Asian Economic and Financial Review
ISSN(e): 2222-6737
ISSN(p): 2305-2147
DOI: 10.55493/5002.v15i12.5782
Vol. 15, No. 12, 1978-1999.

URL: www.aessweb.com

Examining macroeconomic drivers of inflation: Evidence from panel ARDL and wavelet coherence approaches

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Article History
Received: 21 March 2025
Revised: 24 October 2025
Accepted: 26 November 2025
Published: 4 December 2025

Keywords
ARDL
Exchange rate
Inflation
Money supply
Oil price
Unemployment rate
Wavelet coherence.

JEL Classification:
E31; E51; F31; J64; Q43.

ABSTRACT

This study explored the effects of key macroeconomic variables—money supply, exchange rate, unemployment rate, and oil price—on inflation in five ASEAN countries from 1980 to 2020, using a panel ARDL model. The co-movement of this dynamic relationship was analyzed through a Wavelet Coherence approach to strengthen the findings to a certain extent. The analysis showed a positive, significant long-run link between money supply and inflation, emphasizing the need for prudent monetary policies. The absence of short-run effects of money supply on inflation underscores the importance of multidimensional policy formulation. Additionally, the positive exchange rate-inflation relationship in the long run calls for careful consideration in policy decisions. Furthermore, the negative unemployment-inflation relationship emphasizes the need for structural labor market reforms. Lastly, the significant short-term influence of oil prices on inflation warrants vigilance and sustainable energy strategies. This study is a valuable methodological and empirical addition to the existing body of knowledge on inflation dynamics, with its extensive analysis of macroeconomic determinants of inflation in ASEAN countries, using advanced econometric techniques. It bridges theoretical gaps, enriches methodological applications with wavelet coherence analysis, and delivers actionable insights for policymakers in emerging economies.

Contribution/ Originality: This study uniquely integrates panel ARDL with Wavelet Coherence to examine inflation dynamics, offering a novel time-frequency perspective rarely applied to ASEAN economies. It captures both long- and short-run co-movements, providing deeper insights into policy-responsive inflation behavior across multiple macroeconomic dimensions.

1. INTRODUCTION

Inflation, often referred to as the sustained increase in the general price level of goods and services, remains a topic of extensive debate among researchers, encompassing various contexts due to its significant implications. Over the past decade, ASEAN-5 countries have grappled with relatively high annual inflation rates, ranging from 9 percent

to 23 percent on average, while experiencing fluctuations in oil prices, recording figures such as 5.60 percent, -2.11 percent, -4.08 percent, -3.86 percent, and -0.67 percent for Indonesia, Malaysia, the Philippines, Singapore, and Thailand, respectively.

This correlation prompts inquiry into the potential relationship between inflation and oil prices. Since the global financial crisis of 2008, the world economy has endured considerable turmoil, resulting in escalating global inflation rates. Notably, 2008 saw a significant spike in global inflation, surpassing the previous year by more than 6.4 percent. Consequently, regions such as the Middle East, North Africa, and Sub-Saharan Africa experienced the highest year-on-year inflation rates in 2014, with Venezuela and Ukraine topping global inflation charts in 2015 (Hidthiir, Ahmad, Junoh, & Yusof, 2024; O'Neill, 2022). In contrast, inflation rates within the Association of Southeast Asian Nations (ASEAN) exhibited variability, ranging from 5.1 percent in Laos to 1.14 percent in Malaysia. Remarkably, Malaysia emerged with the lowest inflation rate in Southeast Asia in 2020, registering at -1.14 percent. However, projections suggest a shift by 2022, with Myanmar anticipated to reach a 6 percent inflation rate, while Brunei is expected to maintain a 1 percent rate (Statista Research Department, 2021).

Table 1. Average annual inflation rate (%).

Year / Country	Indonesia	Malaysia	Philippines	Singapore	Thailand
1980-1990	8.02	9.03	3.92	8.49	11.36
1991-2000	8.66	10.20	10.04	9.12	11.93
2001-2010	7.81	2.00	3.27	10.84	7.51
2011-2020	9.29	10.13	5.55	27.81	13.41

Source: Key indicators for Asia and the pacific 2021.

The data presented in Table 1 highlights the pervasive challenge of inflation across ASEAN-5 countries, often exacerbated by supply shocks such as natural disasters or fluctuations in production costs like high oil prices. Oil prices and inflation have an obvious complex relationship; however, it exhibits different patterns over time. Therefore, empirical analyses are essential to determine the impact of key variables such as money supply, exchange rate, oil price, and unemployment rate on inflation in these economies. The liberalization of ASEAN countries' economies and the shift to flexible exchange rate regimes are also crucial factors in examining the dynamics of monetary policy and inflation, especially in the context of foreign capital movements and resultant currency adjustments.

The study extends to understanding how fluctuations in exchange rates influence inflation, recognizing the complexities associated with various exchange rate arrangements and the learned behavior between domestic price levels and exchange rates. It also explores the classic trade-off relationship between inflation and unemployment rates, including the Phillips Curve and its relevance for stagflation. The paper also examines the inflationary effects of oil price shocks and considers the importance of oil consumption in developing Asian countries in generating global oil demand and the implications this holds for the global energy market. As such, by filling this void in understanding inflation dynamics and inflation determinants through covering these multiple dimensions, the research aims to provide a significant contribution to the literature on inflation in the ASEAN-5 countries. This is crucial for designing well-informed policies aimed at maintaining price stability and managing inflationary pressures.

It has critical implications for policymakers and economists, providing indispensable insights for effective decision-making to balance inflationary pressures and ensure economic stability in ASEAN-5 nations and other regions. The current study analyzes the complex relationship between inflation and its determinants, such as monetary policy, exchange rates, oil prices, and unemployment rates, and offers useful guidance in this context for formulating appropriate strategies. By gaining insight into the interplay of monetary policy and inflation, policymakers can take steps to regulate the money supply and stabilize prices using contractionary policies. Similarly, understanding how exchange rate fluctuations affect inflation will help policymakers make better decisions regarding setting exchange rate policies to minimize inflationary pressures in open economies such as ASEAN. Additionally, the aforementioned insights shape an understanding of how inflation and unemployment rates resonate with each

other, thus enabling the achievement of optimal levels of both indicators alongside minimal effects on economic growth. Finally, price shocks in oil help understand the inflationary pressures, which may also facilitate designing policies to lessen the effects of energy price variability on domestic price levels and economic performance.

This study makes significant contributions to the current body of knowledge on inflation by providing a comprehensive analysis of the impact of key macroeconomic variables—money supply, exchange rate, unemployment rate, and oil price—on inflation in five selected ASEAN countries over the period from 1980 to 2020. Theoretically, it enriches the understanding of inflation dynamics in emerging Southeast Asian economies by distinguishing between long-run and short-run effects, offering deeper insights into how these macroeconomic factors interact with inflation over time. Methodologically, the study advances empirical research by employing the panel ARDL approach, which accounts for both cross-sectional heterogeneity and dynamic relationships, and by integrating the Wavelet Coherence technique to explore the time-frequency co-movement among the variables, thereby enhancing the robustness of the findings. From a practical standpoint, the study provides valuable policy implications, emphasizing the importance of prudent monetary policies, careful exchange rate management, structural labor market reforms, and sustainable energy strategies.

