,q4, and q5: the optimal lag lengths of the dependent and independent variables.

In order to estimate the short-run and long-run effects, the ARDL model can be reparameterized into the following error correction representation:

$$\Delta \ln grdp_t = \alpha_0 + \sum_{i=1}^{p-1}\alpha_i \Delta \ln grdp_{t-i} + \sum_{j=0}^{q1-1}\beta_j \Delta \ln cap_{t-j} + \sum_{k=0}^{q2-1}\gamma_k \Delta \ln lab_{t-k} + \sum_{l=0}^{q3-1}\delta_l \Delta \ln exgrdp_{t-l}$$
$$+\sum_{m=0}^{q4-1}\phi_m \ln impgrdp_{t-m} + \sum_{n=0}^{q5-1}\theta_n \Delta \ln fdi_{t-n} + \lambda_1 \ln grdp_{t-1} + \lambda_2 \ln cap_{t-1} + \lambda_3 \ln lab_{t-1} + \lambda_4 \ln exgrdp_{t-1}$$
$$+ \lambda_5 \ln impgrdp_{t-1} + \lambda_6 \ln fdi_{t-1} + \varepsilon_t \quad (3)$$

The expected signs of the coefficients are determined as follows:

- The coefficient of capital is expected to be positive because capital accumulation is a core driver of growth in the Solow model.
- The coefficient of labor is also expected to be positive because labor is a fundamental input in production.
- For international trade, the coefficient of lnexgrdp is expected to be positive because exports are often associated with market expansion, exploiting economies of scale, and improving productivity; while the coefficient of lnimpgrdp theoretically can be positive if imports reflect access to high-quality inputs and technology, but it can also be weak or negative if the economy heavily relies on imported inputs.

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- The coefficient of FDI is expected to be positive because FDI can stimulate growth through capital accumulation, technology transfer, and improved production efficiency.

3.3. Estimation Method

The study uses the ARDL–ECM model to simultaneously analyze the long-term relationship and short-term dynamics between the variables. The ARDL approach is suitable in three cases: (i) relatively small sample sizes; (ii) variables that can be integrated in mixed order at I(0) and I(1); and (iii) studies that need to test both long-term equilibrium relationships and short-term adjustment mechanisms within the same estimation framework. Pesaran, Shin, and Smith (2001) showed that the bounds testing method within the ARDL framework is particularly useful when there is uncertainty about the exact integration order of the variables, as long as there are no I(2) variables.

In terms of empirical research, the study follows three main steps: First, the variables are tested for stationarity to ensure there are no second-order integrated variables. Next, the optimal ARDL model is selected based on the appropriate information criteria. Then, the bounds test is used to examine the existence of a long-term relationship between economic growth, capital, labor, exports, imports, and FDI. When a long-term relationship exists, the model is rewritten in the form of ECM to separate the long-term and short-term coefficients, while also assessing the speed of adjustment to the equilibrium state through the error correction coefficient. This approach allows for the consistent testing of the three proposed research hypotheses.

4. Research Data and Variables

4.1. Research Data

The study uses annual time series data for HCMC. The use of annual data is appropriate for the local research context in Vietnam, where indicators such as GRDP, investment capital, labor, imports and exports, and FDI are often published more stably and consistently on an annual data. At the same time, with a small sample size, annual data is still suitable for analyzing long-term relationships and short-term adjustment mechanisms within the ARDL framework. This is also one of the reasons why the ARDL method is often used in time series studies with small samples.

The dataset was constructed to simultaneously reflect traditional growth factors and international integration factors. The dependent variable is real GRDP, representing the scale of the city's economic activity. The explanatory variables include capital, labor, exports on GRDP, imports on GRDP, and FDI. In which, capital and labor represent the basic inputs of the Solow model; the two trade variables reflect the degree of integration of the local economy with the international market; while FDI is included as an extended variable to reflect the technology channel from abroad.

4.2. Measurement of Variables and Data Sources

The real GRDP of Ho Chi Minh City is measured by total income generated within the territory of HCMC. Capital is measured by the development investment capital in the city. Labor is measured by the number of workers currently employed in the city. FDI is measured by the actual or disbursed foreign direct investment, depending on which indicator is more consistent over time. These variables are mainly collected from the Ho Chi Minh City Statistical Yearbook.

