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DYNAMIC RELATIONSHIPS BETWEEN SELECTED MACROECONOMIC VARIABLES AND MALAYSIA'S SECTORAL GROSS DOMESTIC PRODUCT: AN ARDL APPROACH

NORIMAH RAMBELI[1]*, EMILDA HASHIM, ASMAWI HASHIM,
RAFIDURAIDA ABDUL RAHMAN & NUR SYAHIRAH ABDUL HADI

1 Economics Department, Faculty of Management and Economics, Universiti Pendidikan Sultan Idris, 35900 Tanjung Malim, Perak, MALAYSIA. E-mail: norimah@fpe.upsi.edu.my

2 Department of Accounting and Finance, Faculty of Management and Economics, Universiti Pendidikan Sultan Idris, 35900 Tanjung Malim, Perak, MALAYSIA.

3 Management Department, Faculty of Economics and Management, Lanzhou City University, CHINA.

Corespondent Email: norimah@fpe.upsi.edu.my

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Abstract: This study aims to investigate the dynamic relationship between macroeconomic variables gross fixed capital formation (GFCF), external debt (ED), export trade (EXT), remittances (REM), and labor force (LF) with sector GDP in Malaysia, which consists of the primary, secondary, and tertiary sectors. By using the ARDL (Auto-Regressive Distributed Lag) Model approach, the study's results show these variables' short term and long-term effects of those variables on the economic growth of the sectors concerned. The results of the study show that gross fixed capital formation and labor force have a consistent positive effect on GDP in most sectors, emphasizing the role of infrastructure investment and workforce efficiency in driving growth. In contrast, external debt and remittances show mixed effects, reflecting the challenges of financial management and productive use of remittance resources. Export trade has a significant influence but varies by sector, where the primary sector is exposed to the risk of dependence on certain commodity exports, while the tertiary sector is more flexible and able to absorb the impact of the global market. This study contributes to the existing literature by providing empirical insights into how macroeconomic variables affect GDP growth by sector in Malaysia.

Keywords: Gross Fixed Capital Formation, External Debt, Export Trade, Remittances, Labor Force, Sectoral GDP, ARDL Model

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INTRODUCTION

Economic growth is an essential barometer indicating how well an economy is performing in terms of health and resilience. In Malaysia, it is indispensable to comprehend the drivers of GDP growth in respect to appropriately addressing the course of informed policy formulation.

Of these drivers, gross fixed capital formation, external debt, export trade, remittances, and labor force dynamics are crucial drivers shaping the primary, secondary, and tertiary sectors of the country. These sectors are the backbone of the Malaysian economy, and their development is very important in ensuring sustainable growth amidst global uncertainties.

Gross fixed capital formation contributes to developing productive capacity by investing in machinery, infrastructure, and technology that advances productive modernization in the primary sector, industrial productivity in the secondary sector, and efficiency of services in the tertiary sector. External debt may finance much needed development projects in education and industry, for example, but it introduces potential fiscal problems and a lack of sustainability into the future.

Traditionally, Malaysia's GDP has been fuelled by export trade in commodities such as palm oil, rubber, and electronics. While exports ensure foreign exchange and industrial output, the economy remains at risk due to its dependence on a few commodities when demand for them goes down globally. In the same vein, while remittances have contributed significantly by increasing household incomes and boosting domestic consumption, they have also heightened the challenge of brain drain.

The labor force is one of the essential ingredients of economic output, though reliance on foreign labor in the primary and secondary sectors is a challenge, while the tertiary sector is increasingly dependent on skilled labor to maintain the growth of, among others, finance, education, and technology. These are workforce dynamics that will mean Malaysia's long-term economic stability requires addressing these pressing issues.

This paper attempts to analyze the dynamic relationships of these factors with Malaysia's GDP across the primary, secondary, and tertiary sectors. The estimations of the short run and long run effects of these variables on economic growth, using the following econometric methodologies like ARDL are completed. The results are expected to outline the most influential factors driving growth in each sector, accompanied by evidence-based policy recommendations for the achievement of sustainable and well-balanced economic development.

LITERATURE REVIEW

The discussion in the introduction has shown clearly the critical role that macroeconomic variables such as gross fixed capital formation, external debt, export trade, remittances, and labor force dynamics play in influencing the economic growth of Malaysia. It has also pointed out the need for an understanding of the dynamic relationships between these variables and sectoral GDPs for effective policy decisions. Therefore, this chapter forms the basis for relating the macroeconomic variables with GDP, with particular emphasis on Malaysia's primary, secondary, and tertiary sectors. The chapter synthesizes findings from previous studies to establish dynamic interactions between major macroeconomic variables and GDP components. Such insights provide the background for an investigation into sectoral GDP dynamics and the identification of the policy implications thereof for sustainable growth.

First, Gross fixed capital formation is the investment in physical capital, such as infrastructure, machinery, and buildings, which is very important in enhancing productive capacity, efficiency, and innovation. Empirical evidence also shows that gross fixed capital formation is positively related to gross domestic product. For example, Canning and Pedroni (2020) found that infrastructure investments significantly contribute to long term growth across 88 countries. In Malaysia, Zakariah, (2019) explained that gross fixed capital formation has long driven industrial development and economic diversification that eventually caused aggregate GDP growth. However, what is more important is the quality and strategic investment of investments.

Furthermore, External debt has a dual role in economic growth. Although debt may be used to finance all infrastructural and development projects, too much debt results in financial instability and fiscal vulnerabilities. In Malaysia, Lee & Ng (2015). found that external debt, when utilized effectively for developmental purposes, has a positive effect on GDP. However, over reliance on external borrowing without adequate utilization of resources tends to retard growth and raises fiscal risks. This underlines the need to balance growth attained through debt financing with sustainability, as very high levels of debt may crowd out productive investment in the future.

Moreover, Export trade now becomes an added factor for the growth of an open economy like Malaysia. Export oriented industrialization contributed much to GDP growth, especially in the secondary sector. Zakariah (2022) went further to dilate on the contribution of exports of electronics and machinery products from Malaysia. However, reliance on specific exports leaves the economy vulnerable to global demand fluctuations and trade frictions. Studies advocate for export diversification to mitigate risks and ensure sustainable growth (Lederman & Maloney, 2018).

Remittances are funds that migrant workers send back to the country of origin. Some studies, for instance, a study by Ismail & Mahyideen (2021), show that remittances increase economic growth through their positive impact on household expenditure, health, and education. However, since the demand of consumers for services is higher, it is observed that the tertiary sector suffers more from an uneven impact. If remittance inflows are utilized productively, their potential to generate additional development in the rural and backward areas will surely increase.

Labor relations are a great determinant of GDP through productivity and innovation. Malaysia's labor market has undergone a structural transformation from an agriculture-based sector into manufacturing and services. According to Ragayah (2021), human resource development along with upgrading human skills is indispensable in achieving sectoral growth of GDP. Despite the above fact, several challenges still exist about mismatch and inflexibility within the labor markets. Such constraints require policies targeting the issue through training programs for the full utilization of the labor force to become productive.

The existing literature suggests that, at the conceptual level the distinction between aggregate and sectoral effects of macroeconomic variables must be maintained. The primary sector requires agricultural technological and infrastructural investment to reduce post-harvest losses. For the secondary sector, industrial modernization and balanced regional investment are useful, while for the tertiary sector, infrastructural development and digital transformation facilitate service delivery and market expansion. Each sector will respond differently to changes in these variables, so specific policy intervention might be required for each sector.

While the literature emphasizes that strategic planning and optimum resource allocation are important in maximizing the potential of these macroeconomic variables in their contribution to GDP, few studies have pursued these relationships at the sectoral level in Malaysia. The study aims to fill this gap in the analysis of dynamic linkages between gross fixed capital formation, external debt, export trade, remittances, labor force, and GDP in the primary, secondary, and tertiary sectors in Malaysia. These findings would give evidence-based recommendations for pursuing balanced and sustainable economic growth.

