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Testing the Twin Deficit Hypothesis in Belize

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This paper empirically tests the validity of the Twin Deficit Hypothesis (TDH) in Belize— a small, open, and import-dependent economy with a fixed exchange rate regime. Using quarterly data from 2001:Q1 to 2024:Q4, the study employs an autoregressive distributed lag (ARDL) model to analyse both the long-run and short-run relationships, with the external current account balance-to-GDP ratio as the dependent variable and the fiscal balance-to-GDP ratio and private credit-to-GDP ratio as independent variables. The results support the TDH, as improvements in the fiscal balance are found to exert a positive and statistically significant impact on the current account balance in the long run. These findings emphasise the critical role of sound fiscal management in addressing external imbalances that could hinder economic growth. Accordingly, the study confirms the relevance of the TDH in Belize and underscores the importance of fiscal discipline for maintaining external stability.

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Keywords: Twin Deficit Hypothesis, fiscal balance, current account balance, small open economy, ARDL Model, macroeconomic stability, policy implications, Belize

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1.0 Introduction

Belize has consistently experienced external current account and fiscal deficits over the past forty years. From 1984 to 2024, both the external current account balance and the overall fiscal balance have been in deficit simultaneously for all but nine years. The frequent occurrence of these two deficits raises questions about whether they are merely correlated or causally linked, in line with the twin deficit hypothesis (TDH). Recurrent twin deficits are especially troubling in a small, open economy with a fixed exchange-rate regime, as persistent external shortfalls can deplete international reserves and threaten the currency peg. This situation could lead to macroeconomic instability that hampers economic growth. Therefore, examining this relationship empirically could provide valuable insights for policymakers.

The TDH postulates that increases in a government's fiscal deficit will lead to a decline in total national savings, as residents use the extra income to increase consumption. To compensate for the lower savings, there must be increased government borrowing or a reduction in savings, which in turn affects the country's current account balance.

The TDH gained prominence in the 1980s when the US federal budget deficit rose from 2.7 percent of GDP to 5 percent of GDP ($220 billion), and the current account deficit grew from 0 to 3.5 percent of GDP ($153 billion) (Mann, 2002). The simultaneous rise of both deficits implied a growing debt burden alongside higher external investment-service payments. This development raised concerns among policymakers, as they feared the dollar could weaken significantly if foreign investors collectively judged the US to be too heavily indebted to external creditors. To address the rising budget deficit, government officials faced the choice of cutting spending or raising taxes. These decisions were believed to influence private sector behaviour and, ultimately, the external balance.

There has been a wealth of empirical studies exploring the relationship between the fiscal balance and the external current account balance in both advanced and developing economies. For example, the panel estimates by Abbas et al. (2011) showed that improving the fiscal balance by one percentage point of GDP led to a strengthening of the current account balance by 0.3-0.4 percentage points of GDP, with the relationship appearing stronger in developing economies. Empirical estimates from the International Monetary Fund (2024) indicated that fiscal consolidation, whether driven by taxes or spending cuts, resulted in an improvement in Colombia's external current account balance. Afonso and Coelho (2024, p. 19) provided evidence of a bilateral relationship between the fiscal balance and the current account balance for Portugal and Germany, suggesting that it was "necessary to monitor public expenditure, imports and both income and transfers balances with the Rest of the World" whilst promoting a robust export sector.

However, despite the extensive literature available abroad, there have been no country-specific empirical studies attempting to validate the twin deficit hypothesis in Belize. This paper seeks to fill this gap by applying an Autoregressive Distributed Lag (ARDL) model to examine both the long-run and

short-run relationships between the fiscal balance and the external current account balance. The results of the Bounds test support the twin deficit hypothesis, as a statistically significant long-run relationship was found between the fiscal balance and the external current account balance.

The rest of the paper is organised into seven sections. Section 2 reviews the literature on how fiscal balances can influence the current account balance. Section 3 describes the conceptual framework underpinning the study. Section 4 provides a historical overview of this relationship in Belize. Section 5 details the data and ARDL methodology employed. Section 6 presents the main results. Section 7 discusses the implications of the ARDL model results, while Section 8 concludes with policy recommendations.

2.0 Literature Review

There are two main strands of literature emanating from Ricardian and Keynesian theory that present contrasting views on the behavioural mechanisms linking the fiscal balance to the external current account balance. This section reviews these theoretical perspectives and emphasises the empirical evidence supporting each approach.

2.1 The Ricardian Equivalence

The Ricardian equivalence, coined by Barro (1974), suggests that shifting from tax-financed to debt-financed government spending has no impact on aggregate demand, interest rates, or private consumption. This is because households would act altruistically and increase private savings to offset the future tax liabilities needed to finance the fiscal imbalance (Barro, 1974). Moreover, a key assumption was that "current generations are connected to future generations by a chain of operative intergenerational transfers" (Barro, 1974, p. 1106).

The theoretical foundation established by Barro has supported the findings of various empirical studies that did not support the TDH. For example, Roubini (1988), Enders & Lee (1990), Seater (1993), and Kormendi & Protopapadakis (2004) found that budget deficits did not significantly affect the current account deficit, as rational households adjust their saving behaviour to offset government borrowing.

2.2 The Keynesian Approach

Conversely, Keynesian theory argues that government spending increases aggregate demand in the economy because of individuals' marginal propensity to consume, which amplifies the initial government expenditure through the multiplier effect (Keynes, 1936). Fleming (1962) supported this view, finding that increases in a government's fiscal deficit would lead to higher demand for imported goods and services, subsequently weakening the country's balance of payments position. This theory underpins the TDH and has generated extensive research into its validity. For instance, Miller (1988) found a statistically significant positive relationship between the fiscal deficit and the current account deficit. He argued that increased government spending raises aggregate demand within the economy, which domestic production cannot fully meet. This results in increased imports that worsen the trade balance and ultimately widen the external current account deficit. Mann (2002) contributed to the literature by suggesting that, in the US, the TDH is intensified by low levels of private savings alongside global capital inflows. When the government finances its deficit with treasury securities, it causes currency appreciation, which worsens the trade deficit as US exports become more expensive. Bartolini & Lahiri (2006) and Bluedorn & Leigh (2011) extend the applicability of the TDH, as they found that fiscal expansion worsens the external current account deficit through heightened domestic demand and the negative effects on the trade balance.

2.3 Empirical Review

In their efforts to investigate the validity of the TDH, researchers have employed various econometric models such as Vector Autoregressions (VAR), Vector Error Correction (VEC), and Autoregressive Distributed Lag (ARDL).

One such study was conducted in Suriname by Sim-Balker et al. (2014), where a multivariate VEC was used to identify a long-run relationship between the overall fiscal balance and the external current account balance, with the money supply used as an explanatory variable. Their empirical estimations revealed that a 1.0% rise in the fiscal deficit caused a 0.6% increase in the current account deficit, which supported the TDH. Furthermore, Granger causality tests indicated unidirectional causation running from the fiscal account to the current account. Policy recommendations focused on developing a Sovereign Wealth Fund to "mitigate shocks to government revenues in the short term" alongside promoting "agro-industrial production and tourism" (Sim-Balker et al., 2014, p. 17). Lastly, they proposed a gold tax targeting small-scale gold mining to increase government revenues (Sim-Balker et al., 2014).

In Trinidad and Tobago, Thompson et al. (2021) examined the relationship between the current account balance and the fiscal balance using a VEC. They identified a positive long-term relationship between the two variables, and the authors noted that their findings aligned with developing economies where the government accounts "for a large share of domestic demand in oil exporters and its indirect impacts through public employment" (Thompson et al., 2021, p. 23). They found that causation from the current account to the fiscal balance was also consistent with small open energy-based economies that are vulnerable to shocks in international oil prices. Policy advice focused on improving the overall balance by increasing government revenues and reducing expenditure. Including these measures within a medium-term fiscal framework could serve as a buffer against external shocks to the domestic economy (Thompson et al., 2021). The authors also observed that increasing FDI could improve both the fiscal and current account deficits by boosting domestic production and raising energy export earnings.

In another insightful study, Nicholson (2015) used a multivariate VAR that included the fiscal balance, current account balance, and the real effective exchange rate to test the twin deficit hypothesis in Jamaica. The TDH did not hold, as reverse causality was found, signifying that current account deficits lead to fiscal deficits in Jamaica. This was supported by the impulse response functions, which showed that improvements in the fiscal deficit worsened the current account deficit. Nicholson (2015) suggested that the improvement in the fiscal balance reflected reduced government support for the private sector and negatively affected exports. The author postulated that his findings were consistent with open and developing economies and supported the theory that twin deficits mostly occur in developed economies. Policy recommendations focused on improving the current account balance along with the adoption of "prudent fiscal management" to achieve "macroeconomic stability", creating a favourable environment for investments and increasing export capacity (Nicholson, 2015, p. 14).

Alleyne et al. (2011) contributed to the literature by employing a vector autoregressive moving average (VARMA) framework to determine whether the current account balance causes the fiscal balance or vice versa. The analysis focused on several Caribbean countries and produced mixed results. For

instance, causation was bi-directional in Grenada, Guyana, and Jamaica, meaning that the fiscal balance and the current account balance "influence each other simultaneously through feedback effects" (Alleyne et al., 2011, p. 15). In Barbados and Belize, there was unidirectional causality from the current account balance to the fiscal balance. This finding is particularly important for this study, as it suggests that the TDH does not hold for Belize. The authors surmised that fiscal consolidation alone is not sufficient to "address the medium- and long-term structural challenges which result from declining competitiveness in the external sector" (Alleyne et al., 2011, p. 27). It was recommended that Caribbean countries should prioritise improving "export competitiveness in both the services and goods-producing sectors" (Alleyne et al., 2011, p. 27). To achieve this, the labour force must be adequately educated to enhance the technical capacity of relevant economic sectors.