For trade openness, instead of using a composite openness index, the study separates trade into two components: the export-to-grdp ratio (exgrdp) and the import-to-grdp ratio (impgrdp). This approach assistances to better distinguish the roles of the export and import dimensions in local growth, while also being consistent with the empirical results of the study.

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4.3. Data Processing

Before estimation, monetary variables such as GRDP, CAP, and FDI are prioritized to be used at real prices or adjusted to the same price level when necessary to eliminate the impact of inflation. Moreover, the data is employed for descriptive statistical analysis.

Then, the positive and scale-significant variables are converted to their natural logarithm form. Logarithmization has two main benefits in this study: reducing the skewness of the data distribution and the interpretating estimated coefficients in elastic form. Therefore, the variables in the model are denoted as lngrdp, lncap, lnlab, lnexgrdp, lnimpgrdp, and lnfdi, respectively.

Table 1. Description of the variables after logarithmic transformation.

Variable	Symbol	Measurement	Expected sign	Data source
Economic growth	lngrdp	Natural logarithm of real Gross Regional Domestic Product (GRDP) of HCMC	Dependent variable	Ho Chi Minh City Statistical Yearbook
Capital	lncap	Natural logarithm of local investment capital in HCMC	+	Ho Chi Minh City Statistical Yearbook
Labor	lnlab	Natural logarithm of the number of employed workers in HCMC	+	Ho Chi Minh City Statistical Yearbook
Trade exports	lnexgrdp	Natural logarithm of the export-to-GRDP ratio, calculated as exports divided by GRDP	+	Ho Chi Minh City Statistical Yearbook
Trade imports	lnimpgrdp	Natural logarithm of the import-to-GRDP ratio, calculated as imports divided by GRDP	+/−	Ho Chi Minh City Statistical Yearbook
Foreign investment	lnfdi	Natural logarithm of realized FDI	+	Ho Chi Minh City Statistical Yearbook

Table 2. Descriptive statistics.

Variable	Obs.	Mean	Std. Dev.	Min	Max	Skewness
grdp	25	731,914.60	556,253.70	75,863.00	1,778,269.00	0.33
exgrdp	25	0.963	0.351	0.515	1.527	0.37
impgrdp	25	0.952	0.257	0.636	1.329	0.37
cap	25	185,173.60	127,654.00	18,224.46	379,906.00	0.13
lab	25	3,210,521.00	1,572,569.00	259,149.00	4,885,928.00	-0.83
fdi	25	31,797.55	19,548.01	5,811.92	70,126.00	0.28

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Source: Authors' compilation based on data collected from Ho Chi Minh City Statistical Yearbook and estimation using Stata.

Table 2 shows that HCMC experienced significant economic expansion during the study period. GRDP, local investment capital, and FDI have significant fluctuations, reflecting the processes of growth, capital accumulation, and foreign investment attraction changing markedly over time. The two ratios of exgrdp and impgrdp have average values close to 1, indicating that Ho Chi Minh City's economy has a very high level of trade integration. The skewness and kurtosis indices do not indicate any serious abnormalities in the data distribution. Therefore, the data is suitable for further analysis using the ARDL model.

Table 3. Correlation matrix.

Variable	lngrdp	lnexgrdp	lnimpgrdp	lncap	lnlab	lnfdi
lngrdp	1.0000					
lnexgrdp	-0.9452	1.0000				
lnimpgrdp	-0.8893	0.9260	1.0000			
lncap	0.9889	-0.9090	-0.8737	1.0000		
lnlab	0.4143	-0.4858	-0.4727	0.3351	1.0000	
lnfdi	0.9266	-0.8660	-0.8937	0.9510	0.2791	1.0000

Note: Correlations are computed using logged variables. *Source: Authors' estimation using Stata.*

Table 3 presents the correlation matrix between the variables in logarithmic form. The results show that lngrdp has a strong positive correlation with lncap and lnfdi, implying that the economic growth of Ho Chi Minh City is closely linked to capital accumulation and foreign direct investment inflows. Conversely, lnexgrdp and lnimpgrdp have a negative correlation with lngrdp, which may reflect the measurement characteristics of trade variables in the form of ratios to GRDP, rather than implying a direct negative impact of trade on growth.