The rest of the article is structured as follows: a comprehensive review of literature pertinent to this study is provided in Section 2, while Section 3 describes the research methodology. The empirical findings are presented in Section 4, followed by the discussion and policy implications in Section 5. Finally, Section 6 concludes the study.

2. LITERATURE REVIEW

2.1. Inflation

The extensive literature on inflation within macroeconomics defines it as a sustained increase in the general price level of goods and services and the consequent erosion of purchasing power. Theories on inflation typically examine demand-pull and cost-push factors. Demand-pull inflation is observed when aggregate demand outpaces aggregate supply, resulting in higher prices. Cost-push inflation, on the other hand, stems from the rising cost of production (e.g., due to rising wages or input costs such as oil). The financial and monetary landscape of a nation often hinges on the strategies employed by its central bank, with a primary objective being the maintenance of price stability to foster sustainable economic growth.

Low and stable inflation promote economic growth by fostering a flexible, transparent, and predictable economic environment for businesses, investors, consumers, and households, enabling better decision-making with reduced concern over price fluctuations. This leads to greater stability in output, employment, and investment, concurrently mitigating risks for financial intermediaries holding long-term nominal assets and decreasing long-term interest rates and financing costs for long-term investments (Ayal, Bekalu, & Ayenalem, 2024). Conversely, high inflation is associated with diminished growth and increased instability. During periods of extremely low inflation, central banks find it challenging to reduce real short-term interest rates enough to stimulate demand, as nominal rates are near zero. This limits conventional monetary policy and may force central banks to resort to unconventional measures, such as large-scale purchases of long-term assets, to lower long-term rates, potentially causing deflation, higher debt burdens, and difficulty in wage adjustments due to downward nominal rigidity, thereby hindering economic activity (Ha, Ivanova, Ohnsorge, & Unsal, 2019a).

Inflation has generally been lower and decreased more rapidly in economies that adopted (or transitioned to) inflation-targeting regimes. Inflation targeting (IT) is a monetary policy framework in which a central bank establishes an explicit quantitative inflation target for the medium term and adjusts policies accordingly to achieve it. The primary objective is price stability, with monetary decisions centered on controlling inflation, as opposed to money supply or exchange-rate targeting, which are intermediate objectives. This framework emphasizes inflation control as the ultimate goal of maintaining price stability. Since New Zealand implemented it in 1990, IT has become the dominant policy in 37 countries, including both advanced economies and emerging and developing economies

(EMDEs), as of 2019 (Ha, Kose, & Ohnsorge, 2019b) recommended for reducing inflation and enhancing the credibility, transparency, and accountability of central banks. In ASEAN, Inflation targeting (IT) has reduced inflation persistence, with Thailand, Indonesia, and the Philippines adopting explicit IT measures after the Asian financial crisis, while Malaysia and Singapore focused on maintaining price stability. Thailand's IT regime, in place since 2001, has helped anchor inflation expectations and stabilize inflation and exchange rates (Dany-Knedlik & Garcia, 2018).

In the aftermath of the global financial crisis (GFC) (2007-2009), however, the efficacy of inflation targeting (IT) as an optimal policy regime for stabilizing macroeconomic conditions, particularly in responding to large real or financial shocks, came under scrutiny. Central banks that focused primarily on price stability experienced extremely low inflation and failed to prevent the crisis, revealing the narrowness and inadequacy of IT (Frankel, 2012). This overemphasis on consumer price developments (inflation), while ignoring broader prices and market developments, led to low and unstable growth in output and high unemployment. To pursue these objectives simultaneously, additional policy instruments were needed to maintain financial stability alongside price stability, as the short-term interest rate, the key monetary policy tool in the IT framework, was insufficient to fulfill all these functions (Borio, 2014).

The GFC underscored the complexity of managing inflationary pressures and the need for nuanced policymaking strategies. Understanding inflation dynamics becomes paramount in this context, as it offers insights crucial for policymakers. Traditionally, economists have extensively examined various theories regarding the origins of inflation, including the quantity theory of money, demand-pull inflation, and cost-push inflation, among others. Yet, the analytical breakdown of inflation into its constituent contributing components requires a sophisticated approach. Due to the effect of globalization, numerous scholars have embarked on elucidating the factors driving inflation by examining specific independent variables within diverse economic frameworks across different geographical contexts. At the global level, money supply, exchange rates, unemployment, and oil prices are among the variables most frequently highlighted as significant contributors to the growth of the CPI (Putra, 2022; Sajid, Ali, Ahmad, Shil, & Arshad, 2024; Tolasa, Babu, & Kim, 2022; Yilmazkuday, 2022).

2.2. Inflation and Money Supply

The monetarist theory, formulated by Friedman, views the money supply as the primary driver of inflation, asserting that the money supply expands more rapidly than the growth of national income. Due to this monetary imbalance, growth in the money supply triggers inflation, highlighting the pivotal role of the quantity of money relative to output (Brunner & Meltzer, 1972). Monetarists argue that, in the short term, the velocity of money remains relatively fixed due to institutional factors, while output is also considered fixed in the long run, given the inelasticity of long-run aggregate supply (LRAS), which is governed by supply-side factors. It takes approximately nine to twelve months for such monetary expansion to manifest in increased output (Friedman, 1970). Moreover, Friedman emphasized the critical influence of price expectations, suggesting that anticipation of higher inflation may lead workers to seek greater pay and firms to adjust prices accordingly, fueling further inflation. Excessive monetary expansion, often driven by government borrowing to finance budget deficits, can exert strong inflationary pressures, as noted by Ahmad (1970). However, criticisms of monetarism have emerged, with some arguing that the connection between the money supply and inflation is often weak in practice. Additionally, fluctuations in the velocity of circulation (V) and the potential negative repercussions of targeting arbitrary money supply targets such as severe recessions and high unemployment highlight the complexities and limitations of strict monetarist policies (Saliah, Nadarajan, & Teong, 2024).

Empirically, several studies have analyzed the relationship between money supply and inflation. In the Asian region, Saliah, Nadarajan, and Teong (2023) used cointegration and VECM techniques to analyze the relationship between money supply and inflation using monthly data for the periods 2010-2017 in Bangladesh and 2009-2019 in

Indonesia, respectively. In both cases, bidirectional causality was found in the long run, indicating that shifts in the money supply significantly affect inflation and vice versa. However, contrary to the findings of who reported no short-term effect in the case of Bangladesh as studied by reported a short-run and long-run effect of money supply on inflation. Van (2020) used the economic theories of Fisher and Friedman, as well as an econometric model, and focused on the relationship in Vietnam and China through data from 2012–2016. The study concluded that although a sustained rise in the money supply results in an inflationary trend in the long run, it does not lead to inflation in the short run. To put it in layman's terms, the correlation between money supply and inflation in both countries was 99.1%, demonstrating how interconnected money supply and inflation can be.