Banday & Aneja (2019) used an ARDL model to assess the validity of the TDH in China. Control variables included the interest rate, inflation rate, money supply, and the real effective exchange rate. The bounds testing of the model confirmed a long-term relationship between the budget deficit and the current account deficit. However, the causality tests revealed a bidirectional causal relationship, as both deficits influenced each other. Therefore, improvements in the budget deficit were found to enhance the current account deficit, supporting the TDH. Nevertheless, fluctuations in the interest rate and the exchange rate contributed to divergences between the deficits. Policy prescriptions centred around implementing coordinated fiscal and monetary policies to prevent imbalances from reaching critical levels.

In Canada, Janko (2020) employed ARDL and ECM models to analyse the long-term and short-term dynamics between the fiscal balance and the current account balance. Investment and private credit were also incorporated into the model to account for broader macroeconomic factors that could influence the relationship between the two deficits. The ARDL identified a long-run cointegrating relationship between the current account, fiscal balance, investment, and private credit, supporting the TDH. A 1.0 percentage point increase in the fiscal balance-to-GDP ratio caused a 0.4 percentage point rise in the current account balance-to-GDP ratio. Additionally, the ECM also supported the TDH in the short run, as the coefficient was statistically significant and negative (-0.225). This indicates that 22.5% of any deviation from the long-run equilibrium in the current account balance will be corrected in the following quarter. Consequently, adjustments to fiscal policy would require approximately 4.4 quarters for the current account balance to move significantly towards equilibrium.

Hussain et al. (2023) used two ARDL models to investigate the applicability of the TDH hypothesis in Pakistan. The first model used the current account balance as the dependent variable, while the second incorporated the balance of trade. Control variables included money supply, GDP growth, openness of the economy, and the nominal effective exchange rate index. Both models supported the conventional view of the TDH by establishing a statistically significant long-run relationship between the fiscal balance and the current account balance. The findings showed that increases in GDP growth and money supply were associated with deteriorations in the current account balance and the balance of trade, thereby supporting the Keynesian absorption theory.

To summarise, the selected literature presented mixed results regarding the effect of fiscal policy on the external current account balance. The empirical estimates from the VARMA framework used by Alleyne et al. (2011) showed that reductions in the fiscal balance are insufficient to address the structural challenges caused by a weak export sector in most Caribbean countries. Similarly, Nicholson's (2015) multivariate VAR indicated that reduced government spending in Jamaica had a negative impact on exports due to a decline in governmental support to producers. However, the VEC employed by Sim-Balker et al. (2014) in Suriname found that decreased government spending could improve the current account deficit owing to reduced demand for imported goods and services. Thompson (2021) reached a similar conclusion, as his VEC model confirmed the twin deficit hypothesis in Trinidad and Tobago, as a positive long-run relationship was identified between the fiscal deficit and the current account deficit. Lastly, the findings of Banday & Aneja (2019), Janko (2020), and Hussain et al. (2023) also supported the TDH and suggested that fiscal discipline can reduce current account imbalances.

Following Janko (2020), this study will utilise an ARDL and ECM econometric approach to analyse the relationship between the fiscal balance and the current account balance over both the long run and the short run. These techniques are particularly beneficial, as they will distinguish between short-run and long-run effects, helping policymakers understand whether fiscal adjustments will have a temporary or permanent impact on the current account position.

3.0 Conceptual Framework of the TDH

This section outlines the theoretical foundations of the TDH by analysing the production-expenditure identity, disposable-income identity, and the sectoral-deficits identity. The preceding literature review examined the Keynesian and Ricardian behavioural mechanisms through which fiscal balances can influence the current account. Here, the focus shifts to the accounting relationships linking these balances by way of national saving and investment. These frameworks provide the basis for explaining how fiscal imbalances can translate to external current account deficits in small, open economies like Belize.

3.1 Production-Expenditure Identity

The production-expenditure identity connects the total value of output in an economy to its expenditure components. This framework states that a country's gross domestic product (GDP) is the sum of consumption expenditures, investment expenditures, government expenditures, and net exports, expressed as:

$$Y \equiv C + I + G + EX - IM \qquad (1)$$

Where Y = total goods produced in the country (GDP), C = total household consumption of goods and services, I = investment purchases by firms of goods and services, G = government purchases of goods and services, EX = exports of goods and services, and IM = imports of goods and services. The left-hand side of equation (1) can be viewed as production that generates income, and the right-hand side of equation as expenditure that purchases production.

3.2 Disposable-Income Identity

The disposable-income identity then relates the aggregate income described in equation (1) to its uses. This is necessary, as not all the income generated within the domestic economy is available for the purchase of goods and services. The government receives taxes from income but must also make transfer payments to the domestic private sector. Thus, disposable income is income net of taxes and transfers and is shown in equation (2) below:

$$YD \equiv Y - T + TR \equiv C + S \qquad (2)$$

Where YD = disposable income, TR = transfer payments to the domestic private sector, T = taxes, and S = savings.

3.3 Sectoral-Deficits Identity

The two identities presented in equations (1) and (2) can be re-expressed to form the sectoral-deficits identity:

$$[G - (T - TR)] + [I - S] + [EX - IM] \equiv 0 \qquad (3)$$

Where $G - (T - TR)$ = government budget deficit, $[I - S]$ = private sector deficit, and $[EX - IM]$ = foreign sector deficit. In equation (3), the current account balance can be defined as the difference between

exports and imports, government savings as the difference between taxes and government spending, and private savings as the difference between private savings and investment.

However, it is important to note that equation (3) is incomplete, as it assumes that there are no net income flows from abroad and that no transfer payments are made to foreigners. These are critical components of the external current account balance and must be properly accounted for when conceptualising the TDH:

$$YD \equiv Y + NIA + TR - T - NTRA \equiv C + S \tag{4}$$

Therefore, equation (4) introduces the two added terms, where *NIA* = net income from abroad and *NTRA* = net transfer payments and taxes to abroad. Finally, equation (4) can be rearranged to form a more comprehensive version of the sectoral-deficits identity that depicts the current account balance as opposed to the trade balance:

$$[G - (T - TR)] + [I - S] + [EX + NIA - IM - NTRA] \equiv 0 \tag{5}$$

Where [*EX + NIA - IM - NTRA*] = current account balance. Therefore, a current account deficit can result from either a shortfall in private savings relative to investment or from a fiscal deficit (i.e., when government spending exceeds tax revenues).

This framework is especially relevant for small, open, and import-dependent economies like Belize. Higher government spending often stimulates domestic demand that cannot be met solely by domestic production, resulting in increased imports. This weakens the trade balance and contributes to external current account deficits. Furthermore, the importance of investigating the TDH in Belize is amplified by the country's fixed exchange rate regime, which requires a steady inflow of foreign exchange. These inflows typically come from exports of goods and services, including tourism, government borrowings, foreign investment, and remittances, highlighting Belize's reliance on external transactions. The peg also limits monetary policy autonomy, making fiscal prudence critical to macroeconomic stability.

Therefore, the production-expenditure identity and, by extension, the sectoral-deficits identity serves as the theoretical backbone of this paper, as it implicitly captures the relationship between the fiscal balance and the external current account balance.

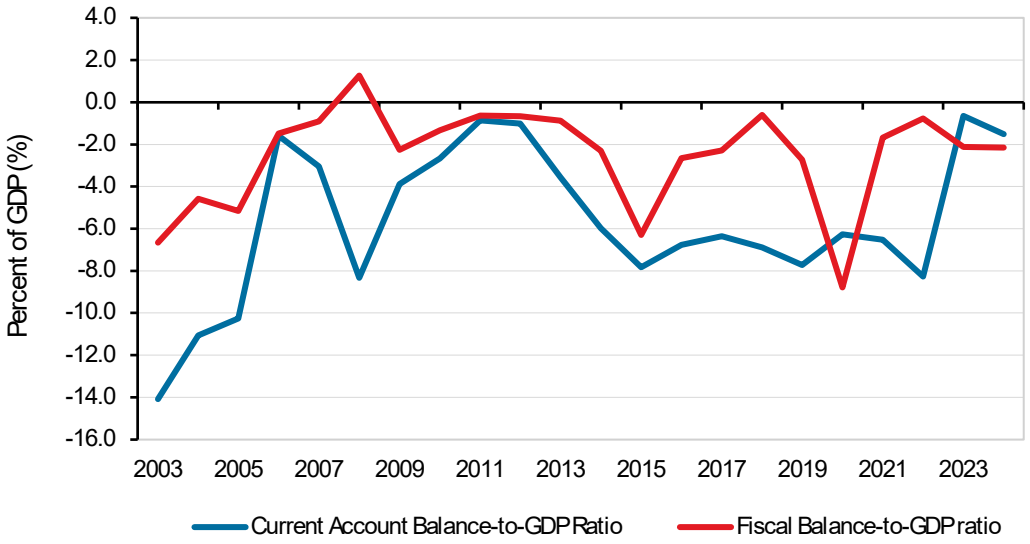
4.0 Evolution of the External Current Account and Fiscal Balance

Belize's external current account balance has recorded a surplus only five times since 1984 and has been in deficit for the last 27 years. This largely reflects expansions in the trade deficit, as the country's agriculture-based export sector has consistently been outpaced by substantial import growth to meet domestic demand as well as the needs of the expanding tourism industry. On the fiscal side, various government administrations have grappled with the political implications of adopting contractionary fiscal policies to address external imbalances versus expansionary fiscal policies to promote economic growth. These difficulties were highlighted in 1993 when the sitting government aimed to reduce pressures on the balance of payments and the fixed exchange rate by "lowering domestic consumption and bringing the fiscal accounts onto a more sustainable footing" (Garcia et al., 2009, p. 2). This was achieved through the implementation of an aggressive contractionary fiscal policy stance, including a temporary wage freeze, a reduction in the public sector's workforce by almost 9.0%, and the introduction of a 15.0% value-added tax. However, rising public discontent with the stringent fiscal policy approach led to a change of government in 1998, as the incoming administration promised an "aggressive reversal of the previous administration's economic strategy" (Garcia et al., 2009, p. 3). These episodes provide historical evidence of instances where policymakers have influenced external sustainability through various degrees of fiscal adjustment. However, a more recent investigation is needed to analyse how the relationship has developed.