Additionally, the relatively high correlation between some explanatory variables, particularly between lncap and lnfdi, as well as between lnexgrdp and lnimpgrdp, indicates the potential existence of multicollinearity to a certain extent. However, the correlation analysis is only preliminary; the dynamic and long-term relationships between the variables will be formally tested through the ARDL model in the following sections.

5. Results and Discussion

5.1. Unit Root Test Results

Before estimating the ARDL model, the study conducted the Augmented Dickey–Fuller (ADF) unit root test on the variables lngrdp, lnexgrdp, lnimpgrdp, lncap, lnlab, and lnfdi. The results show that lngrdp, lnexgrdp, lnimpgrdp, lnlab, and lnfdi do not stop at the level but become stationary after first differencing, while lncap is stationary at the level. Thus, the variables in the model have a mixed integration order between I(0) and I(1), and there is no evidence of I(2) variables. This confirms that the ARDL method is suitable for the small sample context and the annual time series data of the study.

Table 4. Results of the ADF unit root test.

Variables	ADF test at level, lag(0)	p-value	ADF test at first difference, lag(0)	p-value	Order of integration
lngrdp	-2.671	0.0791	-3.190	0.0206	I(1)
lnexgrdp	-1.216	0.6666	-5.103	0.0000	I(1)

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lnimpgrdp	-1.598	0.4845	-6.063	0.0000	I(1)
lncap	-3.109	0.0259	-3.153	0.0228	I(0)
lnlab	-1.744	0.4084	-4.655	0.0001	I(1)
lnfdi	-1.432	0.5670	-3.686	0.0043	I(1)

Note: The decision on the order of integration is prioritized based on the ADF test without trend at level and first difference. No I(2) variables. *Source: Authors' estimation using Stata.*

5.2. Optimal ARDL Specification

Based on the new dataset, in which the aggregate trade variable is separated into lnexgrdp and lnimpgrdp, the optimal model chosen is ARDL(1,1,0,1,1,1). This result shows that current economic growth depends on its own one-period lag, along with the dynamics of expgrdp, impgrdp, capital, labor, and fdi. Structurally, this is a more appropriate specification compared to the model using a composite openness index, as it allows for a clearer distinction of the individual roles of exports and imports in the growth process of Ho Chi Minh City.

Table 5. Results of the optimal ARDL model. Model selected: ARDL(1,1,0,1,1,1).

Variable	Coefficient	Standard Error	t-statistic	p-value
L1.lngrdp	0.7096	0.1223	5.80	0.000
lnexgrdp	0.1239	0.1406	0.88	0.394
L1.lnexgrdp	-0.3646	0.1263	-2.89	0.013
lnimpgrdp	-0.4004	0.1237	-3.24	0.006
lncap	-0.0928	0.1312	-0.71	0.492
L1.lncap	0.3279	0.1417	2.31	0.038
lnlab	-0.0564	0.0207	-2.73	0.017
L1.lnlab	-0.0186	0.0129	-1.44	0.174
lnfdi	0.0428	0.0582	0.74	0.475
L1.lnfdi	-0.1997	0.0563	-3.55	0.004
_cons	3.8004	0.6816	5.58	0.000

Source: Authors' estimation using Stata.

5.3. Bounds Test and Evidence on Long-Run Relationship

The results of the bounds test for the baseline model show that the F-statistic is 7.185, while the t-statistic is -2.376. Specifically considering the F-statistic, this value exceeds the upper bound I(1) at the 5% significance level, implying evidence supporting the existence of a long-term relationship between the variables. However, the t-statistic does not exceed the corresponding critical threshold of I(1), so the bounds test does not allow for a definitive rejection of the hypothesis of no long-term relationship.

Therefore, the appropriate interpretation is: the model provides mixed evidence, positive but not conclusive regarding long-term cointegration. This is a point that needs to be maintained throughout the manuscript to avoid overly strong conclusions.