Stylianou, Nasir, and Waqas (2024) explores the long-run and short-run relationships between the money supply and inflation in Pakistan, utilizing annual data from 1981 to 2021. The findings indicate that there are both short-term and long-term associations between money supply and inflation in Pakistan. Conversely, research by Olaoye and Anyanwu (2024) on Nigeria suggests that increases in the money supply lead to short-term inflationary pressures without a corresponding long-term effect. This implies that, in Nigeria, factors beyond the money supply, such as structural or external influences play a significant role in shaping inflationary trends. Despite employing the same methodology, the Autoregressive Distributed Lag (ARDL) technique, results differ between the two countries. In Nigeria, the impact of money supply on inflation appears to be temporary, whereas in Pakistan, the effect is both persistent and significant. These differences may be attributed to the more stringent economic conditions and policy environments in each country, which influence how monetary variables affect inflation over time.

Using co-integration and several causality tests over the period of 1970-2018, Hicham (2020) studied the interaction among money supply, inflation rate, and economic growth in Algeria. Although the author was able to demonstrate a long-run cointegration relationship among these variables, the estimated results aligned with the Monetarist theory of inflation, which links money supply to economic growth and emphasizes its nonexistence. This research is among those that highlight the significant role of central bank policies on inflation and their impact on the economy, analyzed through Panel VAR methodology. The study covered the period from 2005 to 2022, with inflation as the dependent variable, while the independent variables included money supply, policy interest rates, economic growth, current account deficit, budget deficit, and unemployment (Altınışık & Yücememiş, 2023). As suggested for Bangladesh (Bin Hidthiir et al., 2025) and Indonesia they found a bi-directional relationship between money supply and inflation. Furthermore, the impulse response analysis revealed that each unit change in money supply causes a persistent change over 12 periods with respect to inflation, signifying the cumulative effect of money supply on inflation. Overall, these studies show that there exists a positive and statistically significant association between money supply and inflation in both the short and long run among countries, but the impact varies from one country to another. The East Asian example is particularly influential, as the effect of money supply on inflation is stronger and more persistent than in most other parts of the world, where the influence of money supply tends to be more short-lived or muted. Asian countries are not immune to this phenomenon nor to the variation in inflationary experiences across regions. However, the differential and differentiated roles of monetary policy and economic activity between groups of countries are emphasized here: among these predominantly developed economies, inflation is best explained by bank liquidity, whereas in Asia, the supply of money plays a limited role in improving the explanatory power of inflation. This is consistent with classical demand theories, which suggest that increases in money supply only create inflationary pressure in cases of deficit demand.

2.3. Inflation and Exchange Rate

The Exchange Rate Pass-Through (ERPT) studies how changes in the exchange rate affect domestic prices, especially those for imports, and inflation. The third macroeconomic variable is ERPT, which is defined as the elasticity of domestic prices preferably the Consumer Price Index (CPI) an essential variable for measuring inflation to exchange rate changes. In particular, the FT is the percentage increase in consumer prices associated with a 1

percent depreciation of the effective exchange rate after one period. ERPT influences inflation both directly and indirectly (Ha, Stocker, & Yilmazkuday, 2020). Direct pass-through occurs when a steep depreciation of the domestic currency raises the price of imports, which directly increases the prices of goods and services in the domestic economy, leading to higher inflation. Indirect pass-through: The inflationary effect of changes to the exchange rate can also occur indirectly through increased domestic demand or second-round effects (e.g., rising wage demands to compensate for rising prices) (Hahn & O'Brien, 2018).

However, empirical studies on the extent of ERPT show that it differs between emerging and advanced economies due to factors such as market structure and central bank credibility, alongside the degree of trade openness. Using the ARDL bounds testing, the most probable long- and short-run links between inflation and exchange rates over the preceding two decades were identified by Deka and Dube (2021). They revealed a bidirectional causal relationship between inflation and exchange rates in Mexico. For Mauritania, a one percent depreciation of the ouguiya against the US dollar increases the CPI by 0.42% over the long run (Ly, 2024) displaying quite a high long run ERPT. This means that depreciation of the exchange rate is a potentially major source of inflation in the country. Boubaker and Mouna (2024) examined transmission mechanisms through inflation and inflation expectations using data from the Eurozone, the UK, and Canada. The findings indicate that the effects of exchange rate changes on inflation were significantly larger during recessions. Additionally, inflation tended to respond more quickly to exchange rate shocks than vice versa. Just as the results of Boubaker and Mouna (2024) are relevant to ASEAN, as countries such as Indonesia, Malaysia, and the Philippines experienced greater inflationary impacts when their currencies depreciated during certain periods. Jasová, Moessner, and Takáts (2019) examining and comparing the impact of exchange rate volatility on inflation in 22 emerging and developing economies and 11 advanced economies, the study found a robust result: the lower pass-through mechanism in the emerging groups was conducive to lower inflation. Ha et al. (2020) subsequently, this analysis was extended to 55 emerging and developing economies, providing detailed insights into how the relationship evolved over time. The study found that exchange rate fluctuations generally had a dampening effect on inflation in these economies. However, there was significant variation in the scope and time frame of this effect, depending on each country's inflation threshold. In another study, Hoang, Thi, and Minh (2020) applied a time-series data method to the same analysis in Vietnam, incorporating GDP as an additional influencing variable. The results indicated that an increase in the exchange rate has a negative effect on Vietnam's economic growth through inflation. Specifically, a rise in the exchange rate leads to increased inflationary pressure, which subsequently hampers economic growth.

The literature indicates that exchange rate pass-through tends to be higher and more disruptive in emerging economies, particularly during periods of economic instability. In EMDEs, large currency fluctuations occur with greater frequency, and monetary authorities exhibit a stronger inclination to intervene in response to these movements, compared to advanced economies (Ball & Reyes, 2008). This is particularly relevant for ASEAN countries, where exchange rate fluctuations often have significant impacts on inflation due to high levels of trade openness and dependence on imports. As ASEAN countries continue to integrate into global supply chains, exchange rate volatility can amplify inflationary pressures. This highlights the importance of assessing the influence of ERPT on inflation in the region.

2.4. Inflation and Unemployment Rate

The relationship between inflation and unemployment, commonly referred to as the Phillips Curve introduced in 1958, has been a cornerstone of macroeconomic analysis for decades. According to this classical view, the two variables are usually inversely related (i.e., when one rises, the other falls), implying that lower unemployment rates would result in higher inflation, and vice versa. However, the expectations-augmented Phillips (1970) introduced by Friedman (1968) and Phelps (1967) argued that the short-term tradeoff between inflation and unemployment breaks down in the long term as inflation expectations adjust. This theory posits that in the long run, inflation is solely

determined by monetary policy, and there is no permanent trade-off between inflation and unemployment. High unemployment can therefore reduce inflationary pressures, while low unemployment may lead to upward pressure on wages and prices (Gordon, 2018).