THEORETICAL MODEL

This study is based on the Cobb-Douglas production theory, which was introduced by Cobb and Douglas (1928). The theory explains that the two main factors determining economic output, Y, are capital, K, and labor, L, while technological efficiency A is the key driver of productivity. The basic Cobb-Douglas function is given by:

The production function is expressed as:

$$Y = AK^{\alpha}L^{\beta}$$

However, previous studies have shown that other variables of the macroeconomy apart from capital and labor affected economic growth. Solow (1957) and other researchers such as Abugamea (2022) and Rambeli et al. (2018) pinpointed that external debt, export trade, remittances, and labor force changes have great impacts on GDP. The Cobb-Douglas function is augmented to incorporate these variables to fit the theoretical model into the Malaysian context.

The study adopts an integrative Cobb-Douglas production theory with econometric approaches to ascertain gross fixed capital formation, external debt, export trade, remittances, and labor force dynamics on GDP in the primary, secondary, and tertiary sectors. This extended function allows us to find out the relative contributions of each factor on sectoral economic growth.

This present study will, therefore, incorporate additional variables into the Cobb-Douglas theoretical model using the ARDL approach. The ARDL approach was applied to examine both the short run and long run relationships of sectoral GDP with capital formation, export trade, and labor as proposed by Pesaran and Shin (2022). Such a model can provide a framework to analyze imbalances between capital and labor and Malaysia's economic resilience against global uncertainties. This study utilizes quarterly time series data from 2011 to 2022, while the E-Views software is a significant analytical tool. It is expected that the results will provide sound empirical evidence to inform policy development in promoting balanced and sustainable sectoral economic growth in Malaysia.

MODEL AND DATA

This research used an empirical study of quarterly data from 2011 to 2022, covering the Malaysian economy and its sectoral composition. It considers the three important sectors: primary, secondary, and tertiary. Specifically, it would look into the relationship of GDP with selected macroeconomic variables like gross fixed capital formation (GFCF), external debt (ED), export trade (EXT), remittances (REM), and labor force (LF). The data set was collected

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by compiling data from the Central Bank of Malaysia (BNM) and the Department of Statistics Malaysia (DOSM). For analysis purposes, it is important to note that all variables are log transformed. The models are expressed in functional forms as follows:

Model 1: Aggregate GDP

$$GDP_t = \beta_{01} + \beta_1 GFCF_{t-i} + \beta_2 ED_{t-i} + \beta_3 EXT_{t-i} + \beta_4 REM_{t-i} + \beta_5 LF_{t-i} + \varepsilon_{t1} \quad (1)$$

Model 2: Primary Sector GDP

$$GDP_1 = \beta_{02} + \beta_1 GFCF_{t-1} + \beta_2 ED_{t-1} + \beta_3 EXT_{t-1} + \beta_4 REM_{t-1} + \beta_5 LF_{t-1} + \varepsilon_{t2} \quad (2)$$

Model 3: Secondary Sector GDP

$$GDP_2 = \beta_{03} + \beta_1 GFCF_{t-2} + \beta_2 ED_{t-2} + \beta_3 EXT_{t-2} + \beta_4 REM_{t-2} + \beta_5 LF_{t-2} + \varepsilon_{t3} \quad (3)$$

Model 4: Tertiary Sector GDP

$$GDP_3 = \beta_{04} + \beta_1 GFCF_{t-3} + \beta_2 ED_{t-3} + \beta_3 EXT_{t-3} + \beta_4 REM_{t-3} + \beta_5 LF_{t-3} + \varepsilon_{t4} \quad (4)$$

Where,

GDP_t = Aggregate Gross Domestic Product

GDP_1 = GDP contribution from the Primary Sector

GDP_2 = GDP contribution from the Secondary Sector

GDP_3 = GDP contribution from the Tertiary Sector

$GFCF_t$ = Gross Fixed Capital Formation

ED_t = External Debt

EXT_t = Export Trade

REM_t = Remittances

LF_t = Labor Force

ε_t = Error term representing unobserved factors affecting GDP

Table 1: Variable and description

Symbol	Variables Name	Sources
GDP	Aggregate Gross Domestic Product	Department of Statistics Malaysia (DOSM)
GDP_1	Primary Sector Gross Domestic Product	Department of Statistics Malaysia (DOSM)
GDP_2	Secondary Sector Gross Domestic Product	Department of Statistics Malaysia (DOSM)
GDP_3	Tertiary Sector Gross Domestic Product	Department of Statistics Malaysia (DOSM)
GFCF	Gross Fixed Capital Formation	CEIC data
ED	External Debt	The World Bank Data
EXT	Export Trade	Central Bank of Malaysia (BNM)
REM	Remittances	The World Bank Data
LF	Labor Force	CEIC data

Table 1 shows the time series data used for each study. Data on Aggregate Gross Domestic Product (GDP), Primary Sector Gross Domestic Product (GDP_1), Secondary Sector Gross Domestic Product (GDP_2), Tertiary Sector Gross Domestic Product (GDP_3), were obtained from the Department of Statistics Malaysia (DOSM). The information on Gross Fixed Capital Formation (GFCF) and Labor Force (LF) is drawn from the CEIC data, External Debt (ED) and Remittances (REM) are extracted from The World Bank Data, and Export Trade (EXT) is provided by Central Bank of Malaysia - BNM.

All the variables used in this work have been transformed into natural logarithm forms to address the problem of unit discrepancy and generally improve the strength of the model. These variables' unit root tests and relationship modeling are statistically estimated using the EViews software version 12, which will ease the examination of the statistical relationships between the dependent and independent variables involved in this study.

METHODOLOGY

Therefore, the present paper attempts to investigate Malaysia's dynamic relationships between GDP (aggregate and sectoral) and selected macroeconomic variables: gross fixed capital formation, external debt, export trade, remittances, and labor force. The quantitative analysis was conducted using the ARDL model, which is particularly suitable for the estimation of both short run and long run relationships when the series under investigation may be of mixed integration orders that is, I(0) and I(1).

The quarterly data range is from 2011 Q1 to 2022 Q4, collected from reliable sources such as the Department of Statistics Malaysia, the World Bank, and Trading Economics. In this regard, this period is sufficient to capture the trend and fluctuations in economic activities within a decade, thus ensuring robust and reliable estimations. The research identifies four different models explaining the contribution of macroeconomic variables to GDP at the aggregate level and across three main sectors, namely primary, secondary, and tertiary.

ARDL Model Specification

The ARDL model is used to analyze the long run and short run dynamics between the economic variables. The general form of the ARDL (p, q) model includes both the lagged values of the dependent variable and the current and lagged values of the explanatory variables:

$$\Delta Y_t = \mu + \rho Y_{t-1} + \theta X_{t-1} + \sum_{j=1}^{p-1} \alpha_j \Delta Y_{t-j} + \sum_{j=0}^{q-1} \beta_j \Delta X_{t-j} + \varepsilon_t \quad (5)$$

So, Δ is the first difference, Y_t is the dependent variable, μ shows the intercept, X_t is all the independent variables in Kx1 vector form. Thus, the long run coefficient is present by $\rho \text{ and } \theta$ while the short run coefficient is present by $\alpha \text{ and } \beta$. Then, the lag order of both dependent and independent variables is shown by p and q, respectively. Finally, the ε_t defines the error term. For this study, the dependent variable GDP_t is modeled as a function of its lagged values and the current and lagged values of the independent variables. The equation for each GDP model is expressed as follows:

Model 1: Aggregate Gross Domestic Product

$$\begin{aligned}\Delta GDP_t = {} & \beta_0 + \beta_1 GDP_{t-1} + \beta_2 GFCF_{t-1} + \beta_3 ED_{t-1} + \beta_4 EXT_{t-1} + \beta_5 REM_{t-1} + \beta_6 LF_{t-1} \\ & + \sum_{i=1}^{p} \gamma_{6,i} \Delta GDP_{t-i} + \sum_{i=0}^{q} \gamma_{7,i} \Delta GFCF_{t-i} + \sum_{i=o}^{r} \gamma_{8,i} \Delta ED_{t-i} \\ & + \sum_{i=o}^{s} \gamma_{9,i} \Delta EXT_{t-i} + \sum_{i=o}^{t} \gamma_{10,i} \Delta REM_{t-i} + \sum_{i=o}^{u} \gamma_{11,i} \Delta LF_{t-i} + \delta_1 ECM_{t-1} \\ & + \mu_t \qquad (6)\end{aligned}$$