Table 5. Bounds Test result.

Indicators	Value
F-statistic	7.185
t-statistic	-2.376
Case	3

Conclusion: Stata No rejection at 10%, 5%, and 1% Critical value for small sample (5 variables, 24 observations, 4 short-term coefficients)

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Significance level	I(0) Lower bound F	I(1) Upper bound F	I(0) Lower bound t	I(1) Upper bound t
10%	2.750	4.254	-2.499	-3.807
5%	3.471	5.261	-2.924	-4.340
1%	5.416	7.940	-3.840	-5.497

Note: The F statistic supports the possibility of a long-term relationship, but the t- statistic does not confirm this. Therefore, the correlational evidence is mixed and not definitively conclusive. *Source: Authors' estimation using Stata.*

5.4. Error-Correction Representation: Long-Run and Short-Run Effects

Although the bounds test did not provide a definitive conclusion, the ECM model shows that the error correction coefficient is negative and statistically significant (ECT=−0.2904, p=0.034) (ECT = -0.2904, p = 0.034) (ECT=−0.2904, p=0.034). This implies that approximately 29.0% of the deviation from equilibrium is corrected within one year, indicating that the system tends to return to equilibrium after short-term shocks. From an econometric perspective, this is a signal consistent with a long-term adjustment mechanism, but it still needs to be placed in the context of the bounds test, which has not yet reached a definitive conclusion.

In the long term, exports over GRDP (lnexgrdp) have a negative coefficient and are statistically significant. This result should not be simply understood as exports hindering growth, as the variable in the study is the export-to-GRDP ratio, not the absolute export value. When GRDP grows faster than exports, this ratio can decrease even tho the value of exports continues to rise. Therefore, the negative sign reflects a structural correlation on the ratio, rather than a purely negative causal effect of exports. In the short term, D1.lnexgrdp has a positive and significant sign, indicating that relative exports still play a supportive role in growth in the short term.

Imports over GRDP (lnimpgrdp) also have a negative coefficient in the long term, although it is only significant at the margin. This suggests that a relatively larger import compared to GRDP may reflect a high dependence on intermediate inputs and capital goods from abroad, or it could also reflect the denominator effect when GRDP grows faster than imports. Therefore, this result should be viewed as a trend that needs discussion, rather than a strong conclusion.

Capital (lncap) is the variable with the strongest and most stable results: a large positive coefficient, highly significant in the long term. This aligns closely with the extended Solow model and shows that capital accumulation remains the core driver of economic growth in Ho Chi Minh City. Conversely, in the short term, the differential of capital is negative, implying that the benefits of investment do not arise immediately but require time to transform into output.

Labor (lnlab) has a negative sign in the long term but is only significant at the margin. This result does not deny the role of labor in the extended Solow model; on the contrary, it suggests that the growth of Ho Chi Minh City may no longer primarily depend on the scale of labor, but increasingly rely on the quality of human resources, productivity, and structural economic shifts. Therefore, keeping the labor variable in the model is necessary to ensure theoretical consistency, even if the statistical significance of this variable is not yet strong.

FDI (lnfdi) yields negative results in the long term but positive results in the short term. This structure shows that FDI can create an immediate boost to economic activity through expanded investment and disbursement, but the technology spillover effects and linkages with the domestic business sector are not strong enough to ensure a long-term growth impact in the same direction. This is an important policy finding, as it emphasizes that the quality and absorption capacity of FDI are more important than the scale of capital flows themselves.

Table 6. ECM Results: Long-term and Short-term Effects of the Baseline Model. ECM model: ARDL(1,1,0,1,1,1) Panel A. Error correction coefficient.