As a consequence, numerous empirical analyses find that the Phillips Curve has flattened in recent decades, indicating a dampened response of inflation to variations in the unemployment rate, especially in the long run (Hazell, Poulton, Wiggins, & Dorward, 2022; Heise, Thiemann, & Lierse, 2022; Murphy, 2018). The authors argued that globalization (Heise et al., 2022) and credible monetary and fiscal policies (Powell, 2018) are among the forces and changes that impact classical relationships and dynamics. Moreover, the importation of global supply chains and labor markets, poor labor bargaining conditions (Lombardi, Mohanty, & Shim, 2022) and more access to cheaper imports (Heise et al., 2022) lower the inflationary pressures that would generally accompany higher domestic unemployment. The changing dynamics of inflation and unemployment in this regard have been conspicuously apparent in the advanced economies (De Negro, Giannoni, & Schorfheide, 2020).

Daniel, Adegboye, and Yusuf (2021) in Nigeria, the relationship between inflation and unemployment is not significant (2021), adding that the Phillips Curve assumptions may not always hold true behavior for developing countries. This is consonant with the situation of stagflation, in which inflation may rise alongside a rise in unemployment. In economies undergoing low productivity or a shrinking economy (declining GDP), both high inflation and high unemployment can occur together instead of the expected trade-off. In the ASEAN context, limited evidence of the Phillips Curve was found, with some countries displaying a stable inverse relationship (e.g., Malaysia and Thailand), while a loosening link was observed in others, such as Indonesia and Vietnam, due to structural elements (Nguyen & Tran, 2021). Yap and Tan (2022) suggested that globalization (e.g., liberalization and FDI) and regional economic integration have contributed to a flattening of the Phillips Curve, dampening the responsiveness of inflation to changes in domestic unemployment rates in ASEAN-5 economies. Although the two variables remain inversely related in the short run, this association diminishes or becomes insignificant over the long term (Yap & Tan, 2022). Hussin and Sulaiman (2020) showed a varying relationship between inflation and unemployment using nonlinear models. In economies like Indonesia and the Philippines, where there are significant trade links or supply-side shocks, the trade-off is less pronounced at moderate unemployment levels. Ismail and Bakar (2022) further emphasized the role of trade openness in flattening the Phillips Curve in ASEAN-6 countries, suggesting that greater integration into the global economy reduces the inflationary effects typically seen with low unemployment. Moreover, Cheong and Ooi (2020) stressed the importance of labor market flexibility, noting that ASEAN-5 countries with more flexible labor markets, such as those with lower unionization rates and more dynamic wage-setting mechanisms, exhibit a weaker inverse relationship between unemployment and inflation. In contrast, in Singapore and Malaysia, the trade-off is stronger at low or high unemployment rates, with a greater sensitivity to demand-side factors. The results of Kartika and Kurniasih (2020) show that in the short and long run, the relationship between inflation and unemployment in ASEAN-10 countries (Indonesia, Philippines, Malaysia, Singapore, Brunei Darussalam, Thailand, Vietnam, Laos, Cambodia, and Myanmar) was significantly negative from 2008-2017 data using the dynamic panel data method. This is consistent with Phillips' theory, which holds that inflation and unemployment have a stable, inverse relationship.

Nevertheless, structural shifts following the pandemic have caused the Phillips curves in advanced economies to steepen, reversing the flattening seen over the past few decades. Analysis of sectoral data from 24 advanced European economies showed that higher digitalization and reduced trade intensity are linked to steeper Phillips curves (Ari, Chen, & Ratnovski, 2023). Given ASEAN's accelerating digital transformation and susceptibility to external shocks and evolving economic conditions (Hans, 2020) the uncertainty surrounding the Phillips Curve adds complexity to this task for central banks to navigate inflation control. Understanding the inflation-unemployment relationship thus remains crucial for ascertaining the existence of a trade-off.

2.5. Inflation and Oil Price

Oil is a primary input in production processes, and changes in oil prices directly affect input costs, which can lead to inflationary pressures, especially in oil-importing countries. The supply-side shock theory explains that a sudden increase in oil prices is essentially a negative supply shock causing a shift to the left in the aggregate supply curve because higher oil prices raise production costs for firms, which reduces the quantity of goods and services that can be produced at any given price level, leading to higher overall prices (cost-push inflation). For oil-importing countries, an escalation in oil prices is typically associated with a depreciation of the national currency because of the increased demand for foreign currency to pay for oil imports. A weaker currency makes oil and other imported goods more expensive, which can exacerbate inflationary pressures (imported inflation) (Zhang, Wang, & Khan, 2025).

A large body of literature indicates that the inflationary effect of oil price changes is asymmetric, with positive oil price shocks (price increases) generally having a greater impact than negative shocks (price decreases) (Babuga & Naseem, 2020; Husaini & Lean, 2021; Li & Guo, 2021; Raheem, Adeniyi, & Isah, 2020; Sek, 2022; Wen, Zhao, & Lin, 2021). Rising oil prices typically lead to cost-push inflation, potentially fueling wage-price spirals and contributing to stagflation, while falling oil prices tend to have a weaker or negligible effect, which can impact inflation dynamics differently (Zakaria, Jun, & Khan, 2021).

However, the magnitude of the inflationary response varies across countries, regions, and types of economic shocks (supply, demand, and risk shocks), with some studies (Choi, Furceri, Loungani, Mishra, & Poplawski-Ribeiro, 2018; Ye, Zheng, & Wei, 2023) noting a decline in oil price pass-through over time due to the availability of oil substitutes. According to their findings, the effects of oil price shocks on inflation vary between developed and emerging markets and developing economies (EMDEs). The former are often more insulated due to better monetary control, energy diversification, and less dependency on oil imports. In contrast, Zakaria et al. (2021) found a long-term equilibrium relationship between oil prices and inflation in South Asian countries, where sustained high oil prices can induce structural inflationary pressures, weakening macroeconomic stability and growth, with the inflationary impact likely to intensify over time (Kose & Unal, 2021). The findings of Amarasinghe, Gunathilaka, and Jayathilaka (2018) suggested both a long- and short-term relationship between oil prices and inflation in Sri Lanka, using the Augmented Dickey-Fuller (ADF) test, Johansen cointegration, impulse response functions, and variance decomposition as statistical tools based on monthly data from 2008-2018.

ASEAN countries, particularly those heavily dependent on oil imports, face more direct exposure to the long-run asymmetric effects of global oil price changes both increases and decreases posing challenges for central banks in anchoring inflation expectations. This vulnerability is especially critical for the region, as fluctuations in global oil prices may trigger cost-push inflation, wherein rising oil prices elevate production costs, resulting in increased producer prices (PPI) and, ultimately, consumer prices (CPI) (Husaini & Lean, 2021). The COVID-19 pandemic has introduced new complexities to the oil price-inflation relationship. Aharon, Umar, Vo, and Zaremba (2023) demonstrated that the pandemic magnified the inflationary effects due to oil-specific demand and aggregate demand shocks in the ASEAN5+3 countries. The pandemic has highlighted the nexus between changes in oil prices and disruptions in the supply chain in countries like Malaysia and Thailand, compounding inflation in the aftermath. Such supply chain disruptions, countered by rising oil prices, can induce feedback loops, thereby intensifying inflation in both advanced economies and EMDEs (Ye et al., 2023).