4.1 Trends in Fiscal and Current Account Balances, 2003-2023

This section analyzes the historical trajectory of the current account balance and fiscal balance from 2003 to 2023 (see Figure 1). Both variables exhibit persistent deficits that fluctuate to varying degrees over the review period. A historical assessment of these patterns is crucial in assessing potential linkages between fiscal and external current account imbalances.

Figure 1: External Current Account Balance vs Fiscal Balance



4.1.1 2003 – 2008 Period

In 2003, Belize's fiscal operations generated an overall deficit of $174.4mn (6.7% of GDP), as increased interest outlays on the public sector debt and salary and pension payments coincided with a decline in non-tax revenues. These factors outweighed a rise in taxes on income and goods and services. The deficit was mainly financed through external borrowing, with the public sector's disbursed outstanding external debt rising by $350.4mn to $1,499.4mn (57.2% of GDP). Meanwhile, the external current account deficit widened to $368.6mn (14.1% of GDP) due to increased imports and higher external debt service payments, which overshadowed revenue gains from tourism and domestic exports.

From 2004 to 2006, government officials took measures to implement a fiscal adjustment to ward off a potential balance of payments crisis. Their contractionary fiscal policy stance included increased taxes, reduced capital expenditures, and tightened liquidity requirements for domestic banks. The external debt burden remained substantial, rising by $470.9mn to $1,970.3mn (61.8% of GDP) in 2006 compared to 2003. This posed a significant risk to the sustainability of the fixed exchange rate peg, as a large portion of the debt was short-term and at commercial rates. Consequently, the Government began debt-restructuring negotiations with external private creditors to restore fiscal and external stability. However, these fiscal developments coincided with the start of commercial oil operations and higher prices for citrus juices and sugar, which contributed to a dramatic improvement in the current account deficit to $50.8mn (1.6% of GDP) in 2006.

By early 2007, the Government's debt restructuring negotiations were successfully completed, and external debt was reduced by 21.0% (in net present value). In 2008, the Government recorded its first overall surplus ($44.2mn or 1.3% of GDP) since 1998. However, the improvement in the fiscal accounts did not translate to the external current account deficit, as it worsened to $289.7mn (8.3% of GDP) in 2008, owing to substantial imports of capital investment goods for the telecommunication, electricity, aviation, and petroleum industries.

4.1.2 2009 – 2013 Period

In 2009, Belize's fiscal accounts reverted to a deficit of $76.4mn (2.3% of GDP). This outcome reflected increased expenditure on goods, services, and emoluments that outweighed a contraction in capital spending. Revenues were affected by a sizeable falloff in foreign grants and reduced income from the oil sector. The overall financing gap was covered through government borrowings that pushed up the public sector's external debt by $118.3mn to $2,033.9mn (60.1% of GDP). The decrease in capital spending contributed to a notable decrease in the merchandise trade deficit, as imports declined at a faster pace than exports. This outcome drove a $158.2mn contraction of the current account deficit to $131.2mn (3.9% of GDP).

Over the next four years, the overall deficit decreased by an annual average of $10.2mn before settling at $35.7mn (0.9% of GDP) in 2013. A tightening of the Government's current expenditure combined with improved tax collection efforts boosted revenues, despite declines in income from the oil industry

and foreign grants. A second debt restructuring in 2013 also contributed to the improved fiscal performance, as the net present value of the external debt was reduced by 43.3%, and the repayment period was extended. Despite the improvement in the Government's current balance, expenditures on major capital projects surged, leading to a sizeable expansion in the merchandise trade deficit. As a result, the external current account deficit worsened to $144.9mn (3.6% of GDP) in 2013.

4.1.3 2014 – 2019 Period

In 2014, the overall deficit increased by $63.0mn to $98.7mn (2.3% of GDP) due to increased spending on capital projects, wages and salaries, and interest payments on external debt, which outweighed a rise in tax collections and foreign grants. The deterioration in the fiscal accounts continued in 2015 but reached levels not seen since 2003, with the overall deficit expanding by $177.6mn to $276.3mn (6.3% of GDP). Expenditures faced upward pressure from sizeable infrastructural projects, net lending to a statutory body, and an expanded wage bill following negotiated salary increases for teachers. Concurrently, a global oversupply triggered a collapse in oil prices, causing Belize's crude oil export earnings to plummet by $255.7mn to $36.4mn compared to 2011. This development contributed to the external current account deficit worsening to $343.5mn (7.8% of GDP) in 2015.

In 2016, the overall deficit improved by $157.2mn to $119.1mn (2.6% of GDP), as a decline in large-scale capital projects was only partly offset by negotiated wage increases for the public sector. In 2017, there was a further marginal improvement in the fiscal deficit, which fell by $15.7mn to $103.4mn (2.3% of GDP) owing to reduced outlays on capital projects and heightened tax collection efforts.

These fiscal consolidation efforts culminated in Belize's third debt restructuring of its commercial debt, which reduced the net present value by 28.0%, providing liquidity relief to the government. As part of the negotiations, the loan's maturity was shortened by four years, and the government was required to meet specific fiscal targets. Continued fiscal restraint on capital expenditure resulted in a $75.8mn decline in the overall deficit, lowering it to $27.6mn (0.6% of GDP) in 2018. Meanwhile, the reduction in capital outlays contributed to a reduction in imports of construction materials, and the external current account deficit narrowed to $287.8mn (6.3% of GDP).

However, Belize's improved fiscal performance was short-lived, as the overall deficit worsened by $102.8mn to $130.3mn (2.7% of GDP) in 2019, and the Government failed to meet its fiscal target of a 2.0% primary surplus. This outcome reflected a sizeable decline in non-tax revenue and grants, while spending on capital investment projects rose markedly. The gross financing gap was primarily covered by foreign loans and, to a lesser extent, the drawdown of domestic deposits and the issuance of government securities. Meanwhile, the external current account deficit grew to $369.3mn (7.7% of GDP) in 2019, due to increased imports for goods and services that surpassed gains from tourism and agricultural exports.

4.1.4 2020 – 2023 Period

In 2020, the COVID-19 pandemic caused a sharp contraction in tax revenues due to depressed economic activity. Meanwhile, expenditures shot up for health services and unemployment assistance programmes as the Government tried to mitigate the impact of the public health emergency. Consequently, the overall deficit worsened by $228.5mn to $358.8mn (8.7% of GDP), marking the largest fiscal deficit in Belize's post-independence history. The Government also sought support for the balance of payments by capitalising interest on its commercial debt and issuing a US$30.0mn treasury note.

The emergency fiscal measures implemented by the Government, along with regulatory restrictions imposed on banks to safeguard international reserves, led to a $113.5mn reduction in the external current account deficit to $255.8mn (6.2% of GDP). Notable declines were seen in import expenditures, profit and dividend repatriation, and interest payments on external debt, which offset the considerable decline in tourism inflows and domestic exports.

In 2021, an aggressive fiscal consolidation programme resulted in significant spending cuts for public sector wages, capital investment projects, goods and services, and transfers. On the revenue side, the relaxation of lockdown measures supported an upswing in economic activity and boosted tax receipts, while foreign aid for pandemic assistance surged. These factors contributed to a $277.7mn improvement in the overall deficit, reducing it to $81.1mn (1.7% of GDP).

The most notable development in 2021 was the completion of a debt-for-nature swap in November that resulted in the repurchasing and cancellation of the outstanding principal of the commercial debt using loan proceeds from a global environmental organisation. The public sector's external debt stock fell by $229.4mn to $2,677.0mn, thus enhancing Belize's debt sustainability prospects. The Government's fiscal position further improved in 2022, as the overall deficit declined by $37.2mn to $43.9mn (0.8% of GDP), owing to a strong performance in tax receipts and increased capital grants following the removal of most pandemic-related restrictions. These developments were partly offset by increased government spending, which was driven by a rise in public sector wages, the resumption of interest payments on external debt, and a sizeable arbitral award paid to an international investor.

Concurrently, the release of pent-up demand for goods and services, combined with the removal of regulatory restrictions on domestic banks, led to a significant increase in the merchandise trade deficit and profit repatriations to foreign investors. The arbitral award paid by the Government also caused a significant increase in outward transfers. These factors led to a $155.4mn expansion of the current account deficit to $471.1mn (8.3% of GDP).

In 2023, the Government's overall deficit worsened by $86.4mn to $130.3mn (2.1% of GDP), owing to increased interest payments on its external debt, emoluments to public workers, and the settlement of other outstanding arbitral awards. Conversely, the external current account deficit declined by

$431.6mn to $39.5mn (0.6% of GDP) due to a $334.5mn surge in tourism revenues that outpaced a $142.9mn increase in the merchandise trade deficit. A notable reduction in profit repatriation was also observed following a spike in the previous year, owing to transitory factors.