Variable	Coefficient	Standard Error	t-statistic	p-value
ECT = L1.lngrdp	-0.2904	0.1223	-2.38	0.034

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Panel B. Long-run coefficients

Variable	Coefficient	Standard Error	t-statistic	p-value
lnexgrdp	-0.8290	0.2970	-2.79	0.015
lnimpgrdp	-1.3786	0.7852	-1.76	0.103
lncap	0.8093	0.1534	5.28	0.000
lnlab	-0.2584	0.1497	-1.73	0.108
lnfdi	-0.5401	0.2231	-2.42	0.031

Panel C. Short-run coefficient

Variable	Coefficient	Standard Error	t-statistic	p-value
D1.lnexgrdp	0.3646	0.1263	2.89	0.013
D1.lncap	-0.3279	0.1417	-2.31	0.038
D1.lnlab	0.0186	0.0129	1.44	0.174
D1.lnfdi	0.1997	0.0563	3.55	0.004
_cons	3.8004	0.6816	5.58	0.000

Note: The negative and significant ECT coefficient indicates the existence of an adjustment mechanism toward equilibrium, but since the bounds test has not reached a definitive conclusion, the long-term results should be interpreted with caution. *Source: Authors' estimation using Stata.*

Table 6 presents the ECM results of the ARDL (1,1,0,1,1,1) model. The error correction coefficient is negative and statistically significant, indicating that approximately 29.04% of the deviation from equilibrium is corrected within one year. This result implies the existence of a dynamic adjustment mechanism in the model.

In the long term, lncap has a positive and statistically significant impact, affirming the important role of capital accumulation in the economic growth of Ho Chi Minh City.

Conversely, lnexgrdp and lnfdi have negative coefficients and are statistically significant, while lnimpgrdp and lnlab are only marginally significant.

In the short term, D.lnexgrdp and D.lnfdi have positive and significant effects, indicating that relative exports and FDI can support growth in the short term.

However, since the bounds test has not provided conclusive evidence of cointegration, the long-term coefficients should be interpreted with caution.

5.5. Diagnostic Tests and Model Adequacy

Table 7 presents the diagnostic tests of the baseline model. The results of the Breusch–Godfrey test show no strong evidence of autocorrelation at the 5% significance level, although there are marginal signs at the 10% level. The Skewness/Kurtosis test shows that the residuals follow a normal distribution, implying that the model does not violate the assumption of error distribution.

However, the Breusch–Pagan/Cook–Weisberg test indicates the presence of heteroscedasticity, while the Ramsey RESET test suggests the possibility of model misspecification or omitted variable. To address these issues, the study uses robust standard errors to ensure the robustness of the estimates. At the same time, the results are interpreted cautiously and combined with additional tests in the robustness checks section.

Overall, although there are some common limitations in local-level time series data, the model still provides reliable estimates for analyzing the relationship between economic growth and explanatory factors.

Table 7. Results of the diagnostic test of the baseline model.

Test	Null hypothesis (H_0)	Statistic	p-value	Conclusion
Breusch–Godfrey LM	No autocorrelation	Chi2 = 3.729	0.0535	Not to reject H_0 at the 5% significance level, but the result is

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				marginally significant at the 10% level
Breusch–Pagan/Cook–Weisberg	Homoskedasticity/ Constant variance	Chi2 = 10.92	0.0010	Reject H_0; there is evidence of heteroskedasticity
Skewness/Kurtosis	The residuals are normally distributed	Adj Chi2 = 1.76	0.4140	Not to reject H_0; the residuals are normally distributed
Ramsey RESET	The model is correctly specified/no omitted variables	F = 9.21	0.0032	Reject H_0; there is evidence of model misspecification or omitted variables

Source: Authors' estimation using Stata.

5.6. Robustness Check with COVID-19 Dummy

Table 8. Test the robustness with the COVID-19 dummy variable COVID-19 (dcovid). **Panel A.** The optimal ARDL model with covid The chosen model: ARDL (1,1,0,1,0,1,0).