3. METHODOLOGY

3.1. Data

Using panel data, this study attempts to analyze the effect of money supply, average exchange rate, unemployment rate, and oil prices on inflation in five selected ASEAN countries (Malaysia, Indonesia, Singapore, Thailand, and the Philippines) from 1980 to 2020. These data were collected from several reliable sources for the period from 1980 to 2020. The researcher first visited the World Bank website to download data on inflation,

unemployment, exchange rate, and money supply for the period 1980-1999. Simultaneously, oil prices data for the same reference period were obtained from the Asia Key Indicators and Pacific 2021 database. Then, data from the (ADB) for 2000-2020 were collected, including inflation, money supply, exchange rate, unemployment rate, and oil price data. This stratified selection engendered a rich dataset that allowed for comprehensive analysis and understanding of the economic mechanisms in question.

The selection of the sample period from 1980 to 2020 is motivated by the need to capture long-term trends and short-run fluctuations in inflation dynamics across ASEAN countries. This 40-year span encompasses significant economic events such as the Asian Financial Crisis, the Global Financial Crisis, and multiple oil price shocks, providing a comprehensive context for analysis. However, the selection of variables money supply, average exchange rate, unemployment rate, and oil prices is grounded in both theoretical frameworks and empirical evidence linking these macroeconomic indicators to inflation. These variables represent key demand-side and supply-side factors influencing price levels in an open economy.

Furthermore, the study employs the Panel Autoregressive Distributed Lag (Panel ARDL) model, which is well-suited for examining both short-run and long-run relationships among variables across multiple countries with varying characteristics. This approach accommodates cross-sectional heterogeneity and allows for different speeds of adjustment across countries. Additionally, the Wavelet Coherence approach is applied to analyze the time-frequency co-movement between inflation and its determinants. This innovative method strengthens the analysis by revealing how these relationships evolve over time and at different frequencies, offering deeper insights into the dynamic nature of inflationary processes.

3.2. Measurement of Variables

3.2.1. Inflation

This study examines the phenomenon of inflation within a select group of ASEAN-5 countries. Contemporary economists have reached a consensus on defining inflation as a sustained and noteworthy increase in the overall price level. However, it is imperative to discern genuine inflation from other price fluctuations attributable to factors such as technological advancements, shifts in product preferences, or price indexing. The quantity theory of money posits that an expansion in the money supply invariably serves as a primary driver of long-term inflation. Consequently, for the purpose of this study, inflation is commonly gauged through the consumer price index (CPI), which monitors the average price variations of commodities that households typically consume over time. By adopting the CPI as a measure, this paper seeks to provide a nuanced understanding of inflation dynamics within the context of everyday consumption patterns.

3.2.2. Money Supply

Milton Friedman's assertion in 1970, encapsulated in the phrase "Inflation is always and everywhere a monetary phenomenon," has profoundly influenced modern economic thought. Despite ongoing debates surrounding the different aspects of inflation, economists widely concur that inflation arises when the money supply grows at a faster rate than the real output within an economy. In line with this understanding, this study adopts a specific definition of the money supply, focusing on broad money growth (% annual change). In the context of the United States, money aggregates such as M1, M2, and M3 serve as key indicators of the money supply. M1 encompasses currency in circulation and bank checkable deposits, while M2 expands to include savings deposits (under $100,000) and money market mutual funds. M3, the broadest measure, encompasses M2 along with large time deposits in banks. For the purposes of this paper, M3 data was utilized, offering insights into the broader monetary dynamics influencing inflationary trends.

3.2.3. Exchange Rate

The puzzling process of low pass-through from exchange rates to consumer prices, which has been much debated in economic circles, is often overlooked in recent discussions. Unregulated exchange rates can lead to local currency depreciation and imported inflation as inflated foreign currency rates increase import prices. The exchange rate is well-known for its effect on economic activity, particularly through its impact on the profitability of international trade and investment. To analyze this effect, this paper uses the mean exchange rate of the country during a specific period. This average exchange rate between dollars, sterling, euros, or any other currency, refers to the ratio at which one floating currency can be exchanged for another. It is calculated by dividing the value of previous transactions in the foreign currency by that of previous transactions in the domestic currency, providing a comprehensive perspective on the underlying influence of exchange rate movements on economic activity.

3.2.4. Unemployment Rate

Unemployment is, in fact, a consequence of disproportions in the labor market, which represents one more sign of an imbalance between supply and demand: the supply of labor exceeds demand. Southeast Asia is considered one of the world's regions with the lowest historical unemployment rates, yet they faced a 3.5% unemployment rate of the labor force in 2010. This number highlights the complex interrelationships of labor market policies, macroeconomic policies, and globalization in determining the structure of employment. How efficient it is to solve unemployment heavily depends on how quickly solutions for the issues are evolving with the changing global economy. Given the pervasive impact of inflation and unemployment on economies worldwide, this study employs the unemployment rate (% of the total labor force) as a key metric, representing the proportion of individuals within the labor force actively seeking employment opportunities.

3.2.5. Oil Price

Oil plays an indispensable role as a vital energy source, serving dual purposes as transportation fuel and a foundational raw material in various manufacturing processes (Chang & Wong, 2003). Integrated into the aggregate production function, oil prices are considered a key determinant, with a relative increase in oil prices exerting downward pressure on aggregate supply, consequently driving up overall prices (Cheng & Tan, 2002; Darby, 1982). This intrinsic link between oil prices and inflation underscores the significant influence of oil market dynamics on broader economic indicators. However, empirical data from Thailand during the 1980s reveals a nuanced relationship between oil prices and inflation. Despite fluctuations in oil prices during this period, Thailand's inflation rate displayed a variable trajectory, suggesting that the impact of oil prices on inflation may be influenced by additional contextual factors. In this study, oil prices are defined based on retail gasoline prices sourced from each respective country, offering a granular perspective on the relationship between oil prices and inflation within the Southeast Asian context.

3.3. Model Description

As outlined earlier, this study employs panel data, primarily because it captures the collective impact across a group rather than focusing on individual units, thereby minimizing information loss through aggregation. Panel data also helps reduce the noise associated with individual time series, enhancing the reliability of the analysis (Chen, Li, & Wang, 2023; Westerlund, 2007). Additionally, issues such as heteroscedasticity are less problematic in panel data settings (Hu, Zhang, & Liu, 2023; Sun, Zhao, & Xu, 2023). This approach is particularly advantageous in contexts where data availability is limited, such as in developing countries with shorter time series (Aldieri, Kotsemir, & Vinci, 2023). Panel estimation techniques are well-suited for such conditions, as they account for heterogeneity across units and accommodate dynamic changes over time through repeated cross-sectional observations. Accordingly, this study adopts a heterogeneous panel data modeling approach, specifically the panel ARDL technique, to better capture both short-run dynamics and long-run relationships. The generalized ARDL (p, q, q, …, q) model is formulated as:

$$Yit = \sum_{j=1}^{p} \delta i \Upsilon i, t - j \ + \sum_{j=0}^{q} \beta' X_{i,t-j} \ + \ \varphi_i \ + \varepsilon_{it} \qquad (1)$$

In this equation, Y_{it} represents the dependent variable, while X_{it} is a (k × 1) vector of regressors that may be integrated of order zero [I(0)], order one [I(1)], or cointegrated. The parameters δ_i are scalars linked to the lagged dependent variable, and β_{ij} is a (k × 1) vector of coefficients for the regressors. φ_i accounts for individual fixed effects, where i = 1, ..., N and t = 1, 2, ..., T. The values of p and q denote the optimal lag lengths, and ε_{it} is the error term. Lag selection was guided by criteria such as the Akaike Information Criterion (AIC), Schwarz Bayesian Criterion (SBC or BIC), and the Hannan-Quinn Criterion (HQ).