4.2 Summary

Throughout the review period, it was observed that Belize's fiscal policy stances are largely characterized by boom-and-bust cycles. In the pursuit of economic growth, various government administrations have implemented expansionary fiscal policies that resulted in sizeable budget deficits. These periods of high spending eventually eroded fiscal space and placed pressure on the country's international reserves, as high-interest loans from commercial creditors were needed to bridge the financing gap. During these episodes, noticeable expansions in the merchandise trade deficit occurred, as import growth surged to accommodate widespread capital projects. In addition, heightened interest payments also worsened the external current account balance.

To address the high debt burden and worsening external imbalances, government administrations have had to negotiate several debt restructurings to provide short-term liquidity relief and to steer the country's debt trajectory towards greater sustainability. This had a positive impact on the external current account balance, as interest outlays decreased. Additionally, periodic contractionary policies enacted by the Government have led to reduced spending on capital projects and improvements in the merchandise trade deficit.

These patterns underscore the interdependence between the fiscal balance and the external current account balance in Belize. The data also shows that there were times when the TDH did not hold owing to fluctuations in commodity prices, along with other external factors. Given the complex and evolving nature of this relationship, this empirical investigation is being done to statistically assess the interplay between fiscal deficits and the external current account deficit.

5.0 Empirical Methodology

This study applies an ARDL model to empirically investigate the relationship between Belize's fiscal balance and external current account balance. The ARDL approach is well-suited for this analysis because it captures both short-run and long-run dynamics, accommodates variables with different integration orders, I(0) and I(1), and is suitable for small sample sizes.

5.1 Model Specification and Data

To examine the relationship between the external current account balance and fiscal balance, elements of the production-expenditure identity, alongside relevant macroeconomic indicators, will be empirically evaluated using an ARDL model. The study utilised a quarterly time series of data spanning 2001: Q1 to 2024: Q4 for Belize, covering variables such as the external current account balance-to-GDP ratio, fiscal balance-to-GDP ratio, and private credit-to-GDP ratio. The choice of explanatory variable is based on the sectoral-deficits identity, which underscores the roles of both public and private sector behaviour in shaping the external current account balance. Therefore, the chosen variables reflect commonly investigated channels through which fiscal and monetary conditions can influence the dynamics of the TDH and were also employed by Janko (2020). All data were sourced from the Central Bank of Belize and the Statistical Institute of Belize.

Upon estimating the ARDL model, the fiscal balance-to-GDP ratio is expected to exhibit a positive coefficient, consistent with the assumptions of the TDH, which posits that fiscal consolidation leads to improvements in the current account balance. Meanwhile, the private credit-to-GDP ratio is expected to have a negative coefficient, as credit expansion results in increased aggregate demand for imported goods and services, thereby worsening the current account.

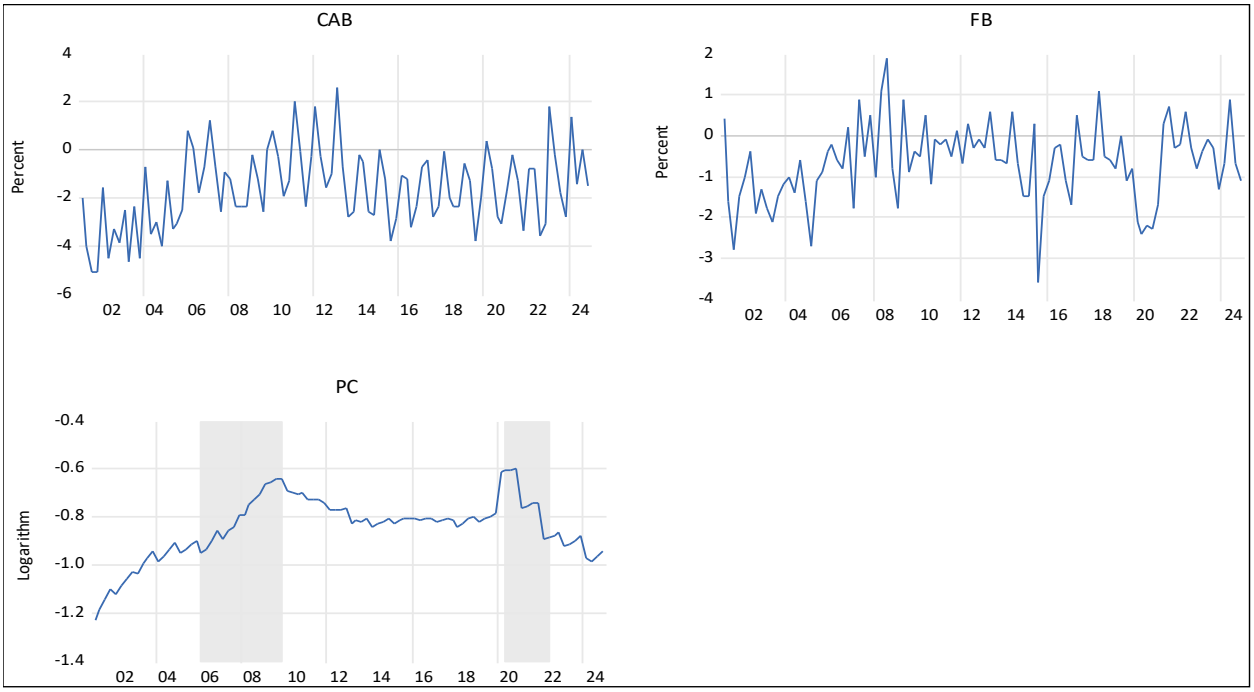
5.2 Time Series Analysis

Figure 2 depicts the graphical representation of the current account balance-to-GDP ratio (CAB), fiscal balance-to-GDP ratio (FB), and private credit-to-GDP ratio (PC) on a quarterly basis from 2001:Q1 to 2024:Q4.

The CAB and FB variables do not exhibit a clear linear trend, as sharp fluctuations occur throughout most of the time series below zero.

Meanwhile, PC demonstrated pronounced upward trends that consistently precede periods of contraction. From 2006 to 2009, the sizeable upswing was attributed to the Government's expansionary fiscal policy aimed at boosting economic growth. However, this period was also marked by domestic banks' poor lending practices, which led to a sharp decline in asset quality. This prompted the Central Bank to implement stricter macroprudential policies, which contributed to the decrease in credit growth from 2010-2019. Finally, the COVID-19 pandemic caused the final phase of fluctuation, as monetary and macroprudential measures were eased to support credit growth amid a dramatic slowdown in economic activities.

Figure 2: Time Series Data



Source: Author's Calculation

The peaks and troughs observed in the variables could be indicative of structural breaks that may need to be accounted for in the ARDL model. Failure to capture these potential breakpoints can lead to biased estimates, which can invalidate the model.

5.2.1 Data Transformation

It is important to apply appropriate data transformations, where feasible, to ensure consistency in scale, linearity, and statistical robustness. Therefore, PC was seasonally adjusted[1] to remove recurring quarterly fluctuations that can obscure underlying trends in the data. Furthermore, the variable was then expressed in logarithmic form to reduce skewness, stabilise variance, and correct for deviations from normality, owing to its strong upward trend that was observed in Figure 2. However, CAB and FB were left at their levels, owing to the presence of negative values throughout both time series, which precluded the use of logarithmic or seasonal adjustment transformations.

5.2.2 Stationarity Tests

Prior to conducting structural break tests, unit root tests were used to determine the order of integration for each variable. A key advantage of an ARDL framework is its ability to handle variables with mixed integration orders, specifically I(0) or I(1). However, including I(2) variables renders the model invalid. Therefore, Augmented Dickey-Fuller (ADF) and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) tests were employed to assess the stationarity of CAB, FB, and PC (see Table A-1). The ADF test's null hypothesis is a unit root (non-staionarity), while the KPSS test's null is staionarity. Additionally, both

[1] PC was seasonally adjusted using the X-13ARIMA-SEATS package in EViews.

tests were performed with a constant and no trend, as well as with a constant and trend, to improve the robustness of the assessment. The r
esults of both tests satisfied the stationarity condition, as no variable was integrated of order two, I(2).

5.2.3 Structural Break Test

To identify potential structural breaks within the time series data, a Bai-Perron multiple breakpoint test and a Quandt-Andrews unknown breakpoint test were used on CAB, FB, and PC (see Tables A-2 & A-3). These tests are especially helpful for a time series that shows several periods of sharp fluctuations due to various economic shocks or policy changes, as seen in Figure 2. The null hypothesis of both the Bai-Perron and Quandt-Andrews tests states that there are no structural breaks in the regression parameters during the sample period.

The Bai-Perron test identified one statistically significant structural break[2] in the timeseries model (2006: Q1). In 2006, the Government's overall deficit improved significantly from 6.8% of GDP to 1.8% of GDP, as debt-related interest and fees declined owing to the debt restructuring programme. Meanwhile, Belize's external position also experienced a significant turnaround, with the external current account deficit narrowing from 14.4% of GDP to 2.0% of GDP, as the trade deficit shrank due to strong crude oil sales.

The Quandt-Andrews unknown breakpoint test confirmed the findings from the Bai Perron test, as the 2006:Q1 period was identified as a structural break point. Interestingly, the COVID-19 pandemic was not detected as a structural break in either test despite the significant downturn in economic activities that occurred. To improve the robustness of the model, this period will also be evaluated for statistical significance alongside the other structural breakpoints to validate its inclusion in the ARDL model.

5.2.4 Dummy Variable Analysis

An ARDL model was employed to determine the statistical significance of the structural break points identified by the Bai-Perron and Quandt-Andrews tests by assigning dummy variables to represent each break point (see Table A-4).