Model 2: Primary Sector Gross Domestic Product

$$\begin{aligned}\Delta GDP_{1t} = {} & \beta_{01} + \beta_1 GDP_{1t-1} + \beta_2 GFCF_{1t-1} + \beta_3 ED_{1t-1} + \beta_4 EXT_{1t-1} + \beta_5 REM_{1t-1} \\ & + \beta_6 LF_{1t-1} + \sum_{i=1}^{p} \gamma_{6,i} \Delta GDP_{1t-i} + \sum_{i=0}^{q} \gamma_{7,i} \Delta GFCF_{1t-i} + \sum_{i=o}^{r} \gamma_{8,i} \Delta ED_{1t-i} \\ & + \sum_{i=o}^{s} \gamma_{9,i} \Delta EXT_{1t-i} + \sum_{i=o}^{t} \gamma_{10,i} \Delta REM_{1t-i} + \sum_{i=o}^{u} \gamma_{11,i} \Delta LF_{1t-i} + \delta_2 ECM_{1t-1} \\ & + \mu_t \qquad (7)\end{aligned}$$

Model 3: Secondary Sector Gross Domestic Product

$$\Delta GDP_{2t} = \beta_{02} + \beta_1 GDP_{2t-1} + \beta_2 GFCF_{2t-1} + \beta_3 ED_{2t-1} + \beta_4 EXT_{2t-1} + \beta_5 REM_{2t-1} + \beta_6 LF_{2t-1} + \sum_{i=1}^{p} \gamma_{6,i} \Delta GDP_{2t-i} + \sum_{i=0}^{q} \gamma_{7,i} \Delta GFCF_{2t-i} + \sum_{i=o}^{r} \gamma_{8,i} \Delta ED_{2t-i} + \sum_{i=o}^{s} \gamma_{9,i} \Delta EXT_{2t-i} + \sum_{i=o}^{t} \gamma_{10,i} \Delta REM_{2t-i} + \sum_{i=o}^{u} \gamma_{11,i} \Delta LF_{2t-i} + \delta_3 ECM_{2t-1} + \mu_t \quad (8)$$

Model 4: Tertiary Sector Gross Domestic Product

$$\Delta GDP_{3t} = \beta_{03} + \beta_1 GDP_{3t-1} + \beta_2 GFCF_{3t-1} + \beta_3 ED_{3t-1} + \beta_4 EXT_{3t-1} + \beta_5 REM_{3t-1} + \beta_6 LF_{3t-1} + \sum_{i=1}^{p} \gamma_{6,i} \Delta GDP_{3t-i} + \sum_{i=0}^{q} \gamma_{7,i} \Delta GFCF_{3t-i} + \sum_{i=o}^{r} \gamma_{8,i} \Delta ED_{3t-i} + \sum_{i=o}^{s} \gamma_{9,i} \Delta EXT_{3t-i} + \sum_{i=o}^{t} \gamma_{10,i} \Delta REM_{3t-i} + \sum_{i=o}^{u} \gamma_{11,i} \Delta LF_{3t-i} + \delta_4 ECM_{3t-1} + \mu_t \quad (9)$$

After determining the optimal lag lengths using AIC a bounds test for cointegration is then performed to check for the presence of a long run relationship among the variables. If cointegration is found, the long run coefficients are estimated, and an error correction model (ECM) is used to capture the short run dynamics as per the mentioned equations (6,7,8, and 9).

Unit Root Test

The unit root test in this study will seek to establish whether the data series, aggregate and sectoral, and the independent variables of gross fixed capital formation, external debt, export trade, remittances, and labor force are stationary or non-stationary over time. Stationarity, in the aspect of time series analysis, is crucial, as it retains the statistical characteristics of the process under study, say mean and variation, constant to generate valid and feasible results (Cryer & Chan, 2022). Testing for stationarity is relevant in this thesis to validate whether the data can be used for the ARDL model since it requires that the variables must be either at levels stationary or first difference stationary respectively. Non stationarity in time series data often leads to spurious regression findings that may misrepresent the relationships that exist between GDP (aggregate and sectoral) and the selected macroeconomic variables.

The unit root test helps in the robustness and accuracy of the econometric analysis by ensuring that the time series data used in this study is stationary. This is a prerequisite step for the conduction of the bounds test for cointegration and estimation of the short term and long term relationships effectively.

Augmented Dickey-Fuller (ADF)

The Augmented Dickey-Fuller test, in contrast, is a statistical test used to determine whether a time series series is stationary or contains a unit root. In this respect, the ADF test will be applied in the context of the thesis concerning GDP, aggregate, and sectoral primary, secondary, and tertiary and the independent variables of the model, such as gross fixed capital formation, external debt, export trade, remittances, and labor force are tested for the suitability of an ARDL.

ADF is an augmented version of the Dickey Fuller test, in that it allows higher order autoregressive or moving average structure in the residual error by adding lagged differences of the dependent variable. By doing so, it significantly improved the reliability of the test statistic, especially when one suspects autocorrelation in the data.

The hypothesis used for this test is:

H_0: The series has a unit root (non-stationary)
H_1: The series is stationary (no unit root)

If the null hypothesis is rejected, then the variable is stationary; otherwise, it may be necessary to difference the variable to make it stationary. In this study, the ADF test ensures that the variables are either $I(0)$ that is, stationary at levels or $I(1)$ that is, stationary after first differencing. This is a prerequisite for the ARDL bounds testing approach, which allows for mixed orders of integration but requires the absence of $I(2)$ variables.

The ADF test of stationarity supports the robustness of the econometric analysis, thus forming a very sound basis for the analysis of short term and long-term relationships of GDP with the selected macroeconomic variables. The advantage of using ADF in a stationary test is that can still be estimated even though it has a different level of orders integration. This is the advantage of ADF compared to Eagle-Granger (1987) and Johansen and Juselius method (1990) which requires the same level of orders integration.

Bound Cointegration Test

This study employs a quantitative method, economics model approached, namely the Auto-Regressive Distributed Lag (ARDL), inspired by Rambeli et al. (2019). The ARDL model estimates both short run and long run relationships. Autoregressive (AR) is a type of regression model in which the dependent variable is regressed against its own lagged values, while distributed lagged (DL) is a type of regression model that includes not only the present value but also the past value or lag of the explanatory variable. The ARDL model is defined as a model that contains among the regressors at least one lag of the dependent variable.

Furthermore, the ARDL model will be regarded as a regression model that contains either the present value or the lagged variable of the dependent variable among its explanatory variables. The ARDL model is very useful in econometrics. This model can make static theory a dynamic one by considering the role of time explicitly (Gujrati, 2021).

Long-Run Auto-Regressive Distributed Lag (ARDL) Model

The long-run ARDL model is designed to examine the equilibrium relationships between GDP (aggregate and sectoral: primary, secondary, and tertiary) and the independent variables gross fixed capital formation, external debt, export trade, remittances, and labor force. This model allows the estimation of long-term coefficients while incorporating the dynamics of short-term adjustments.