Variable	Coefficient	Standard Error	t-statistic	p-value
L1.lngrdp	0.6716	0.1254	5.35	0.000
lnexgrdp	0.1458	0.1466	0.99	0.338
L1.lnexgrdp	-0.3893	0.1305	-2.98	0.011
lnimpgrdp	-0.3808	0.1319	-2.89	0.013
lncap	-0.1250	0.1414	-0.88	0.393
L1.lncap	0.3945	0.1537	2.57	0.023
lnlab	-0.0691	0.0194	-3.56	0.003
lnfdi	0.0192	0.0669	0.29	0.779
L1.lnfdi	-0.1657	0.0668	-2.48	0.028
dcovid	-0.0420	0.0501	-0.84	0.417
_cons	3.7117	0.7301	5.08	0.000

Panel B. ECM of the model with COVID

Component	Variable	Coefficient	p-value
ADJ	ECT = L1.lngrdp	-0.3284	0.021
LR	lnexgrdp	-0.7415	0.020
LR	lnimpgrdp	-1.1596	0.100
LR	lncap	0.8207	0.000
LR	lnlab	-0.2104	0.099
LR	lnfdi	-0.4461	0.025
LR	dcovid	-0.1279	0.437
SR	D1.lnexgrdp	0.3893	0.011
SR	D1.lncap	-0.3945	0.023
SR	D1.lnfdi	0.1657	0.028

Panel C. Bounds test and diagnostic tests of the model with COVID

Indicator	Statistic	p-value	Conclusion
Bounds F-statistic	5.626	I(1) p = 0.035	Evidence of a long-run relationship based on the F-statistic
Bounds t-statistic	-2.618	I(1) p = 0.397	Not confirmed based on the t-statistic
Breusch–Godfrey LM	Chi2 = 1.642	0.2001	No evidence of autocorrelation

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Breusch–Pagan/Cook–Weisberg	Chi2 = 8.63	0.0033	Evidence of heteroskedasticity
Skewness/Kurtosis	Adj Chi2 = 1.47	0.4793	Residuals are normally distributed
Ramsey RESET	F = 12.75	0.0009	Potential functional form misspecification

Note: The model includes a COVID-19 dummy variable used as an additional robustness check. The variable dcovid takes the value of 1 for the period 2020–2021 and 0 for the remaining years. The results show that the addition of this variable does not significantly change the sign and economic significance of the main variables.

Source: Authors' estimation using Stata.

To assess the robustness of the main results, the study adds a dummy variable for COVID for the period 2020–2021 to control for the unusual shock caused by the COVID-19 pandemic. When this variable was included in the model, the optimal specification chosen was ARDL(1,1,0,1,0,1,0). The results show that the signs and economic significance of the main variables generally remain stable compared to the baseline model.

Specifically, the error correction coefficient continues to have a negative sign and is statistically significant, with a value of -0.3284 and a p-value of 0.021. This indicates that approximately 32.84% of the deviation from equilibrium is corrected within one year. This result further reinforces the evidence of the existence of a dynamic adjustment mechanism in the model, although the bounds test results still need to be interpreted with caution.

Regarding the long-term impact, lncap continues to have a positive, large, and statistically significant coefficient, affirming the stable role of capital accumulation in the economic growth of Ho Chi Minh City. lnexgrdp and lnfdi still have negative values and are statistically significant in the long term, while lnimpgrdp and lnlab are only significant at the margin.

In the short term, D.lnexgrdp and D.lnfdi continue to have a positive and significant impact, indicating that relative exports and FDI can support growth in the short term.

Overall, the addition of the COVID-19 dummy variable did not significantly change the main conclusions of the baseline model. Particularly, the variable dcovid is not statistically significant in both the ARDL and ECM models. This implies that after controlling for key economic variables, the COVID-19 shock does not create a statistically significant distinct impact on GRDP growth in the current specification. However, these results should be interpreted with caution as the COVID-19 period only includes a limited number of observations in the annual data series.

Regarding the bounds test, the F-statistic of the model with dcovid exceeds the I(1) threshold at the 5% significance level, but the t-statistic does not fully confirm the level relationship. Therefore, similar to the baseline model, the evidence of the long-term relationship remains mixed.

Regarding model diagnostics, the inclusion of dcovid supports improve the autocorrelation test, as the Breusch–Godfrey LM no longer indicates an autocorrelation issue. The residuals also continue to follow a normal distribution.

However, heteroscedasticity and the RESET test still indicate some limitations in model specification. Therefore, the model with dcovid is considered an additional robustness check, rather than a replacement for the baseline model.