The error correction version of the ARDL (p, q, q, ..., q) model is expressed as:

$$\Delta Y_{it} = \theta_i \left[Y_{it-1} - \lambda' X_{i,t} \right] + \sum_{j=1}^{p-1} \xi_{ij} \Delta Y \, it - j + \sum_{j=1}^{p-1} \beta_{ij} \Delta X_{i,t-j} + \ \varphi_i \ + \varepsilon_{it} \qquad (2)$$

Here, $\theta_i = -(1 - \delta_i)$ represents the speed at which the system adjusts back to equilibrium (with $\theta_i < 0$ indicating a return to long-run equilibrium). λ' denotes the long-run coefficients, and the term $(Y_{it-1} - \lambda' X_{it})$ functions as the error correction term (ECT), which captures the long-run relationship among variables. Short-run dynamics are reflected in the coefficients α_j and β_j.

In this context, Y is the dependent variable representing energy consumption, which is modeled with both lagged and differenced values to capture short- and long-term effects. The independent variables (X) include foreign direct investment, carbon dioxide emissions, average exchange rate, and income per capita, also considered with their respective lags and differences.

This study used the Continuous Wavelet Transform (CWT) approach, as used by Aladwani (2023) and Huang, Chen, and Li (2023) to find and quantify the co-movement between variables over many time horizons. The CWT technique works with signals that have a zero mean and records both time and frequency components. Its capacity to offer localized oscillation in both the frequency domain ($\Delta\omega$) and the time domain (Δt), or concurrently in both, is one of its primary advantages. Two essential properties of wavelets are scaling and shifting that allow the creation of a sequence of "daughter" wavelets. The CWT may be mathematically represented as the integral of the signal multiplied by the scaled and shifted versions of a "mother" wavelet function ψ, with respect to location, scale, and time. ψ, with respect to time, scale, and position.

$$C(scale, \ position) = \int_{-\infty}^{\infty} x_t \psi \left(scale, \ position, t\right) dt$$

Where: C is the wavelet coefficient; t is time. To effectively capture both high- and low-frequency components of a signal, the wavelet transform employs a fundamental function known as the mother wavelet, which is systematically scaled (stretched or compressed) and shifted (advanced or delayed) in time. This scaling and shifting process allows for a flexible analysis of localized variations within the signal across different time horizons. In this study, we leverage this adaptability through the application of wavelet coherence, a technique that measures the co-movement or synchronicity between two time series within a bivariate framework. Specifically, our research investigates the dynamic relationship between inflation and key macroeconomic variables, namely, the money supply, average exchange rate, unemployment rate, and oil prices.

4. RESULT

4.1. Pre-Estimation Results

For the empirical analysis, this study employs the Panel Autoregressive Distributed Lag (Panel ARDL) dynamic approach to examine the effects of foreign direct investment, carbon dioxide emissions, average exchange rate, and income per capita on energy consumption per capita across selected ASEAN countries. In addressing the research hypotheses, the analysis integrates both statistical evaluations and a comprehensive discussion of the findings in theoretical and conceptual terms. In addition to the empirical findings, the study reports the descriptive statistics for the variables under investigation and conducts diagnostic tests to ensure the robustness and adequacy of the selected models.

Table 2 shows the descriptive statistics, where inflation, measured as a percentage of the Consumer Price Index, demonstrates a moderate average rate of approximately 1.13, with a standard deviation of about 1.10, indicating moderate variability. Money supply, represented as a percentage of Gross Domestic Product, exhibits an average of 4.24, with relatively low variability around the mean. The exchange rate, denoted as the average exchange rate per US dollar, shows significant variability with a mean of around 3.39 units of local currency per US dollar and a relatively high standard deviation of approximately 2.88. The unemployment rate averages at about 1.30, reflecting a relatively low level of unemployment, with moderate variability around the mean. Oil prices, measured per liter, indicate an average price of approximately 2.32, with significant variability and a standard deviation of around 2.76.

Table 2. Descriptive statistics.

Variable	Variable name	Obs.	Mean	Std. Dev.	Min.	Max.
INF	Inflation (% of consumer price index)	205	1.13	1.10	-4.09	4.07
MSS	Money supply (% of gross domestic product)	205	4.24	0.57	2.65	5.03
EXCR	Average exchange rate (per US$)	205	3.39	2.88	0.22	12.47
UNEMPR	Unemployment rate (%)	205	1.30	0.64	0.42	2.47
OILP	Oil prices (Price per liter)	205	2.32	2.76	0.99	9.06

Table 3. Metrix correlation.

Variables	MSS	EXCR	UNEMPR	OILP
MSS	1.00			
EXCR	-0.60	1.00		
UNEMPR	-0.40	0.26	1.00	
OILP	-0.55	0.97	0.22	1.00

The relationship of the variables in the dataset is shown in the correlation analysis in Table 3. There is a moderately significant negative correlation (correlation coefficient=−0.60) between money supply (MSS) and exchange rate (EXCR), meaning that as money supply increases, the exchange rate tends to contract. More specifically, the second significant correlation is found between the exchange rate (EXCR) and oil price (OILP), which yields a correlation coefficient of approximately 0.97, suggesting that whenever the exchange rate increases, the oil price also increases. Thirdly, the money supply (MSS), in billions, is strongly negatively correlated with the unemployment rate (UNEMPR), with an index of -0.4, indicating that as money supply increases, the unemployment rate tends to decrease slightly. The last correlation, with the highest correlation coefficient of 0.22, is a low positive correlation between oil prices (OILP) and the unemployment rate (UNEMPR), suggesting that an increase in oil prices slightly increases the unemployment rate.

Table 4. Unit root.

Variable	Level	First difference
INF	Stationary	NA
MSS	Non-stationary	Stationary
EXCR	Non-stationary	Stationary
UNEMPR	Stationary	NA
OILP	Non-stationary	Stationary

Table 4 displays the results of the unit root test. This test serves as a fundamental statistical tool for determining the order of integration of the variables, up to AR (2). Both first- and second-generation unit root tests are employed, specifically using the Im-Pesaran-Shin (IPS) methodology, to ensure robustness in assessing stationarity. As shown in the table, the variables INF (inflation) and UNEMPR (unemployment rate) are stationary at the level, whereas MSS (money supply), EXCR (exchange rate), and OILP (oil prices) become stationary after first differencing. These

results support the suitability of applying the panel ARDL model for estimation (Çelik, Yıldırım, & Kaya, 2023; Im, Pesaran, & Shin, 2003; Phillips, 2023).

Following the unit root analysis, optimal lag lengths for each variable are selected based on commonly accepted lag criteria to avoid issues related to degrees of freedom. For example, a lag structure such as (1,0,0,0) may be adopted. Once the optimal lag structure is established, Pedroni (1999) and Pedroni (2004) cointegration test is applied to examine the existence of long-run relationships among the variables. The statistically significant ECT and long-run coefficients support the evidence of cointegration.