Model 1 – Long Run ARDL Equation: Aggregate Gross Domestic Product

$$GDP_t = \alpha_{01} + \sum_{i=1}^{p} \emptyset_i \, GDP_{t-i} + \sum_{i=0}^{q1} \beta_1 \, GFCF_{t-i} + \sum_{i=0}^{q2} \beta_2 \, ED_{t-i} + \sum_{i=0}^{q3} \beta_3 \, EXT_{t-i} + \sum_{i=0}^{q4} \beta_4 \, REM_{t-i} + \sum_{i=0}^{q5} \beta_5 \, LF_{t-i} + \varepsilon_{t1} \qquad (10)$$

Model 2 – Long Run ARDL Equation: Primary Sector Gross Domestic Product

$$GDP_1 = \alpha_{02} + \sum_{i=1}^{p} \emptyset_i \, GDP_{t-1} + \sum_{i=0}^{q1} \beta_1 \, GFCF_{t-1} + \sum_{i=0}^{q2} \beta_2 \, ED_{t-1} + \sum_{i=0}^{q3} \beta_3 \, EXT_{t-1} + \sum_{i=0}^{q4} \beta_4 \, REM_{t-1} + \sum_{i=0}^{q5} \beta_5 \, LF_{t-1} + \varepsilon_{t2} \qquad (11)$$

Model 3 – Long Run ARDL Equation: Secondary Sector Gross Domestic Product

$$GDP_2 = \alpha_{03} + \sum_{i=1}^{p} \emptyset_i \, GDP_{t-2} + \sum_{i=0}^{q1} \beta_1 \, GFCF_{t-2} + \sum_{i=0}^{q2} \beta_2 \, ED_{t-2} + \sum_{i=0}^{q3} \beta_3 \, EXT_{t-2} + \sum_{i=0}^{q4} \beta_4 \, REM_{t-2} + \sum_{i=0}^{q5} \beta_5 \, LF_{t-2} + \varepsilon_{t3} \qquad (12)$$

Model 4 – Long Run ARDL Equation: Tertiary Sector Gross Domestic Product

$$GDP_3 = \alpha_{04} + \sum_{i=1}^{p} \emptyset_i \, GDP_{t-3} + \sum_{i=0}^{q1} \beta_1 \, GFCF_{t-3} + \sum_{i=0}^{q2} \beta_2 \, ED_{t-3} + \sum_{i=0}^{q3} \beta_3 \, EXT_{t-3} + \sum_{i=0}^{q4} \beta_4 \, REM_{t-3} + \sum_{i=0}^{q5} \beta_5 \, LF_{t-3} + \varepsilon_{t4} \qquad (13)$$

Where,

GDP_t = Aggregate Gross Domestic Product

GDP_1 = Primary Sector Gross Domestic Product

GDP_2 = Secondary Sector Gross Domestic Product

GDP_3 = Tertiary Sector Gross Domestic Product

$GFCF_t$ = Independent variables

ED_t = Independent variables

EXT_t = Independent variables

REM_t = Independent variables

LF_t = Independent variables

α_0 = Constant term

$\emptyset_i$ = Coefficients of the lagged dependent variable.

β_i = Long term coefficients of the independent variables.

ε_t = Error term.

The coefficients of the long run β_i represent the impact of each independent variable on GDP once the system is at equilibrium. These coefficients, which were computed from the estimated ARDL model, represent the responses of GDP to structural changes in external debt, export trade, remittances, labor force dynamism, or GFCF in the long run.

For instance, A positive β_2 for export trade suggests that higher exports increase GDP growth in the long run.

A negative β_1 sign of external debt indicates that too much borrowing can reduce the GDP in the long run.

Error Correction Term (ECT)

Once cointegration is established, the ARDL model incorporates an Error Correction Term (ECT) that expresses the speed of adjustment back toward the long-run equilibrium after temporary shocks. The ECT is defined as:

$$\Delta GDP_t = \lambda(GDP_{t-1} - \beta_1 GFCF_{t-1} - \beta_2 ED_{t-1} - \beta_1 EXT_{t-1} - \beta_1 REM_{t-1} - \beta_1 LF_{t-1}) + \varepsilon_t$$

Where,

λ = Adjustment coefficient

GDP_{t-1} = Lagged dependent variable

= Independent variables are also lagged to capture their long term effects.

A significant and negative λ confirms the presence of cointegration and indicates the rate at which the system returns to equilibrium after a disturbance. In this study, the long run ARDL model is applied separately for aggregate GDP and each sectoral GDP (primary, secondary, tertiary). This approach provides insights into how macroeconomic variables influence Malaysia's economic performance over time. The results will help policymakers identify key drivers of growth and design targeted interventions for sustainable development.

Short Run Auto-Regressive Distributed Lag (ARDL) Model

The short-run ARDL model focuses on the immediate relationships of current GDP and all its sectoral components in turn to the selected independent variables: gross fixed capital formation, external debt, export trade, remittances, and labor force. The obtained model describes only the short run dynamics and adjustments while approaching long term equilibrium levels.

Model 1 – Short Run ARDL Equation: Aggregate Gross Domestic Product

$$\Delta GDP_t = \alpha_{01} + \sum_{i=1}^{p-1} \emptyset_i \Delta GDP_{t-i} + \sum_{i=0}^{q1} \beta_1 \Delta GFCF_{t-i} + \sum_{i=0}^{q2} \beta_2 \Delta ED_{t-i} + \sum_{i=0}^{q3} \beta_3 \Delta EXT_{t-i} + \sum_{i=0}^{q4} \beta_4 \Delta REM_{t-i} + \sum_{i=0}^{q5} \beta_5 \Delta LF_{t-i} + \lambda_1 ECT_{t-i} + \varepsilon_{t1} \quad (14)$$

Model 2 – Short Run ARDL Equation: Primary Sector Gross Domestic Product

$$\Delta GDP_1 = \alpha_{02} + \sum_{i=1}^{p-1} \emptyset_i \, \Delta GDP_{t-1} + \sum_{i=0}^{q1} \beta_1 \, \Delta GFCF_{t-1} + \sum_{i=0}^{q2} \beta_2 \, \Delta ED_{t-1} + \sum_{i=0}^{q3} \beta_3 \, \Delta EXT_{t-1} + \sum_{i=0}^{q4} \beta_4 \, \Delta REM_{t-1} + \sum_{i=0}^{q5} \beta_5 \, \Delta LF_{t-1} + \lambda_2 ECT_{t-1} + \varepsilon_{t2} \quad (15)$$

Model 3 – Short Run ARDL Equation: Secondary Gross Domestic Product

$$\Delta GDP_2 = \alpha_{03} + \sum_{i=1}^{p-1} \emptyset_i \, \Delta GDP_{t-2} + \sum_{i=0}^{q1} \beta_1 \, \Delta GFCF_{t-2} + \sum_{i=0}^{q2} \beta_2 \, \Delta ED_{t-2} + \sum_{i=0}^{q3} \beta_3 \, \Delta EXT_{t-2} + \sum_{i=0}^{q4} \beta_4 \, \Delta REM_{t-2} + \sum_{i=0}^{q5} \beta_5 \, \Delta LF_{t-2} + \lambda_3 ECT_{t-2} + \varepsilon_{t3} \quad (16)$$

Model 4 – Short Run ARDL Equation: Tertiary Gross Domestic Product

$$\Delta GDP_3 = \alpha_{04} + \sum_{i=1}^{p-1} \emptyset_i \, \Delta GDP_{t-3} + \sum_{i=0}^{q1} \beta_1 \, \Delta GFCF_{t-3} + \sum_{i=0}^{q2} \beta_2 \, \Delta ED_{t-3} + \sum_{i=0}^{q3} \beta_3 \, \Delta EXT_{t-3} + \sum_{i=0}^{q4} \beta_4 \, \Delta REM_{t-3} + \sum_{i=0}^{q5} \beta_5 \, \Delta LF_{t-3} + \lambda_4 ECT_{t-3} + \varepsilon_{t4} \quad (17)$$

Where,

Δ = Represents the first difference of the variables, capturing short term changes.

ECT_{t-1}= Error Correction Term, derived from the long run model, which measures the speed of adjustment back to equilibrium after a deviation.

λ = Adjustment coefficient, expected to be negative and significant if cointegration exists.

α_0, β_i , $\emptyset_i$ = Retain their definitions from the long run model but focus on short term effects.

Diagnostic Test

Diagnostic tests were performed to check the goodness of fit of the ARDL model and the reliability and validity of the models used within this study. The tests identify problems that concern serial correlation, heteroscedasticity, normal distribution, and structural stability. To validate the model specification, the Jarque-Bera test of normality by (Jarque & Bera, 1980), the Breusch-Godfrey LM test for serial correlation (Godfrey,1978), the Breusch-Pagan-Godfrey test for heteroscedasticity and the CUSUM and CUSUM of Squares tests for stability are performed.

These diagnostic tests are applied to all four of the ARDL models in this study: aggregate GDP, primary sector GDP, secondary sector GDP, and tertiary sector GDP. With these diagnostic tests, the appropriateness of the specification of these models, their robustness, and the absence of any statistical problems are guaranteed; hence, the findings will be interpretable and credible. These diagnostic test results form a very sound basis for the analysis of the relationship between GDP, in both aggregate and sectoral levels, and the independent variables to ensure that policy recommendations based on the results are reliable and valid.