Based on the results, only the dummy variable corresponding to the COVID-19 pandemic was statistically significant at the 1% level[3]. Conversely, the dummy variable capturing 2006:Q1 was not statistically significant at conventional levels despite indicating a structural shift in both breakpoint tests. Nevertheless, the 2006:Q1 period remains economically significant owing to the pronounced improvements in both the external current account deficit and the fiscal deficit, which represented clear departures in outcome when compared to previous periods. Therefore, the final ARDL specification will include both dummy variables, as this will better capture the structural shifts that affected the variables of interest within the study.

[2] The breakpoint was statistically significant at the 5% level.
[3] Statistical significance was assessed using the T-statistic of its coefficient in the ARDL regression output.

5.3 ARDL Model

Following the identification and testing of structural breakpoints using dummy variables, the ARDL model will be employed to examine the relationship between the current account balance and the fiscal balance, along with other variables of interest. This econometric approach captures both short-run and long-run dynamics within a single framework. Short-run effects are estimated through the inclusion of differenced variables, while the long-run relationship is identified via the lagged levels of the regressors. Furthermore, the model's error correction form offers insights into the speed at which deviations from the long-run equilibrium are corrected over time.

5.3.1 Deterministic Specification

To determine the appropriate deterministic specification for the ARDL model, a visual inspection of the time series data was conducted. Pesaran et al. (2001) emphasise that the choice of deterministic specification is critical, as it directly affects the validity of the bounds test for cointegration. Since the dependent variable (CAB) does not exhibit a clear deterministic trend, but fluctuates around a non-zero mean, the model was specified with an unrestricted constant and no trend (Case 3).

5.3.2 Lag Structure

Selecting the optimal lag length is also essential, as it enhances the robustness and reliability of the inferences made from the ARDL model. Lag lengths that are too short may fail to capture short-run dynamics, resulting in autocorrelated residuals and potential model misspecification. In contrast, too many lags can reduce the degrees of freedom in the model and lead to overfitting. To address this issue, the Akaike Information Criteria (AIC) was used to guide lag selection. A maximum of three lags was specified for the dependent variable and four for the regressors, consistent with the quarterly frequency of the data. The AIC identified a (2,3,1) lag structure for the ARDL model, assigning 2 lags for the dependent variable, 3 lags for the first regressor, and 1 lag for the second regressor.

5.3.3 ARDL Model Representation

The ARDL model implies that the following long-run relationship between the CAB and FB exists alongside another explanatory variable—PC:

$$\begin{aligned} CAB_t = \alpha_0 + \alpha_1 CAB_{t-1} + \alpha_2 CAB_{t-2} + \beta_0 FB_t + \beta_1 FB_{t-1} + \beta_2 FB_{t-2} + \beta_3 FB_{t-3} + \gamma_0 PC_t \\ + \gamma_1 PC_{t-1} + \delta_1 COVID\_DUMMY_t + \delta_2 D2006_t + \varepsilon_t \end{aligned} \tag{6}$$

where CAB_t is the current account balance-to-GDP ratio, FB_t is the fiscal balance-to-GDP ratio, PC_t is logged private credit-to-GDP ratio, $COVID\_DUMMY_t$ represents the dummy variable accounting for the COVID-19 pandemic (2020:Q2 to 2022:Q2), and $D2006_t$ represents the dummy variable accounting for 2006:Q1. Finally, ε_t represents the white noise error term.

5.3.4 Error Correction Form

The ARDL model can be reparametrized to show the error correction form:

$$\Delta CAB_t = \emptyset_0 + \sum_{i=1}^{1} \psi_i \Delta CAB_{t-i} + \sum_{j=0}^{2} \theta_j \Delta FB_{t-j} + \sum_{k=0}^{0} \lambda_k PC_{t-k} + \delta_1 COVID\_DUMMY_t + \delta_2 D2006_t - \phi ECT_{t-1} + \varepsilon_t \quad (7)$$

where Δ represents each variable in first differences, ECT_{t-1} is the error correction term derived from the cointegrated long-run vector, is the speed of adjustment coefficient, and ε_t is the white noise error term.

5.3.5 Cointegrating Vector

Lastly, the cointegrating vector is given by:

$$ECT_{t-1} = CAB_{t-1} - (\beta_1 FB_{t-1} + \beta_2 PC_{t-1}) \quad (8)$$

The cointegrating vector defines the stable long-run relationship among CAB, FB, and PC. Furthermore, this representation illustrates how the system will converge to equilibrium following short-term deviations.

5.3.6 ARDL Bounds Test

Following Pesaran et al. (2001), the ARDL Bounds testing approach is employed to examine the long-run relationship between CAB, FB, and PC. This test evaluates the joint significance of the lagged level variables through an F-statistic, which is compared against critical bounds. Cointegration is confirmed if the F-statistic exceeds the upper bound, but if it falls below the lower bound, cointegration is not present among the variables. If the F-statistic falls between the upper and lower bounds, the results of the Bounds test are deemed inconclusive. In this study, the Bounds test confirmed the existence of cointegration among the variables at the 1% significance level, as the F-statistic (20.523) exceeded the upper bound of 6.360. (See Table A-5).

The T-statistic was also used to assess the statistical significance of the error correction term. A significant and negative error correction term confirms that short-run deviations from the long-run equilibrium are corrected over time, providing further evidence of a stable long-run relationship among the variables in the system. Since the T-statistic (-7.794) was less than the 1% critical value (-4.100), the null hypothesis of no long-run relationship was rejected. Therefore, the F-statistic and T-statistic jointly justify the validity of the ARDL model in estimating the long-run dynamics of the twin deficit relationship.

5.3.7 Diagnostic and Stability Tests

A series of diagnostic and stability tests were performed to ensure that the results obtained from the ARDL model were not spurious due to various econometric issues such as autocorrelation, heteroskedasticity, and normality. The Breusch-Godfrey LM test for serial correlation indicated no evidence of autocorrelation in the residuals, as the probability value (0.3341) exceeded the 5%

significance level (see Table A-6). Therefore, the null hypothesis of no serial correlation could not be rejected. Similarly, the Breusch-Pagan-Godfrey test for heteroskedasticity suggested that the variance of the residuals was constant, with a probability value (0.4157) exceeding the 5% significance level, so the null hypothesis of homoskedasticity was not rejected (see Table A-7). The Jarque-Bera normality test indicated that the residuals were approximately normally distributed, as the probability value (0.0631) exceeded the 5% significance level (see Table A-8). Consequently, the null hypothesis of normally distributed residuals was not rejected.

In addition, the model's structural stability was examined using the CUSUM and CUSUMSQ tests (see Tables A-9 & A-10). In both cases, the plots remained within the 5% significance bounds throughout the sample period, indicating that the model is structurally stable and free from parameter instability. Therefore, these diagnostic and stability tests confirm that the model satisfies key classical assumptions. Lastly, a Ramsey RESET test was conducted to assess whether the ARDL model suffered from functional form misspecification. The probability value was 0.1298, which exceeded the 5% significance level, and the null hypothesis of correct model specification was not rejected (see Table A-11).

5.3.8 Forecast Evaluation

To assess the predictive ability of the model, several forecast evaluation statistics were computed (see Table A-12). The results indicated a Root Mean Squared Error (RMSE) of 0.012419 and a Mean Absolute Error (MAE) of 0.010315, which suggested that the actual and predicted values were closely aligned.

Meanwhile, the Theil's Inequality Coefficient was 0.302, below the upper threshold of 1, which signified a good forecast accuracy. The bias proportion, which captures systematic forecast error, was effectively zero (0.000039). This result indicates that the prediction errors were random as opposed to consistently being over- or understated. Therefore, the evaluation statistics confirm that the ARDL model has strong in-sample forecasting ability, reinforcing the robustness of the empirical findings and the credibility of the policy prescriptions.

6.0 Results

This section presents the empirical findings from the ARDL model, which investigates both short-term and long-term relationships between CAB, FB, and PC.

6.1 Long-Run Empirical Estimates

The long-run relationship between CAB, FB, and PC was estimated using the cointegrating specification derived from the ARDL model. Table 1 presents the normalised long-run coefficients derived from the ARDL model shown in Table A-13:

Table A.1: ARDL Long-Run Coefficients

Variable*	Coefficient	Std. Error	t-Statistic	Prob.
FB(-1)	0.662	0.236	2.802	0.006
PC(-1)	0.039	0.013	2.956	0.004

The long-run coefficients of the model indicate that a one percentage-point increase (decrease) in the FB is associated with a 0.662 percentage-point increase (decrease) in the CAB, significant at the 1% level. Therefore, this result provides statistical evidence of the TDH in Belize. Concurrently, a one percentage-point increase in PC is associated with a 0.04 percentage-point increase in CAB, statistically significant at the 1% level.

6.2 Short-Run Empirical Estimates

To assess the short-run relationship between the fiscal and current account balances, the ARDL model was reparametrized into its error correction form, as shown in Table 2 below:

Table A.2: ARDL Error Correction Model

Variable	Coefficient	Std. Error	t-Statistic	Prob.
COINTEQ*	-1.046	0.132	-7.942	0.000
D(CAB(-1))	0.243	0.100	2.443	0.017
D(FB)	0.202	0.150	1.348	0.181
D(FB(-1))	-0.491	0.156	-3.155	0.002
D(FB(-2))	-0.324	0.137	-2.361	0.021
D(PC)	-0.125	0.037	-3.395	0.001
COVID_DUMMY	-0.008	0.005	-1.655	0.102
D2006	0.019	0.013	1.438	0.154
C	0.022	0.003	7.452	0.000

The error correction term (ECT) was negative and statistically significant at the 1% level (p = 0.0000), with a coefficient of -1.046, confirming the existence of a stable long-run relationship among the variables. Furthermore, the coefficient indicates that approximately 104.6% of any short-run deviation from the long-run equilibrium is corrected within a single quarter. This implies that the system corrects rapidly and overshoots as it returns to the long-run equilibrium.