Generally, the robustness check with the COVID-19 dummy variable shows that the main results remain relatively stable. Capital continues to be the factor with the strongest and most consistent long-term impact on Ho Chi Minh City's economic growth. Relative exports and FDI have a positive impact in the short term but have not yet created a long-term effect in the same direction. This result implies that the growth of Ho Chi Minh City does not only depend on the extent of international trade expansion and FDI attraction in terms of quantity, but also on the quality of international trade, the quality of FDI, the ability to absorb technology, and the efficiency of capital utilization.

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6. Conclusion and Policy Implications

This study examines the relationship between the economic growth of Ho Chi Minh City and trade-production resource variables within the framework of the extended Solow model, using the ARDL model with annual time series data. The experimental results show that the variables have mixed integration orders between I(0) and I(1), therefore ARDL is the appropriate method. The chosen baseline model is ARDL(1,1,0,1,1,1). In the ECM structure, the error correction coefficient is negative and statistically significant, indicating that the system tends to adjust back to equilibrium after short-term shocks. However, the bounds test only provides mixed evidence, so the study does not interpret the results as an absolute affirmation of long-term cointegration. Therefore, the findings should be understood as empirical evidence with strong suggestiveness, but still approached with academic caution.

In terms of economic content, the results show that capital is the factor with the most positive, strong, and stable impact in the long term. This confirms the central role of capital accumulation, infrastructure investment, logistics capacity, technology, and production capacity in the economic growth of Ho Chi Minh City. Meanwhile, exports on GRDP have a positive impact in the short term but a negative one in the long term; imports on GRDP tend to be negative in the long term; FDI is positive in the short term but negative in the long term; and labor is retained in the model according to the extended Solow logic but with weaker statistical results. Overall, these findings suggest that the growth of Ho Chi Minh City is no longer primarily dependent on the expansion of trade and capital attraction in a broad sense, but increasingly on the quality of trade, the quality of FDI, the ability to absorb technology, and the efficiency of capital utilization.

From a policy perspective, the above results align with the official direction of the Central Government and the Government toward Ho Chi Minh City. Resolution 31-NQ/TW focuses on developing Ho Chi Minh City toward rapid and sustainable growth based on renewing the growth model, restructuring the economy, enhancing productivity, quality, efficiency, and international competitiveness, while also building the city into a center for economics, finance, trade, and science-technology in the Southeast Asia region. The Ho Chi Minh City Planning period 2021–2030, with a vision for 2050, also emphasizes the need to make breakthroughs in productivity, quality, and competitiveness, restructure the industrial and service sectors, promote the digital economy, digital industry, logistics, and innovation.

Based on that, the first policy implication is that Ho Chi Minh City needs to shift its focus from expanding trade in quantity to enhancing the quality of international trade.

Because the long-term coefficient of exports on GRDP does not align with growth, the city should not only pursue the goal of absolute value increase but should also promote exports with higher technology content, added value, and domestic value. This aligns with the Goods Import-Export Strategy until 2030, which emphasizes sustainable development of import-export activities, balanced structure, enhancing position in the global value chain, developing Vietnamese goods brands, and forming production centers to supply raw materials for key export industries. For Ho Chi Minh City, this means prioritizing the development of supporting industrial clusters, high-tech industries, knowledge export services, and high value-added links in the regional supply chain.

The second implication is the need to better control the quality of imports, rather than viewing imports as purely a disadvantageous variable. The negative impact of imports on GRDP in the long term indicates that the growth model may still heavily depend on imported inputs. Therefore, the appropriate direction is not to mechanically reduce imports, but to restructure imports by prioritizing source technology, modern machinery and equipment, strategic input materials, and intermediate products that help enhance productivity. At the same time, the city needs to strongly develop the supporting industry and localization capacity to reduce dependence on import groups that can be substituted domestically. This approach aligns with the Action Program for implementing the Goods Import-Export Strategy by 2030, which emphasizes developing domestic supply sources for raw materials and enhancing production capacity to serve exports.