Stability Test

The CUSUM and CUSUMSQ tests are employed to assess the stability of the coefficient β. Both tests are employed to assess the stability of the model, which is utilized to ascertain whether the model experienced any structural alterations throughout the 30-year research duration. These tests are of equal significance in assessing the extent to which they can be employed to generate precise estimations. The CUSUMSQ test is employed to assess the enduring stability of the ARDL model, ensuring its accuracy. According to Ploberger and Kramer (1990), the CUSUMSQ test is deemed to possess less statistical power in comparison. In addition, it may be argued that CUSUMSQ is a superior method due to its ability to address the concern regarding the impact of the process type in the regression model on the limit distribution of the test, as highlighted by Deng and Perron (2008).

EMPIRICAL FINDINGS

Augmented Dickey-Fuller (ADF) Unit Root Test

In any further analysis of econometric modelling, the stationarity of the data must be verified for the reliability of the analysis. The present study tests for unit roots using the Augmented Dickey-Fuller test in time series data for all variables. Stationarity of the series is a major assumption in econometric models since the use of non-stationary data may result in spurious results and unreliable inferences. The ADF test checks whether these variables GDP, gross fixed capital formation, external debt, export trade, remittances, and labor force are stationary at levels or need to be differenced to become stationary. This result will show the order of integration of data, that is, whether it is I(0) or I(1), and present the platform for conducting the ARDL model and Bound Test for cointegration. The subsequent analysis will be based on these findings to ensure robust estimations of both short- and long-term relationships among the variables**.**

Table 1: Augmented Dickey-Fuller (ADF) Unit Roots TestNoted: The numbers in [ ] represent the number of lags that follow the Akaike Info Criterion (AIC).

Variables	LEVEL FORM			FIRST DIFFERENCE		
	Intercept	Trend And Intercept	None	Intercept	Trend And Intercept	None
$\mathbf{GDP}_t$	-2.462461 (9) 0.1310	-2.554876 (9) 0.3019	0.454290 (9) 0.8087	- 6.442320*** (9) 0.0000	- 5.600014*** (9) 0.0002	-6.482738*** (9) 0.0000
$\mathbf{GDP_1}$	-0.377710 (2) (0.9045)	-1.674013 (2) (0.7471)	- 4.127025* ** (2) (0.0001)	- 6.175718*** (5) (0.0000)	- 6.102802*** (5) (0.0000)	-2.858919*** (5) (0.0052)
$\mathbf{GDP_2}$	-2.386438 (2) (0.1510)	-1.718409 (2) (0.7270)	0.750690 (2) (0.8729)	- 10.24793*** (8) (0.0000)	- 6.547377*** (8) (0.0000)	-10.24388*** (8) (0.0000)
$\mathbf{GDP_3}$	-1.229370 (9) (0.6534)	-2.013073 (9) (0.5774)	3.278089 (9) (0.9996)	- 7.195571*** (9) (0.0000)	- 7.222299*** (9) (0.0000)	-1.656124** (9) (0.0918)
GFCF	- 2.937834** * (9) 0.0486	-2.075775 (7) 0.5445	-0.708618 (9) 0.8648	- 6.542652*** (9) 0.0000	- 6.427522*** (9) 0.0000	-6.533319*** (9) 0.0000
ED	-2.769250** (9) 0.0705	-3.379529** (9) 0.0665	3.043580 (9) 0.9992	- 8.265112*** (9) 0.0000	- 8.442023*** (9) 0.0000	-7.118856*** (9) 0.0000
EXT	1.271321 (4) 0.9981	-1.961758 (4) 0.6065	1.455929 (4) 0.9621	- 7.752947*** (4) 0.0000	- 6.521856*** (4) 0.0000	-7.441820*** (4) 0.0000
REM	-3.060791** (4) 0.0369	-3.328534** (4) 0.0747	-0.301909 (9) 0.5705	- 6.837008*** (9) 0.0000	- 7.773688*** (9) 0.0000	-6.958257*** (9) 0.0000
LF	-3.138334** (4) 0.0311	-3.033366 (4) 0.1354	1.640447 (8) 0.9736	-2.835657** (2) 0.0612	-3.112362 (2) 0.1156	-1.359640 (2) 0.1589

Table 1 shows the results of the ADF unit root test at levels and first differences including no intercept, intercept, and with trend and an intercept using autoregressive (AR) models. The significant results are highlighted. These results indicate that some variables are stationary in their level forms, but others get the stationarity only after the first differencing. The table presents the unit root test of some variables of the macroeconomic data of Malaysia that comprises Aggregate Gross Domestic Product, Primary Sector Gross Domestic Product, Secondary Sector Gross Domestic Product, Tertiary Sector Gross Domestic Product, Gross Fixed Capital Formation, External Debt, Export Trade, Remittances, and Labor Force.

From the results against the level form for GDP, it can be depicted that the t-statistic for the intercept (-2.462461) is greater than the critical value. So, GDP is nonstationary under this condition. The t-statistics for the intercept (-2.554876) and none (0.454290) are greater than their respective critical values, again confirming non stationarity for trend and intercept, and none. At first difference, t-statistics for intercept (-6.442320), trend and intercept (-5.600014), and none (-6.482738) are all less than the critical values, which indicates that after first differencing, GDP gets stationary. It implies that GDP is integrated of order I(1).

Gross Fixed Capital Formation (GFCF) has mixed stationarity at the level form. The t-statistic intercept (-2.937834) is less than the critical value, indicating weak stationarity under this condition. For trend and intercept (-2.075775) and none (-0.708618), the t-statistics are greater than the critical values, hence non-stationarity. The t-statistics for the intercept (-6.542652), trend and intercept (-6.427522), and none (-6.533319) are all significantly below the critical values, hence confirming stationarity after the first differencing. Thus, though GFCF is weakly stationary with intercept at level, it is mostly integrated of order I(1).

Next, External debt (ED) is weakly stationary at the level form under some conditions. The computed t-statistic for an intercept of -2.769250 and trend and intercept of -3.379529 is close to but below the critical values, which indicates weak stationarity. However, the t-statistic for none is 3.043580, greater than the critical value and it confirms non-stationarity. At first difference, all t-statistics (-8.265112 for intercept, -8.442023 for trend and intercept, and -7.118856 for none) are significantly lower than the critical values, confirming that after first differencing, stationarity can be achieved. Hence, ED is weakly stationary at the level under certain conditions but is more reliably integrated with order I(1).

Furthermore, Remittances (REM) also exhibit weak stationarity at the level form. In the case of intercept (-3.060791) and trend and intercept (-3.328534), t-statistics are lower than the critical values, hence indicating weak stationarity. In the case of none (-0.301909), the t-statistic is higher than the critical value hence showing non stationarity. In this regard, at the first difference, the t-statistics for intercept (-6.837008), trend and intercept (-7.773688), and none (-6.958257) are all below the critical values and thus stationarity after first differencing. This means that while REM might be weakly stationary under certain conditions at level, it is overall integrated of order I(1).

Moreover, in the case of the labor force, LF, a mixed set of results is reported at the level form. From here, the t-statistic for the intercept (-3.138334) is less than the critical value, so the series is weak and stationary. In contrast, for trend and intercept (-3.033366) and none (1.640447), the t-statistics are greater than the critical values, so those series are non-stationary. First difference: The t-statistics for the intercept (-2.835657) and trend and intercept (-3.112362) are close to the critical values. However, none (-1.359640) is still higher. These inconclusive results could indicate that further testing of LF is required to reach a more conclusive stationarity and order of integration.

In other words, most of the variables, such as GDP, GFCF, ED, and REM, are non-stationary at levels but become stationary after the first differences. Hence, they are integrated into order I(1). At the same time, some variables could be weakly stationary at levels, for instance, GFCF and REM under certain conditions. These findings emphasize the importance of differencing to ensure stationarity before other analyses, including cointegration testing**.**

Bound Cointegration Test Results

The Bound test in this research is conducted based on the F-statistic that verifies the presence of cointegration within the long run among selected variables. In addition, under the null hypothesis, there is no cointegration among the variables. When the computed F-statistic is higher than the upper-bound critical values, then one may reject the null hypothesis of no cointegration. Similarly, when it is lower than the lower bound critical value, one cannot reject the null hypothesis of no cointegration.