In the short run, FB displays both immediate and lagged impacts on CAB. In further detail, a one percentage-point increase in FB is associated with a 0.202 percentage-point increase in CAB. However, the p-value (0.1812) is statistically insignificant. In contrast, at the first lag, FB had a negative coefficient (-0.491) that was statistically significant at the 1% level. Similarly, at the second lag, a one percentage-point increase in FB leads to a -0.324 percentage-point decline in CAB, statistically significant at the 5% level (p = 0.0205).

Meanwhile, the negative coefficient of PC (-0.125) was statistically significant at the 1% level (p = 0.0011). This result was in accordance with a priori expectations, as expansions in private credit, spurred by aggregate demand, can lead to heightened imports of goods and services, worsening the external current account deficit.

7.0 Discussion

The results of this study confirm the existence of a long-run relationship between FB and CAB in Belize, consistent with the TDH. Specifically, the positive and statistically significant long-run coefficient on FB suggests that fiscal discipline contributes to improvements in CAB. This supports the Keynesian perspective, which posits that fiscal imbalances lead to external imbalances through their effects on national savings and import demand. However, PC exhibited a statistically significant positive long-run coefficient. This result was contrary to a priori expectations, which typically associate credit growth with increased import demand. Notwithstanding, the long-run coefficient on PC was small in magnitude, which limits its economic significance. Furthermore, other structural or macroeconomic factors may be at play that can obscure the expected negative relationship between the two variables. For instance, the allocation of credit to export-oriented sectors could lead to an improved trade deficit, as productive capacities are enhanced in the long run.

The short-run dynamics revealed more complex patterns. For instance, the initial effect of a one percentage-point increase in FB was positive, but statistically insignificant. Concurrently, the lagged effects of FB on CAB were negative but statistically significant. This likely reflects timing issues in fiscal operations. In large infrastructural projects, the government contracts construction services from the private sector, but in many cases, most of the payment is backloaded and disbursed only upon project completion. Consequently, the current account deficit often worsens during the early stages of construction due to increased imports of high-value materials. By the time the bulk of the payment is made, the associated fiscal deficit has materialized, but the current account deterioration has already occurred. This lag between government expenditure and its external impact may also help explain why the contemporaneous coefficient on the fiscal balance was statistically insignificant.

The response of CAB to a one percentage-point increase in PC was negative and statistically significant in the short run, which differed from the long run findings and supported the Keynesian perspective. This indicates that increases in private credit have more immediate short-term effects on the current account deficit than fiscal adjustments.

Notwithstanding, these findings highlight the importance of not relying solely on short-term fiscal adjustments to address external imbalances. Moreover, in the long term, the government must continue to facilitate the diversification of the export sector to reduce the trade-in-goods deficit.

Furthermore, the results presented contrast with the panel estimations of Alleyne et al. (2011), which did not find evidence of the TDH in Belize. This divergence could be attributed to the updated time frame (2001–2024), which captures new structural dynamics, including multiple debt restructurings and the economic impact of the COVID-19 pandemic. The current findings suggest that fiscal developments play a more prominent role in influencing Belize's external position in the long run.
The ARDL model also demonstrated potential as a forecasting tool for the external current account balance. This notion was supported by standard evaluation metrics such as the RMSE, MAE, and Theil's Inequality Coefficient. The low values of these indicators suggested that the model's forecasts

closely approximate actual outcomes and enhance the practical utility of the study. Forward-looking projections of the external current account balance can serve as a warning signal to policy officials to implement corrective measures to safeguard the country against a balance of payments crisis. Future studies should build upon this model by incorporating additional high-frequency variables that would improve predictive accuracy.

However, an important limitation in TDH studies in small and open economies remains the complexities of the current account balance and the many interlinkages that can make it difficult to model. For example, the country is heavily reliant on tourism inflows to mitigate the impact of the trade deficit. Tourism earnings are highly susceptible to external shocks that are out of the government's control, such as natural disasters that can destroy coastal areas that attract tourist visitors. Therefore, these structural characteristics must also be at the forefront of policy discussions, as they play a critical role in shaping the responsiveness of the external current account balance to fiscal adjustments.

8.0 Conclusion

This study provides evidence supporting the twin deficit hypothesis for Belize. Using quarterly data from 2001:Q1 to 2024:Q4, it estimates that improvements in FB have a statistically significant long-term effect on CAB. The policy implications are particularly important for Belize, as the country must maintain sufficient international reserves to maintain the fixed exchange rate. Therefore, prudent management of the fiscal accounts can serve as an effective tool for correcting external imbalances. Historically, Belize has typically implemented fiscal adjustments as a last resort when fiscal space has been significantly eroded by unsustainable government spending. Furthermore, these contractionary fiscal policies have often been at the request of foreign creditors as a condition for debt restructuring negotiations. Government officials are advised to adopt a more proactive approach to managing Belize's fiscal accounts. There must also be continued efforts to diversify the export sector, since the trade-in-goods deficit remains one of the main causes of external imbalances in Belize.

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10.0 Appendix

Table A.1: Stationarity Tests[1,2]

	Levels				First-differences			
Test	Constant, no trend	Conclusion	Constant, trend	Conclusion	Constant, no trend	Conclusion	Constant, trend	Conclusion
ADF								
CAB	-2.3754 [0.1515]	Non-Stationary	-2.2246 [0.4702]	Non-Stationary	-19.9846 [0.0001]	I(1)	-19.948 [0.0000]	I(1)
FB	-7.5080 [0.0000]	Stationary	-7.6427 [0.0000]	Stationary	-10.6191 [0.0000]	I(0)	-10.571 [0.0000]	I(0)
PC	-3.013 [0.0372]	Stationary	-2.216 [0.4750]	Non-Stationary	-9.517 [0.0000]	I(0)	-9.944 [0.0000]	I(0)
KPSS								
CAB	0.4964 [0.4630]	Non-Stationary	0.2681 [0.1460]	Non-Stationary	0.073 [0.4630]	I(1)	0.072 [0.1460]	I(1)
FB	0.1953 [0.4630]	Stationary	0.1427 [0.1460]	Stationary	0.135 [0.4630]	I(0)	0.129 [0.1460]	I(0)
PC	0.4330 [0.4630]	Stationary	0.2333 [0.1460]	Non-Stationary	0.525 [0.4630]	I(0)	0.059 [0.1460]	I(0)

[1]ADF test H0: (r-1)=0, Probability values are in brackets
[2] KPSS test, asymptotic critical values are in brackets

Table A.2: Bai-Perron Multiple Breakpoint Test

Multiple breakpoint tests

Bai-Perron tests of L+1 vs. L sequentially determined breaks

Date: 05/27/25 Time: 13:10

Sample: 2001Q1 2024Q4

Included observations: 96

Breaking variables: FB PC C

Break test options: Trimming 0.15, Max. breaks 5, Sig. level 0.05

Sequential F-statistic determined breaks:			1
Break Test	F-statistic	Scaled F-statistic	Critical Value**
0 vs. 1 *	5.046003	15.13801	13.98
1 vs. 2	4.157315	12.47194	15.72

* Significant at the 0.05 level.

** Bai-Perron (Econometric Journal, 2003) critical values.

Break dates:

	Sequential	Repartition
1	2006Q1	2006Q1

Table A.3: Quandt-Andrews Breakpoint Test

Quandt-Andrews unknown breakpoint test
Null Hypothesis: No breakpoints within 15% trimmed data
Varying regressors: All equation variables
Equation Sample: 2001Q1 2024Q4
Test Sample: 2004Q4 2021Q2
Number of breaks compared: 67

Statistic	Value	Prob.
Maximum LR F-statistic (2006Q1)	5.046003	0.0300
Maximum Wald F-statistic (2006Q1)	15.13801	0.0300
Exp LR F-statistic	1.271428	0.0758
Exp Wald F-statistic	4.645463	0.0360
Ave LR F-statistic	2.371109	0.0241
Ave Wald F-statistic	7.113328	0.0241

Note: probabilities calculated using Hansen's (1997) method

Table A.4: ARDL Model with Dummy Variables

Dependent Variable: CAB
Method: ARDL
Date: 05/30/25 Time: 10:32
Sample: 2001Q3 2024Q4
Included observations: 94
Dependent lags: 2 (Automatic)
Automatic-lag linear regressors (2 max. lags): PC FB
Static regressors: COVID_DUMMY D2006
Deterministics: Unrestricted constant and no trend (Case 3)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 18
Selected model: ARDL(2,1,0)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
CAB(-1)	0.202706	0.098690	2.053976	0.0430
CAB(-2)	-0.231194	0.091839	-2.517375	0.0137
PC	-0.133658	0.038126	-3.505684	0.0007
PC(-1)	0.184892	0.036953	5.003394	0.0000
FB	0.270914	0.160740	1.685422	0.0955
COVID_DUMMY	-0.012709	0.005089	-2.497313	0.0144
D2006	0.016800	0.013353	1.258143	0.2117
C	0.029420	0.010968	2.682286	0.0088
R-squared	0.406547			-0.016223
Adjusted R-squared	0.358243	S.D. dependent var		0.016260
S.E. of regression	0.013026	Akaike info criterion		-5.762487
Sum squared resid	0.014592	Schwarz criterion		-5.546036
Log likelihood	278.8369	Hannan-Quinn criter.		-5.675057
F-statistic	8.416384	Durbin-Watson stat		2.066839
Prob (F-statistic)	0.000000			

*Note: p-values and any subsequent test results do not account for model selection

Table A.5: Bounds Test

Null hypothesis: No levels relationship

Number of cointegrating variables: 2

Trend type: Unrest. constant (Case 3)

Sample size: 93

Test Statistic	Value
F-statistic	20.523648
t-statistic	-7.794391

	10%		5%		1%	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
			F-Statistic			
80	3.260	4.247	3.940	5.043	5.407	6.783
Asymptotic	3.170	4.140	3.790	4.850	5.150	6.360
			t-Statistic			
Asymptotic	-2.570	-3.210	-2.860	-3.530	-3.430	-4.100

* I(0) and I(1) are respectively the stationary and non-stationary bounds.