Table 5. Cointegration.

Test Stats.	Panel	Group
v	1.27	.
rho	-3.85	-3.44
t	-6.06	-6.92
adf	-5.26	-5.73

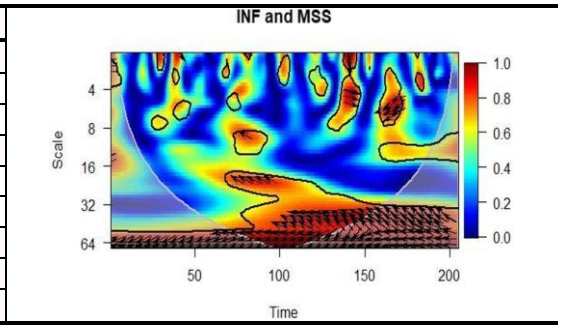
The results of the cointegration test are illustrated in Table 5. By analyzing two different sets of cointegration results, this paper explores whether there are long-term relationships between the variables used in the estimation. For both panel and group statistics (not shown), we reject the null hypothesis of no cointegration at the 1% significance level in favor of cointegration. This underlines how imperative it was to perform the cointegration test in search of substantive and stable relationships between the variables studied.(Wagner, Leiss, & Schneider, 2023).

4.2. Post-Estimation Results

Before the estimation process, the Hausman test is used to determine the most appropriate and efficient estimation method between the PMG and MG estimators, aiming to yield higher-quality results. The p-value resulting from the test is used to make this decision. When the Hausman test's p-value exceeds the 5% significance level, it confirms that the PMG estimator is a better fit for the estimation procedure. By uniformly applying these criteria to each panel of datasets from the selected group of ASEAN member states, a layer of methodological rigor is added, thereby strengthening the reliability and validity of the subsequent analysis.

Table 6. Money supply to inflation.

D.INF	Coef.	Std. err	z	P>|z|
LR				
MSS	1.20	0.31	-3.94	0.00
ECT	-0.58	0.06	-10.16	0.00
SR				
MSS (D1)	-1.09	1.15	-0.95	0.34
_cons	3.63	0.38	9.58	0.00
Pooled mean group estimation: Error				
Number of obs. = 200				
Number of groups = 5				



Furthermore, according to Table 6, the coefficient of money supply (MSS) across the selected ASEAN countries has a positive and significant long-term relationship with inflation. This indicates that an increase in the money supply is correlated with an increase in inflation over the long run. This finding is consistent with a study by Fumey, Dankwah, Acquah, Sackitey, and Moro (2025). So, when additional money enters the economy, it can sometimes boost demand for goods and services more than the economy can supply, causing prices to rise. This study highlights the need to oversee and control the money supply in order to uphold price stability and curb inflationary forces in the long run. Moreover, as in previous results, in selected ASEAN countries, money (MSS) does not statistically influence

inflation in the short run. This indicates that money supply changes, like variations in the number of dollars circulating or the reserves in bank institutions, are not directly reflecting these countries' inflation. It should be emphasized that the short-term effect may not be obvious for an extended timeframe, but the relation may still exist due to the inelasticity of money with the price level over the longer time period. Other factors or variables not considered in this analysis may be pulling short-term inflation in different directions. However, the importance of the ECT coefficient suggests there is an adjustment related to the inflation policy of the country. This underlines the statistical importance of the coefficient linked to the ECT, signifying the existence of an adjustment mechanism at a rate of 6%. These results can be examined through wavelet coherence analysis, which indicates that over the long term, the effect of money supply (MSS) is in-phase (positively correlated) with inflation in ASEAN countries; however, it is out-phase (negatively correlated) in the short run with inflation. The result is also consistent with the monetarist theory of inflation. Monetarist economists such as Milton Friedman posit that inflation is essentially a monetary phenomenon, suggesting that money supply has a direct influence on the economy's level of inflation. An increased supply of money is expected to lead to a proportional increase in the general price level over the long term. This result corroborates that in the selected ASEAN countries, movements in the money supply over time exert a lasting effect on inflation, supporting the monetarist view.

Table 7. Exchange rate to inflation.

D.INF	Coef.	Std. Err	z	P>|z|
LR				
EXCR	0.63	0.27	-2.35	0.02
ECT	-0.51	0.11	-4.65	0.00
SR				
EXCR (D1)	-1.17	2.69	-0.44	0.66
_cons	1.15	0.44	2.61	0.01
Pooled mean group estimation: Error				
Number of obs. = 200				
Number of groups = 5				

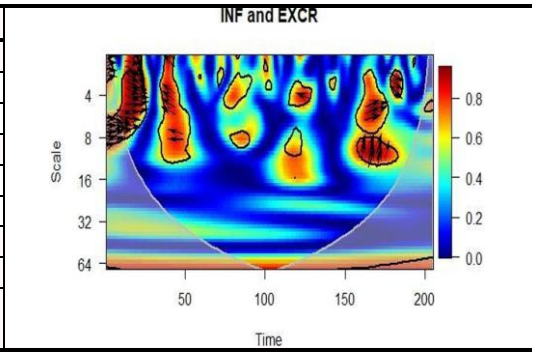
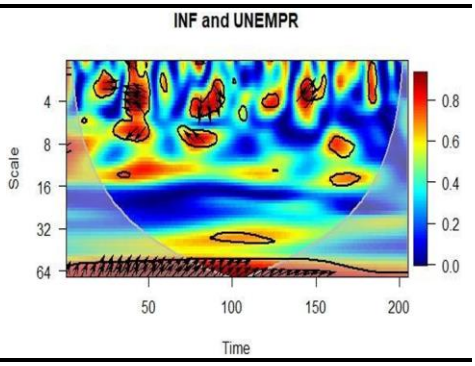


Table 7 demonstrates that in the selected ASEAN member countries, the exchange rate has a long-term positive effect on inflation. The result reinforces the findings of Hoang et al. (2020). In practical terms, it suggests that as the exchange rate increases over time, so does the level of inflation in these countries. This finding could be interpreted in several ways. One possibility is that the local currency depreciates in relation to foreign currencies, indicated by a higher exchange rate, which raises the cost of imported goods and services. This, in turn, contributes to overall inflationary pressures within the economy. Another interpretation could be that a higher exchange rate stimulates export competitiveness, which may lead to a rise in the demand for goods and services produced domestically, causing upward pressure on prices. The analyses also suggest that the exchange rate has no short-term impact on inflation in these countries. This implies that fluctuations in the exchange rate, whether due to the appreciation or depreciation of the local currency, are not immediately reflected in the general price level of goods and services within these economies. In practical terms, it means that short-term changes in the exchange rate are not strong drivers of inflationary pressures in the ASEAN region. Other factors, such as domestic demand, production costs, and government policies, may play a more dominant role in influencing short-term inflation dynamics. However, it's essential to consider that the absence of a short-run effect does not necessarily imply a lack of influence in the long run, as exchange rate adjustments may gradually impact inflation over time. The significance of the Error Correction Term (ECT) indicates the presence of an adjustment effect concerning the country's inflation policy. This emphasizes the statistical importance of the Error Correction Term (ECT), signifying the existence of an adjustment mechanism at a rate of 5%. These results can be examined through wavelet coherence analysis, which indicates that in the long run, the effect of the exchange rate is not found with inflation in ASEAN countries; however, it is in-phase (positively

correlated) in the short run with inflation. The result is also aligned with the theory of exchange rate pass-through. According to this theory, movements in the exchange rate can influence domestic inflation over the long run by affecting the prices of imported goods and services. As the value of the local currency declines, imported inflation increases, contributing to the rise of general price levels in the economy, and vice versa. Therefore, a long-term positive effect of the exchange rate on inflation suggests that changes in exchange rates are gradually transmitted to domestic prices, contributing to inflationary pressures over time.