This test is important in confirming whether there exists a long-run equilibrium relationship among the variables used in this thesis, namely, GDP, gross fixed capital formation (GFCF), external debt (ED), exports (EXT), remittances (REM), and labor force (LF). The Bound Test assesses cointegration within the context of the ARDL framework, enabling the identification of long run associations while allowing for variables integrated of different orders, I(0) and I(1).

What follows is the estimations of the dependent variable GDP against the independent variables of GFCF, ED, EXT, REM, and LF to get the results of the F-statistic cointegration bound test through ARDL. The result of the estimations obtained through ARDL is as shown in the relevant tables showing the F-statistics for the models and the critical values as proposed by Pesaran et al. (2001).

Table 2: Bound Test for Cointegration for Model 1: Aggregate GDP in Malaysia – Full Model

Model	Calculated F-Statistic	K
GDP = f (GFCF, ED, EXT, REM, LF)	4.752074	5
Critical value for Case II: Restricted Constant and No Trend	I(0)	I(1)
10%	2.306	3.353
5%	2.734	3.92
1%	3.657	5.256

Notes: 1. The critical value for bounds testing are abstracted from Pesaran et al. (2000), Table C2(ii): Case II: restricted intercept and unrestricted trend: critical value for k=5 (full model).
2. * denotes that the F-statistics falls above the 10.0% significance level, ** above the 5.0% significance level, and *** above the 1.0% significance level.

Table 2 shows the results for the bound test for cointegration for Model 1: Aggregate GDP in Malaysia. The F-statistic is 4.752074, which is greater than the upper bound critical value of 5.256 at the 1 percent level of significance. Hence, there is evidence of a long run relationship between the variables. Therefore, the null hypothesis of no co-integration is rejected and it can be deduced that in the long term, the macroeconomic variables that are GFCF, ED, EXT, REM, and LF are cointegrated with GDP. The estimated coefficients themselves confirm the suitability of employing an ARDL methodology in this study, as it captures dynamic interaction among the variables within the Malaysian economic context.

Table 3: Bound Test for Cointegration for Model 2: Primary Sector GDP in Malaysia

Model	Calculated F-Statistic	K
GDP_1= f (GFCF, ED, EXT, REM, LF)	14.58040	5
Critical value for Case II: Restricted Constant and No Trend	I(0)	I(1)
10%	2.276	3.297
5%	2.694	3.829
1%	3.674	5.019

Notes: 1. The critical value for bounds testing are abstracted from Pesaran et al. (2000), Table C2(ii): Case II: restricted intercept and unrestricted trend: critical value for k=5 (full model).
2. * denotes that the F-statistics falls above the 10.0% significance level, ** above the 5.0% significance level, and *** above the 1.0% significance level.

The result is presented for the cointegration bound test for Model 2: Primary Sector GDP in Malaysia. This has been highlighted in Table 3, where the F-statistic is 14.58040. This exceeds the upper bound critical value of 5.019 at the 1% significance level, and thus evidence of the long run relationship between the variables is clearly established. This implies the rejection of no cointegration null hypothesis. In other words, this suggests that GFCF, ED, EXT, REM, and LF are cointegrated with the primary sector GDP in the long run and further justifies the appropriateness of applying the ARDL methodology in the current study since it captured the dynamic relationship that exists between the variables underlying the Malaysian primary sector.

Table 4: Bound Test for Cointegration for Model 3: Secondary Sector GDP in Malaysia

Model	Calculated F-Statistic	K
GDP_1= f (GFCF, ED, EXT, REM, LF)	12.78191	5
Critical value for Case II: Restricted Constant and No Trend	I(0)	I(1)
10%	2.306	3.353
5%	2.734	3.92
1%	3.657	5.256

Notes: 1. The critical value for bounds testing are abstracted from Pesaran et al. (2000), Table C2(ii): Case II: restricted intercept and unrestricted trend: critical value for k=5 (full model).
2. * denotes that the F-statistics falls above the 10.0% significance level, ** above the 5.0% significance level, and *** above the 1.0% significance level.

From the results shown for the bound test, using the cointegration bound test, Model 3: Secondary Sector GDP in Malaysia has the F-statistic calculated at 12.78191. This is well above these upper-bound critical values of 5.256 at the 1% significance level. Based on this result, there is full evidence of the existence of a long run relationship between macroeconomic variables GFCF, ED, EXT, REM, and LF with primary sector GDP.

This implies the rejection of the null hypothesis of no cointegration, which further suggests that in the long run, cointegration among the selected variables with GDP exists for the primary sector. That also confirms the appropriateness of using the ARDL approach in the present study since it efficiently captures the dynamic interaction among the variable series involved in relating to the Malaysian primary sector.

Table 5: Bound Test for Cointegration for Model 4: Tertiary Sector GDP in Malaysia

Model	Calculated F-Statistic	K
GDP_3= f (GFCF, ED, EXT, REM, LF)	7.844596	5
Critical value for Case II: Restricted Constant and No Trend	I(0)	I(1)
10%	2.306	3.353
5%	2.734	3.92
1%	3.657	5.256

Notes: 1. The critical value for bounds testing are abstracted from Pesaran et al. (2000), Table C2(ii): Case II: restricted intercept and unrestricted trend: critical value for k=5 (full model).
2. * denotes that the F-statistics falls above the 10.0% significance level, ** above the 5.0% significance level, and *** above the 1.0% significance level.

From Table 5, which presents the results of the cointegration bound test for Model 4: Tertiary Sector GDP in Malaysia, the computed F-statistic is 7.844596, greater than the upper bound critical value of 5.256 at the 1% significance level. There is evidence of a long run relationship between the variables, GFCF, ED, EXT, REM, LF, and tertiary sector GDP. This rejects the null hypothesis of no cointegration. In other words, there is cointegration between the tertiary sector's GDP and other macroeconomic variables in the long run. Thus, the results support the appropriateness of the ARDL approach in modeling the dynamic relationship among the concerned variables regarding the Malaysian tertiary sector.

Long Run Coefficients Estimation

The estimation of the ARDL long run model is important in estimating the equilibrium relationship between GDP and its aggregate and sectoral values, GFCF, ED, EXT, REM, and LF. The long run coefficients estimated in this analysis capture the sustained impacts of these variables on economic growth across Malaysia's primary, secondary, and tertiary sectors. This section therefore analyses the contribution of each variable to GDP in the long run, including both positive and negative effects. Also, it pinpoints sector specific dynamics and how structural and policy factors influence the nexus between macroeconomic drivers and economic performance. These findings yield very useful evidence for designing targeted and long term policy interventions to enhance sustainable and balanced growth within Malaysia's economy.

Table 6: ARDL long-run estimation for Model 1, Model 2, Model 3, and Model 4

Period	Model 1	Model 2	Model 3	Model 4
GFCF	-0.453341**	- 0.263500***	1.184898***	0.298785***
	(-1.717010)	(4.463037)	(6.594993)	(3.331355)
ED	-1.657550***	-0.071236	-0.778674***	-0.414709***
	(-3.652302)	(-0.855006)	(-3.577322)	(-3.683548)
EXT	-0.214145	- 0.416315***	-0.658998**	0.223685**
	(-0.748530)	(-6.312021)	(-2.738144)	(2.270113)
REM	-0.831247***	- 0.439909***	-0.225605	0.285228*
	(-3.236987)	(-4.099491)	(-0.827154)	(2.875562)
LF	3.430894***	-0.065605	3.171581***	2.131309***
	(3.211209)	(-0.255610)	(5.096647)	(7.498777)
C	5.270244	11.26353***	-14.86960***	-13.16763***
	(1.546365)	(6.542974)	(-5.637863)	(-9.028919)

Notes: *** denotes statistically significant at the 1% level, ** statistically significant at the 5% level, * statistically significant at the 10% level.