Table A.6: Breusch-Godfrey Serial Correlation LM Test

Breusch-Godfrey Serial Correlation LM Test:

Null hypothesis: No serial correlation at up to 2 lags

F-statistic	1.111373	Prob. F(2,80)	0.3341
Obs*R-squared	2.514090	Prob. Chi-Square(2)	0.2845

Test Equation:

Dependent Variable: RESID

Method: ARDL

Date: 05/30/25 Time: 11:22

Sample (adjusted): 2001Q4 2024Q4

Included observations: 93 after adjustments

Presample missing value lagged residuals set to zero.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CAB(-1)	0.174493	0.178563	0.977209	0.3314
CAB(-2)	-0.151547	0.190369	-0.796067	0.4283
FB	-0.059197	0.172622	-0.342931	0.7325
FB(-1)	-0.011446	0.178859	-0.063996	0.9491
FB(-2)	0.064702	0.165821	0.390189	0.6974
FB(-3)	-0.017657	0.156880	-0.112553	0.9107
PC	0.004833	0.038608	0.125177	0.9007
PC(-1)	-0.004811	0.037892	-0.126956	0.8993
COVID_DUMMY	-5.99E-05	0.005862	-0.010221	0.9919
D2006	-0.000530	0.013495	-0.039272	0.9688
C	0.000249	0.012905	0.019269	0.9847
RESID(-1)	-0.229731	0.206808	-1.110840	0.2700
RESID(-2)	0.184114	0.226962	0.811210	0.4197

R-squared	0.027033	Mean dependent var	5.92E-19
Adjusted R-squared	-0.118912	S.D. dependent var	0.012136
S.E. of regression	0.012837	Akaike info criterion	-5.743956
Sum squared resid	0.013183	Schwarz criterion	-5.389936
Log likelihood	280.0939	Hannan-Quinn criter.	-5.601013
F-statistic	0.185229	Durbin-Watson stat	1.943227
Prob(F-statistic)	0.998714		

Table A.7: Breusch-Pagan-Godfrey Heteroskedasticity Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey
Null hypothesis: Homoskedasticity

F-statistic	1.043037	Prob. F(10,82)	0.4157
Obs*R-squared	10.49465	Prob. Chi-Square(10)	0.3982
Scaled explained SS	8.639560	Prob. Chi-Square(10)	0.5666

Test Equation:
Dependent Variable: RESID^2
Method: Least Squares
Date: 05/30/25 Time: 11:24
Sample (adjusted): 2001Q4 2024Q4
Included observations: 93 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	9.26E-05	0.000191	0.484315	0.6295
CAB(-1)	-0.000975	0.001638	-0.595070	0.5534
CAB(-2)	-0.002483	0.001672	-1.485225	0.1413
FB	-0.001539	0.002724	-0.564898	0.5737
FB(-1)	0.005170	0.002768	1.868007	0.0653
FB(-2)	-0.002138	0.002610	-0.819278	0.4150
FB(-3)	0.001514	0.002591	0.584518	0.5605
PC	0.001171	0.000628	1.865636	0.0657
PC(-1)	-0.001185	0.000623	-1.901915	0.0607
COVID_DUMMY	3.44E-05	9.01E-05	0.381402	0.7039
D2006	-0.000136	0.000219	-0.619758	0.5371

R-squared	0.112846	Mean dependent var	0.000146
Adjusted R-squared	0.004656	S.D. dependent var	0.000213
S.E. of regression	0.000213	Akaike info criterion	-13.96290
Sum squared resid	3.71E-06	Schwarz criterion	-13.66335
Log likelihood	660.2749	Hannan-Quinn criter.	-13.84195
F-statistic	1.043037	Durbin-Watson stat	2.307974
Prob(F-statistic)	0.415687		