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The third implication is that Ho Chi Minh City needs to shift from a quantity-based FDI attraction strategy to a selective FDI strategy focused on quality and spillover effects. Experimental results show that FDI supports short-term growth but does not create a similar impact in the long term. This suggests that not all FDI capital flows contribute equally to sustainable growth. In the context of Resolution 98/2023/QH15 allowing Ho Chi Minh City to pilot special mechanisms and policies and expand the space for selecting strategic investors, the city should prioritize FDI projects with high technology content, R&D, innovation, design centers, data, finance, logistics, digital industries, and sectors capable of deep integration with the domestic business sector. The amendment and supplementation of Resolution 98 in 2025 also opens up more institutional space for new development tools, including Ho Chi Minh City's free trade zone, further clarifying the requirement to link institutional incentives with upgrading the quality of growth, rather than merely attracting capital flows.

The fourth implication is that the city needs to continue viewing investment and capital accumulation as the main pillars of growth, but it must be linked to improving the efficiency of capital allocation. Because capital is the variable with the strongest long-term impact, development policies need to prioritize transportation infrastructure, seaports, warehousing, logistics digitization, regional connectivity, and innovation infrastructure. This aligns with the direction of the Ho Chi Minh City Master Plan 2021–2030 and Resolution 31-NQ/TW on building the city into a hub for international exchange and integration, a center for modern service and industrial sectors, and a leader in the digital economy and digital society. In fact, the orientations to promote green logistics, sustainable logistics, and a circular economy in Ho Chi Minh City are also consistent with the implication from research findings that sustainable growth requires not only increased investment but also improved investment quality and resource utilization efficiency.

The fifth implication relates to the labor market and productivity. Although the labor variable does not yield results as strong as capital, keeping labor in the model is theoretically necessary. This result suggests that the scale of labor itself is no longer a strong driver of growth in Ho Chi Minh City; instead, the city needs to prioritize enhancing the quality of human resources, digital skills, logistics skills, supply chain management capabilities, and technology absorption capacity. This is also in line with the direction of Resolution 31-NQ/TW and the city's planning, which prioritizes innovation, science and technology, and high-quality human resources as the foundation for long-term competitiveness.

The sixth implication is about the design of local institutions. Due to the robustness results with the COVID-19 dummy variable not significantly altering the main conclusions, it can be seen that the core issue does not lie in a single short-term shock, but in the long-term growth structure of the city. Therefore, effectively leveraging the special mechanisms under Resolution 98 should focus on removing institutional bottlenecks for investment, logistics, innovation, attracting strategic investors, and developing new economic spaces. In the current context, this could include accelerating the establishment of modern logistics centers, high-tech service growth poles, linking ports – industrial zones – trade – finance, and better leveraging Ho Chi Minh City's regional central role in the international production and trade network.

However, the study also has limitations that need to be clearly acknowledged. Firstly, the bounds test has not provided conclusive evidence of long-term cointegration. Secondly, diagnostic tests still indicate the phenomenon of heteroscedasticity and the possibility of model misspecification. Thirdly, the trade variables in the study are measured as a ratio of GRDP, so the sign of the coefficient should be interpreted in the context of the ratio structure, and should not be equated with the impact of absolute import-export volume. Therefore, the policy implications drawn from the study should be considered as directions with strong empirical foundations, but they still need to be further validated by subsequent research with more detailed data, alternative measures for trade, and additional testing methods.

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In summary, the research shows that the economic growth of Ho Chi Minh City during the study period is most closely linked to capital accumulation, while the impact of international trade and FDI depends on the time dimension and the quality of the integration process.

Therefore, the most important policy message is that Ho Chi Minh City needs to shift from a growth model based on expanding trade and attracting capital extensively to a growth model based on the quality of trade, the quality of FDI, upgrading technology, developing modern logistics, and enhancing productivity. This is also the most suitable direction in line with the current policy orientations of the Central Government and the Government for Ho Chi Minh City in the period leading up to 2030 and the vision for 2050.

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Abbreviations

The following abbreviations are used in this manuscript:

CAP	Capital
GRDP	Gross Regional Domestic Product
FDI	Foreign Direct Investment
HCMC	Ho Chi Minh City
OECD	Organizational Economic Country Development

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