Results of the long run estimation are summarized in Table 6 and show the varying impacts of these macroeconomic variables on GDP in Malaysia. The GFCF's coefficient in Model 1 is -0.453, significant at 5% this means that for a 1% increase in GFCF, GDP declines by 0.45%, hence a negative effect on aggregate GDP. ED exhibits a highly significant coefficient of -1.658 significant at 1% which means that with every 1% increase in ED, there is a fall of 1.66% in GDP, hence possibly reflecting inefficiencies or misallocations in the use of money spent on external debt. Moreover, EXT is insignificantly affecting this model, as shown by the coefficient of -0.214 (p=0.4614), reflecting no substantial impact on GDP. On the other hand, REM is strongly negatively disposed, with a coefficient of -0.831 significant at 1% showing that higher remittances may crowd out domestic investment. The labor force, LF, positively influences GDP with a coefficient value of 3.431 significant at 1%, and shows human capital's vital contribution. The constant term is positive but statistically insignificant.

In Model 2, the GFCF coefficient is -0.264, significant at 1% indicating that with a 1% increase in GFCF, GDP in the primary sector decreases by 0.26%. The external debt variable, ED is insignificant in this model since its p-value is 0.3960. Thus, it has no significant effect on the GDP of the primary sector. Exports are very significant and negative, with a coefficient of -0.416 significant at 1 % implying that for every 1% increase in exports, primary sector GDP decreases by 0.42%, presumably reflecting overdependence on non-primary exports.

Moreover, Remittances (REM) are also strongly negative, with a coefficient of -0.440 significant at 1%. Labor Force (LF) is insignificant in this model, p=0.7987, and thus does not have any measurable impact on the GDP of the primary sector. The constant term is significant and positive, meaning there is some base level of GDP, all other things being held constant.

Furthermore, Gross Fixed Capital Formation (GFCF) has a great positive effect, estimated at 1.185, with significance at a level 1% shown in Model 3. This infers that a 1% increase in GFCF results in increasing GDP in the secondary sector by 1.19%. The ED exerts a highly significant negative effect, the coefficient equals -0.779 significant at level 1% meaning that more External debt probably does not match the needs of growth in the secondary sector. EXT is strongly negative at p=0.0103 with a coefficient of -0.659, while REM is insignificant in this model. LF is strongly positive at a coefficient of 3.172 and a p-value less than 0.001. The constant term is negative and significant since this is the secondary sector, which requires positive inputs from the macro-economy to show growth.

On the other hand, In Model 4, GFCF exerts a positive effect at 1% significance level, the coefficient value being 0.299, which means that for every 1% increase in GFCF, GDP in the tertiary sector increases by 0.30%. ED has a negative coefficient of -0.415, which is statistically significant at 1% level indicating thereby that possibly education investments are not directly benefiting tertiary GDP. From these, the results show that EXT is positive and significant at 0.0232 with a coefficient value of 0.224, hence export expansion positively contributes to the tertiary sector. REM is positive and significant at 0.0074 with a coefficient of 0.285, hence, it reflects remittances' supportive role in this sector. The LF is still one of the major drivers with a coefficient value of 2.131 significant at a 1% level which indicates labor force growth is vital for the development of the tertiary sector. The negative and significant constant term implies that the sector relies heavily on macroeconomic inputs to achieve sustainable growth.

Short Run Coefficients Estimation (ECM)

The estimation of the ARDL short run model considers the immediate and short term effects of macroeconomic variables such as GFCF, ED, EXT, REM, and LF on Malaysia's GDP at both the aggregate and sectoral levels. The short run coefficients from this analysis reveal the dynamic adjustments and transient effects that take place before reaching equilibrium. This section investigates sectoral variations in short run relationships through the interactions of variations in investments, trade, debt, remittances, and labor with the gross domestic product at different levels of the primary, secondary, and tertiary sectors.

Table 7: ARDL Short Run Results for Model 1, Model 2, Model 3, and Model 4

The Short-run coefficient estimates

Period	Lag	Model 1	Model 2	Model 3	Model 4
ΔGFCF	0	-0.262359*** (3.268144)	-0.076575** (-3.431371)	1.886862*** (17.60859)	0.694052*** (13.24967)
	1	0.361576*** (4.274269)	0.128089*** (3.956063)	0.535777*** (4.627595)	0.467327*** (7.904264)
	2	0.380008*** (4.222542)	0.028372 (1.453606)	0.950599*** (9.581501)	0.568475*** (8.962316)
	3	-	-0.019630 (-1.192799)	0.872085*** (6.178290)	0.438872*** (6.856794)
	4	-	- 0.085677*** (-3.575703)	-	-
	5	-	-0.081262** (-2.927486)	-	-
ΔED	0	-1.316139*** (-7.015310)	-0.025587 (-0.690668)	-1.302021*** (-5.464818)	0.481614*** (-5.034765)
	1	-0.457954** (-2.291078)	0.031717 (0.772267)	-0.761289*** (-3.248917)	-0.115277 (-1.195741)
	2	-	0.279760*** (5.255438)	-0.507507** (-2.248241)	0.011947 (0.136963)
	3	-	0.329244*** (4.730670)	-	0.163885 (1.760127)
	4	-	0.266375*** (4.246578)	-	0.169025** (1.981020)
	5	-	0.123018** (2.927202)	-	-
ΔEXT	0	-0.009280 (-0.087353)	- 0.176863*** (-5.954246)	-0.490667*** (-4.086637)	-0.042013 (-0.670989)
	1	-0.244897*** (-3.082542)	0.001848 (0.057032)	0.882446*** (7.447367)	-0.256041*** (-4.868898)
	2	-0.478567*** (-5.113781)	-0.036925 (-1.756508)	-0.017955 (-0.122066)	-0.507485*** (9.707190)
	3	-0.283371*** (-3.178393)	-0.050709** (-2.460185)	-0.535539*** (-4.216622)	-0.684860*** (-8.175804)
	4	-	-0.006520 (-0.262600)	-	-0.081772 (-1.411260)

	5	-	0.038450 (1.370919)	-	-
Δ REM	0	-	-0.091240** (-2.163090)	0.165181 (0.838762))	0.446059*** (5.862732)
	1	-	0.130717** (2.438709)	0.500410** (2.400692)	-0.077404 (-0.952750)
	2	-	0.072665 (1.843782)	-0.105320 (-0.536000)	-0.219025** (-2.459866)
	3	-	0.124832** (3.096016)	-0.444223** (-2.320650)	-0.513992*** (-6.725679)
	4	-	0.203122*** (4.826732)	0.403260** (2.320015)	-
	5	-	0.130863** (3.029035)	-	-
LF	0	4.629970** (2.312821)	-0.319979 (-0.894074)	0.526086 (5.096647)	-0.869348 (-0.930309)
	1	0.173968 (0.070414)	0.100249 (0.228324)	2.895302 (0.982417)	1.266001 (1.161911)
	2	5.932108** (2.338737)	-0.947341 (-1.862075)	-2.813527 (-0.949084)	-1.211028 (-1.028126)
	3	-8.514167*** (-4.292291)	-2.896014*** (-4.727418)	-3.654638 (-1.229445)	-4.693985*** (-4.069570)
	4	-	-	-12.23208*** (-4.046163)	-5.410398*** (-3.655018)
	5	-	-	-	-
ECT(-1)		-0.526328*** (-6.448306))	-0.926759*** (-5.762513)	-1.545739*** (-11.19208)	-1.294858*** (-8.958585)

Notes: 1. *** denotes statistically significant at the 1% level, ** statistically significant at the 5% level, * statistically significant at the 10% level.
2. Δ denotes differenced variable.

ARDL short run results for Models 1, 2, 3, and 4 underline the dynamic interaction between a few major macroeconomic variables concerning sectoral GDP in Malaysia. The signs and significant positive and negative coefficients of GFCF across its various lags were highly significant at the 1% level for example, in Model 1 it was 0.361576 at lag 1, while in Model 3, it was at 1.886862 lag 0. This shows that the various changes in investment capital have different short run impacts on other economic sectors. In the models that ED mostly demonstrates negative signs, -1.316139 lag 0 in Models 1 and -1.302021 lag 0 in Model 3, indicate overdependence on external borrowing in decreasing aggregate and secondary sector

GDP within a short time horizon. The impact is positive though over some lags as shown specifically in Model 4 which is 0.481614 at lag 0.