Table A.8: Normality Test

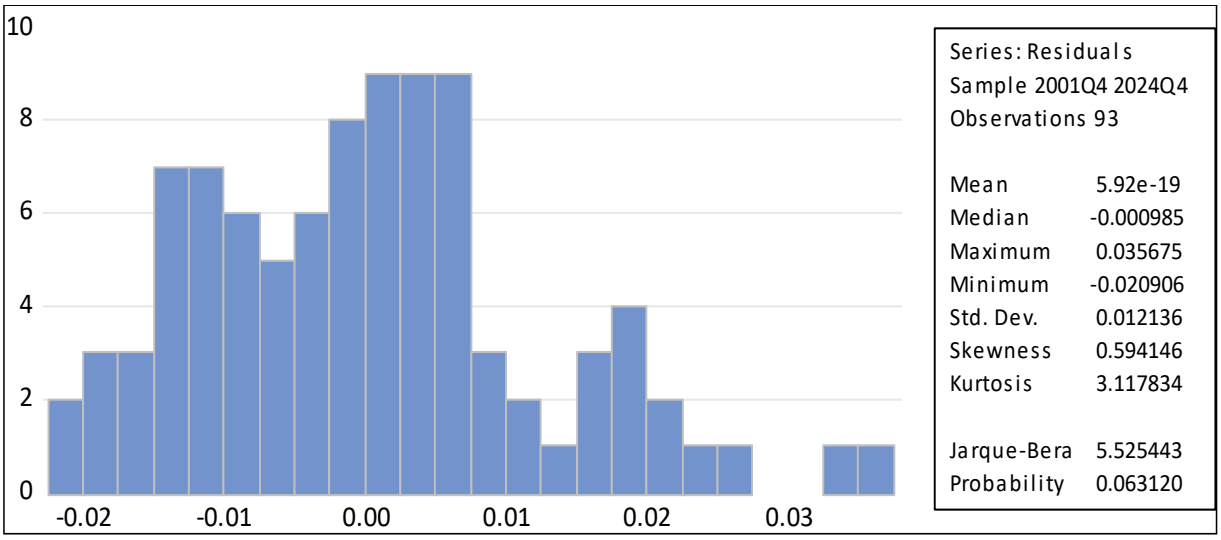

Table A.9: CUSUM Test

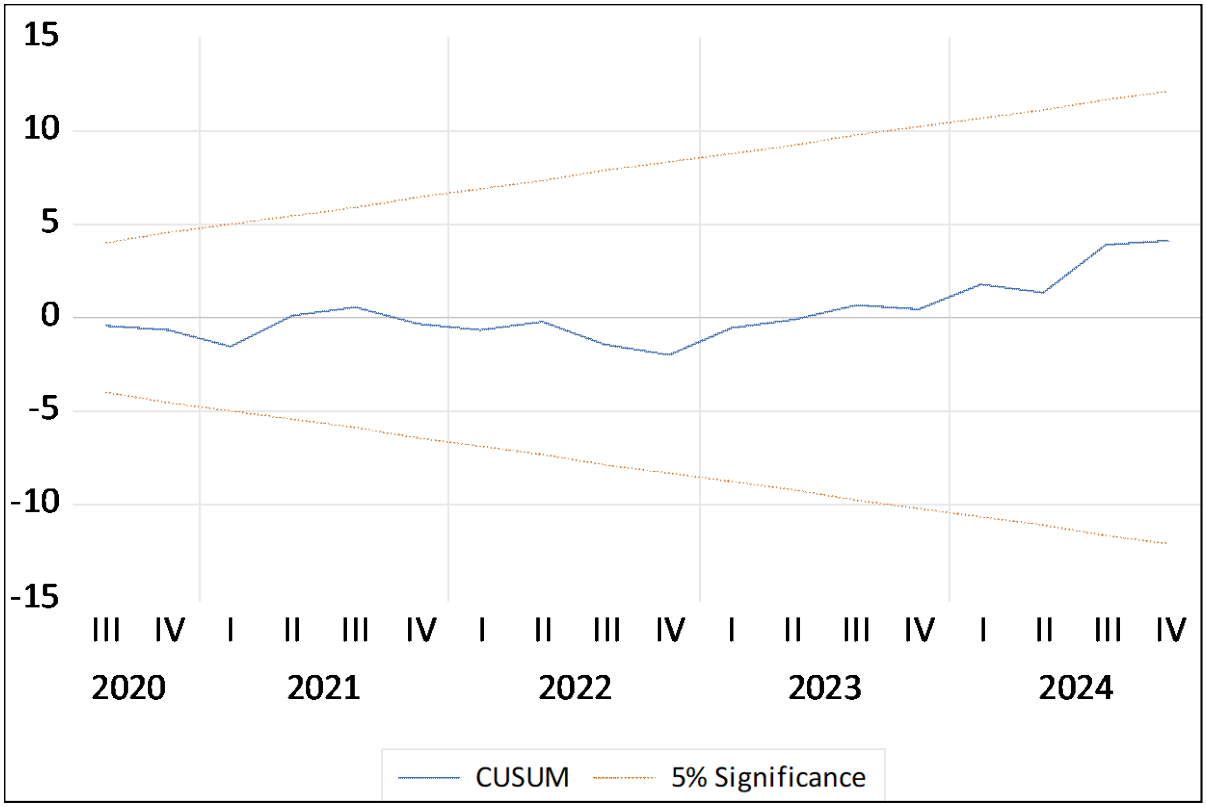

Table A.10: CUSUMSQ TEST

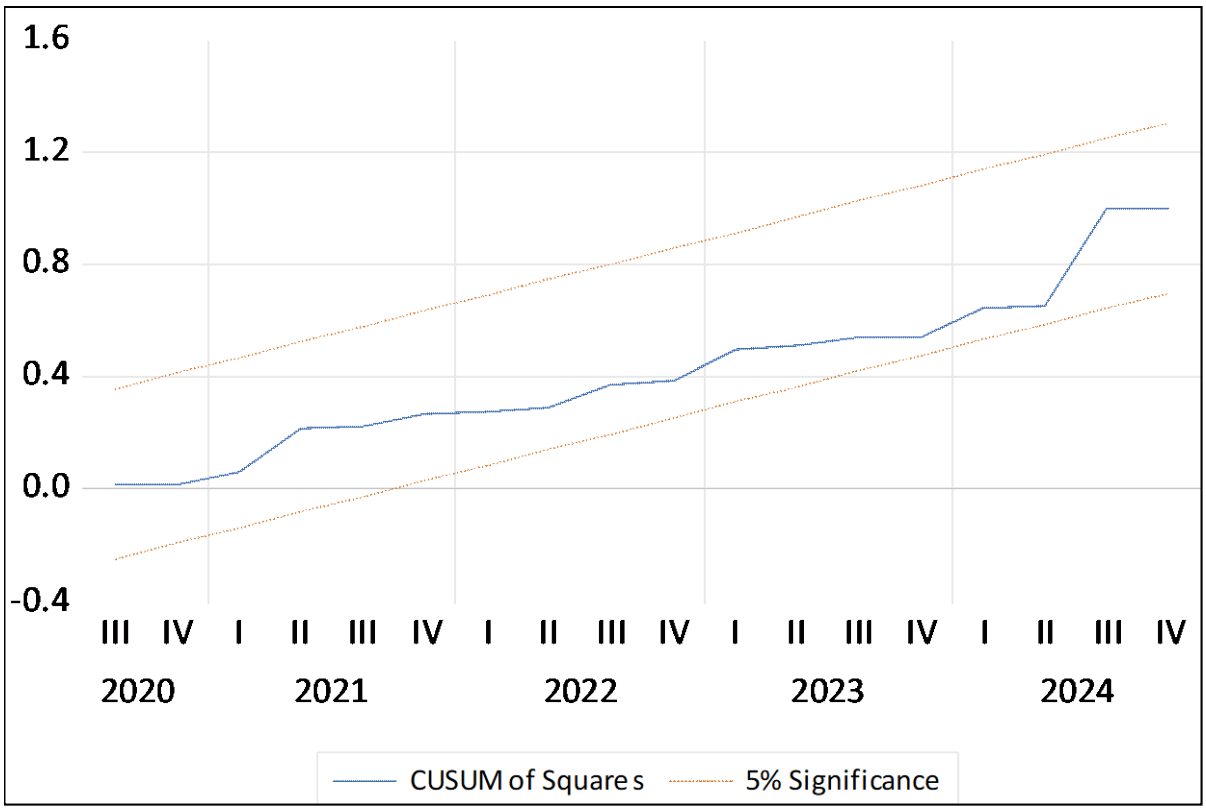

Table A.11: Ramsey RESET Test

Ramsey RESET Test
Equation: CORRECT_ARDL
Omitted Variables: Squares of fitted values
Specification: CAB CAB(-1) CAB(-2) FB FB(-1) FB(-2) FB(-3) PC PC(-1) COVID_DUMMY D2006 C

	Value	df	Probability
t-statistic	1.530547	81	0.1298
F-statistic	2.342576	(1, 81)	0.1298
Likelihood ratio	2.651465	1	0.1035

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.000381	1	0.000381
Restricted SSR	0.013550	82	0.000165
Unrestricted SSR	0.013169	81	0.000163

LR test summary:

	Value
Restricted LogL	278.8196
Unrestricted LogL	280.1453

Unrestricted Test Equation:
Dependent Variable: CAB
Method: Least Squares
Date: 06/02/25 Time: 09:49
Sample (adjusted): 2001Q4 2024Q4
Included observations: 93 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CAB(-1)	0.322111	0.127493	2.526505	0.0135
CAB(-2)	-0.366364	0.128523	-2.850572	0.0055
FB	0.318158	0.180149	1.766083	0.0811
FB(-1)	0.007890	0.166015	0.047526	0.9622
FB(-2)	0.302091	0.179737	1.680736	0.0967
FB(-3)	0.444478	0.174075	2.553371	0.0125
PC	-0.187965	0.055799	-3.368595	0.0012
PC(-1)	0.252108	0.067957	3.709790	0.0004
COVID_DUMMY	-0.012131	0.006102	-1.987842	0.0502
D2006	0.021423	0.013249	1.616895	0.1098
C	0.039260	0.015875	2.473027	0.0155
FITTED^2	17.15579	11.20892	1.530547	0.1298

R-squared	0.436411	Mean dependent var	-0.015849
Adjusted R-squared	0.359874	S.D. dependent var	0.015937
S.E. of regression	0.012751	Akaike info criterion	-5.766566
Sum squared resid	0.013169	Schwarz criterion	-5.439779
Log likelihood	280.1453	Hannan-Quinn criter.	-5.634619
F-statistic	5.701981	Durbin-Watson stat	2.093410
Prob(F-statistic)	0.000001		

Table A.12: ARDL Forecast Evaluation

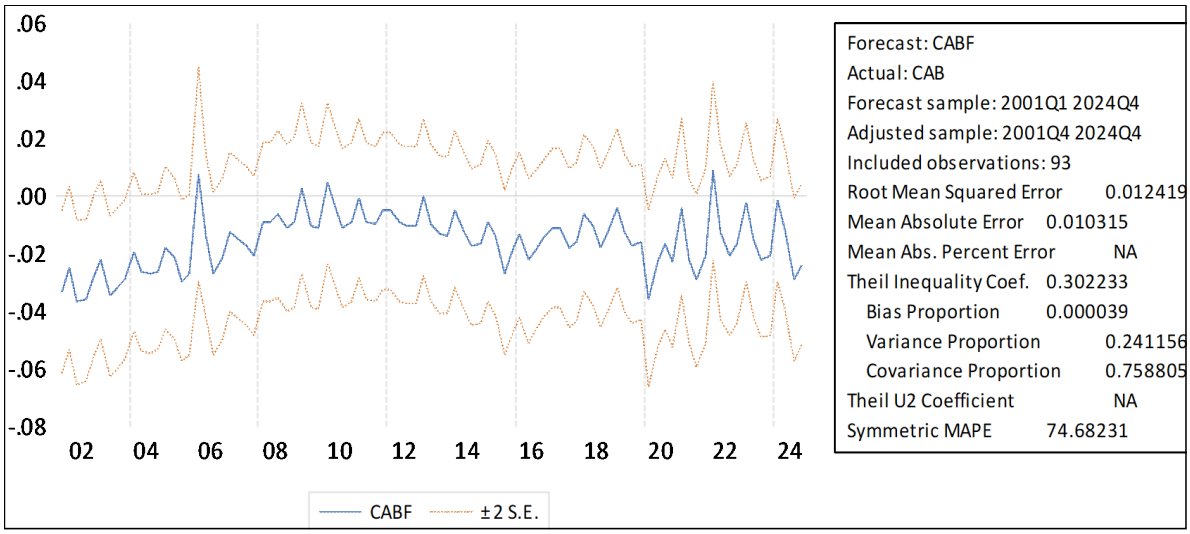

Table A.13: ARDL Model

Dependent Variable: CAB
Method: ARDL
Date: 05/29/25 Time: 16:29
Sample: 2001Q4 2024Q4
Included observations: 93
Dependent lags: 3 (Automatic)
Automatic-lag linear regressors (4 max. lags): FB PC
Static regressors: COVID_DUMMY D2006
Deterministics: Unrestricted constant and no trend (Case 3)
Model selection method: Akaike info criterion (AIC)
Number of models evaluated: 75
Selected model: ARDL(2,3,1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
CAB(-1)	0.197651	0.09899	1.996602	0.0492
CAB(-2)	-0.24323	0.10104	-2.407135	0.0183
FB	0.201776	0.16465	1.225514	0.2239
FB(-1)	-2.39E-05	0.16729	-0.000143	0.9999
FB(-2)	0.166666	0.15773	1.056686	0.2938
FB(-3)	0.324149	0.15658	2.070227	0.0416
PC	-0.12491	0.03794	-3.292449	0.0015
PC(-1)	0.165231	0.03767	4.386108	0
COVID_DUMMY	-0.00778	0.00545	-1.42939	0.1567
D2006	0.018783	0.01324	1.418305	0.1599
C	0.02245	0.01156	1.942646	0.0555

R-squared	0.420112	Mean dependent var	-0.0158
Adjusted R-squared	0.349394	S.D. dependent var	0.01594
S.E. of regression	0.012855	Akaike info criterion	-5.7596
Sum squared resid	0.01355	Schwarz criterion	-5.46
Log likelihood	278.8196	Hannan-Quinn criter.	-5.6386
F-statistic	5.940656	Durbin-Watson stat	2.12533
Prob(F-statistic)	0.000001		

*Note: p-values and any subsequent test results do not account for model selection.