The result is mixed for EXT, as negative coefficients, such as -0.176863 (lag 0 in Model 2) and -0.244897 (lag 1 in Model 1), underline the short run challenges for specific sectors, while positive effects, such as 0.882446 (lag 1 in Model 3), show that exports can support GDP in the secondary sector. Next, REM also shows significant short run effects, especially in Model 4, where coefficients like 0.446059 (lag 0) show the positive contribution of remittances to the tertiary sector. However, other models show negative impacts for some lags, which really shows the nuanced influence of remittances on short-term GDP.

However, the resultant LF varies from positive contributions at 4.629970 when considering Lag 0 for Model 1, for instance, to negative ones like -8.514167 for Model 1 lag 3, so evidence seems to point to a more complex contribution pattern by labor in terms of both sectoral dynamics and lag structure in determining GDP.

Finally, coefficients of the ECT are negative and highly significant throughout all models, such as -0.526328 in Model 1 and -1.545739 in Model 3, confirming the presence of adjustment mechanisms toward long run equilibrium. The magnitude of such coefficients shows rapid correction of deviations, particularly in the secondary and tertiary sectors, where the magnitudes of the coefficients are higher. In sum, the short run analysis indicates that the effects of the macroeconomic variables on GDP are dissimilar across the sectors, with GFCF, ED, EXT, REM, and LF having significant but dissimilar influences. The findings underpin the notion of tailored policies to optimize such variables for sectoral growth in Malaysia.

Diagnostic Tests

Diagnostic tests are necessary to validate that the regression models are robust and reliable; this will make sure that there is no problem in serial correlation, heteroscedasticity, or non-normality of residuals that would affect the estimation results. Therefore, the next section presents the result of the Breusch-Godfrey Serial Correlation LM test, Breusch-Pagan-Godfrey, and heteroscedasticity test presented in Table 8, and Table 9, respectively.

The Breusch-Godfrey Serial Correlation LM test is used to test for serial correlation in the residuals. The serial correlation may make the estimates of the parameters inefficient, and hence wrong conclusions might be drawn. The null hypothesis is that residuals are not serially correlated. From Table 8, the probability value of the LM test is 0.2639 which is greater than the 5% level of significance. Therefore, thus the null is not rejected because no serial correlation of the residuals exists. This finding finds an agreement with previous works from both Breusch (1978) as well as Godfrey (1978) who, in their attempt, have suggested that a need for the testing of heteroscedasticity must exist for regression models to achieve validity. This test shows that the variance for the residuals varies not on some observations but on all. Contrary to that, the no alternative hypothesis.

From Table 9, the probability value of 0.3068 is greater than the 5% level of significance. Thus, the null hypothesis is not rejected. This suggests that the model is homoscedastic; hence, the estimates are efficient and not biased. The test is based on the procedure of Breusch and Pagan (1979), for checking for heteroscedasticity in regression models. The normality Test for the Jarque-Bera test shows the normality in residuals of the regression model, which is a fundamental assumption to be considered for valid hypothesis testing and inferences that one can get.

Table 8: Breusch-Godfrey Serial Correlation LM Test

F-statistic	Obs*R-squared	Prob.F(2,22)	Prob. Chi-Square(2)
0.709050	2.664450	0.5030	0.2639

Table 9: Heteroscedasticity test (Breusch-Pagan-Godfrey)

	Heteroscedasticity Test		
F-statistic	1.213413	Prob. F(19,24)	0.3233
Obs*R-squared	21.55811	Prob. Chi-Square (1)	0.3068

Stability Test

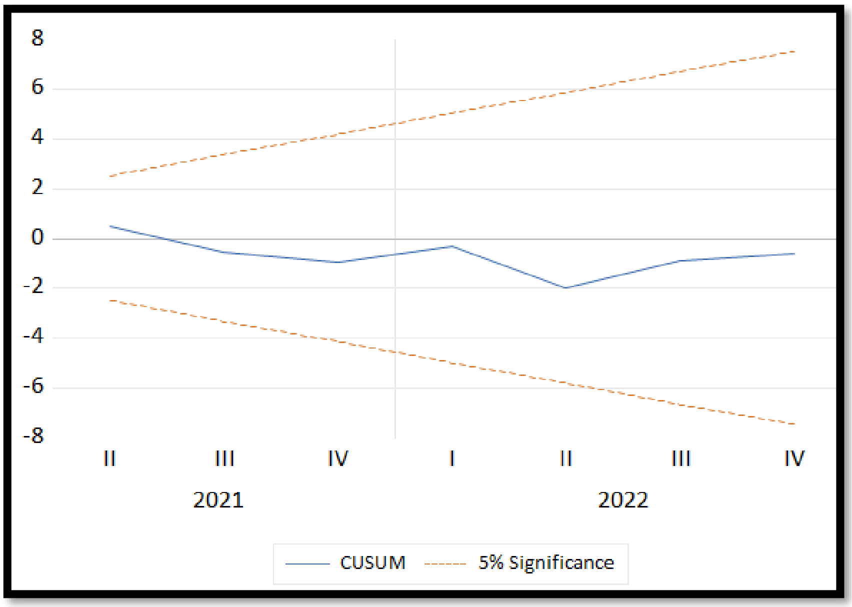

Figure 1:Plot of Cumulative Sum (CUSUM) test of recursive residuals for Aggregate GDP in Malaysia

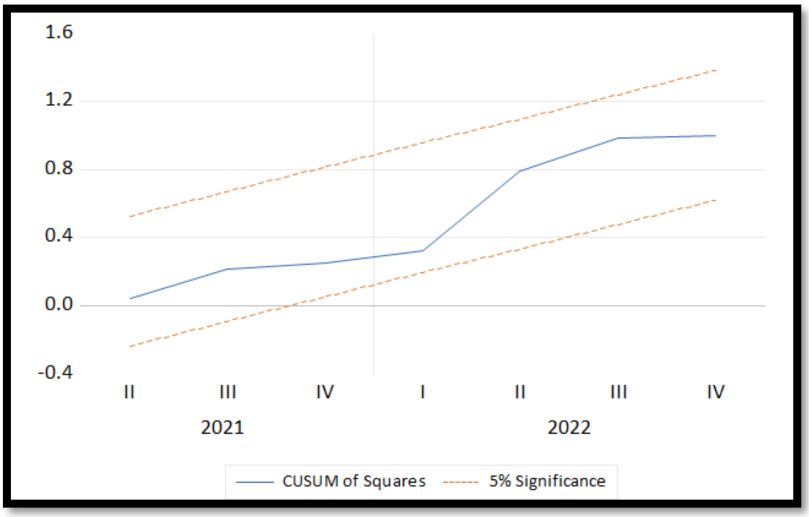

Figure2: Plot of Cumulative Sum of Square (CUSUMSQ) test of recursive residuals for Aggregate GDP in Malaysia

These stability tests are, CUSUM and the CUSUM of Squares-on recursive residuals behind the aggregate data for Malaysia, ranging between 2021 and 2022, thus showing stability within this model. The red dashed lines are the 5 percent significance level bounds over which the statistic blue line goes in both series. The CUSUM test indicates the stability of the model, as the test statistic is always within the bounds throughout the period. Besides, the result of the CUSUM of Squares test also shows no significant deviation, because the test statistic is always within the upper and lower bounds during the period. This result fails to reject the null hypothesis at the 5% level of significance, indicating that the model is stable and well specified over the period under study.

CONCLUSION

This study identifies the main macroeconomic factors that influence sector GDP growth in Malaysia. The ARDL model confirms that there is a long-term relationship between GDP and gross fixed capital formation, foreign debt, export trade, remittances, and labor force. The results show that the effects of these factors differ significantly between sectors. The primary sector faces the challenge of dependence on exports, while the secondary sector benefits greatly from capital investment but is negatively impacted by foreign debt. The tertiary sector showed resilience with labor force growth and remittances playing an important role. These findings emphasize the importance of sector specific strategies to achieve sustainable economic growth and provide useful guidance to policy makers in addressing Malaysia's economic challenges.

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