Table 8. Unemployment rate to inflation.

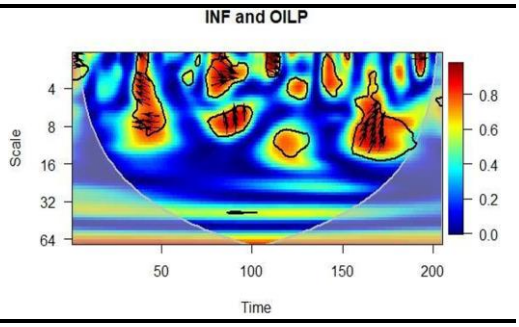
D.INF	Coef.	Std. Err	z	P>|z|
LR				
UNEMPR	-0.21	0.21	-0.98	0.33
ECT	-0.53	0.02	-21.32	0.00
SR				
UNEMPR (D1)	-0.18	0.49	-0.36	0.72
_cons	0.69	0.19	3.74	0.00
Pooled mean group estimation: Error				
Number of obs. = 200				
Number of groups = 5				



In selected ASEAN countries, the unemployment rate adversely impacts inflation in both the long-run, as presented in Table 8. The result is similar to Kartika and Kurniasih (2020) study. There are several factors that could explain the inverse correlation that the unemployment rate typically has with inflation in these countries, both in the short- and long-run. The first is the effect of consumer expectations and consumer confidence, where low unemployment creates consumer optimism and increases spending, and subsequently, when unemployment rises with confidence, consumer become more, which decreases demand and leads prices to fall. Also, wage growth is volatile since low unemployment may put upward pressure on wages, leading to higher production costs and eventually prices, while high unemployment pressures wages down, leading to price stability. In addition to unemployment's direct impact on inflation through wage developments, the monetary policy reaction over the path of unemployment, in the form of interest rate changes by central banks, affects borrowing costs, spending, and investment, and therefore also inflationary pressures. Changes in productivity within the economy, as reflected in adjustments in the levels of unemployment, also influence the dynamics of inflation, in the sense that high productivity and low unemployment in equilibrium are expected to lead to an increase in output but not an increase in prices. Furthermore, global factors such as shifts in demand for exports or fluctuations in commodity prices can further affect both unemployment and inflation rates in ASEAN countries, highlighting the interconnectedness of these economies with global markets. However, the significance of the ECT indicates the presence of an adjustment effect concerning the country's inflation policy. This emphasizes the statistical importance of the ECT, signifying the existence of an adjustment mechanism at a rate of 5%. These results can be examined through wavelet coherence analysis, which indicates that in the short run as well as in the long run, the effect of the unemployment rate is out-of-phase (negatively correlated) with inflation in ASEAN countries. The result aligns with certain aspects of the Marxian theory of unemployment, particularly concerning the relationship between unemployment and inflation within capitalist economies. In Marxist economics, unemployment is viewed as a structural feature of capitalism, resulting from the inherent contradictions and dynamics of the capitalist mode of production. According to Marxian theory, during periods of high unemployment, there is downward pressure on wages due to surplus labor and competition among workers for jobs. This downward pressure on wages can dampen inflationary pressures, as lower wages reduce production costs for capitalists and can lead to lower prices for goods and services. Additionally, high unemployment can weaken workers' bargaining power, limiting their ability to demand wage increases that could contribute to inflation.

Table 9. Oil price to inflation.

D.INF	Coef.	Std. err	z	P>|z|
LR				
OILP	0.34	0.06	-5.33	0.00
ECT	-0.65	0.05	-13.49	0.00
SR				
OILP (D1)	2.38	0.42	5.66	0.00
_cons	1.16	0.49	2.35	0.02
Pooled mean group estimation: Error				
Number of obs. = 200				
Number of groups = 5				



The short- and long-run interaction between oil price and inflation in the selected ASEAN countries is shown in Table 9. The result obtained is consistent with the study of Amarasinghe et al. (2018). This correlation is probably because oil is a significant input of production for many industries and sectors in the economy. This means that when oil prices increase, costs for businesses such as transportation and energy costs are also increased. Higher production costs are typically passed on to the consumer through price increases on goods and services, thus creating upward pressure on inflation. In addition, rising oil prices can affect inflation indirectly by changing consumer spending habits. Higher oil prices can create more expense for transportation and energy, reducing consumers' purchasing power and possibly suppressing overall demand. The significance of the ECT indicates the presence of an adjustment effect concerning the country's inflation policy. This emphasizes the statistical importance of the ECT, signifying the existence of an adjustment mechanism at a rate of 7%. These results can be zoomed into through wavelet coherence analysis, which indicates that the effect of oil price is in-phase (positively correlated) with inflation in the short-term in ASEAN countries; however, the long-term effect is nonexistent. The result aligns with the Law of Demand and Supply theory, particularly in terms of how shifts in oil prices impact the supply side of the economy and subsequently affect inflation. When oil prices increase, it directly affects the cost of production for businesses across various sectors, such as transportation, manufacturing, and agriculture. These rising production costs cause the aggregate supply curve to shift to the left, meaning that firms are only prepared to supply fewer goods and services at any given price level. As a result, the equilibrium price level in the economy rises, leading to inflation. Additionally, the Law of Demand and Supply also applies to the demand side of the economy. A rise in oil prices reduces consumers' purchasing power, as they have to spend more of their income to match the increased expenses incurred on transportation and energy. Such a decline in purchasing power can lead to lower total demand for goods and services and a price decline. But for oil, the effect on the supply side, most notably the cost-push effect, tends to dominate, resulting in an overall positive impact on inflation.

5. DISCUSSION AND POLICY IMPLICATIONS

The long-run positive and significant association between the money supply (MSS) and inflation in ASEAN countries examined has important policy implications for monetary authorities and policymakers. This indicates that long-term changes in the money supply play an influential role in causing inflation in these economies. As such, it emphasizes the need for sound and proactive monetary policies that ensure price stability and mitigate inflationary pressures in the long run. Central banks and monetary authorities of ASEAN countries may want to consider relative preemptive measures on the money side. This means paying close attention to monetary aggregates and taking measures to keep the rate of money supply growth in line with economic activity and inflation expectations. This stability promotes trust in the currency and allows long-term planning for future investors.

Additionally, the absence of an important short-run impact of monetary aggregates on inflation would also require policymakers to be cautious about interpreting short-term movements in these aggregates as indicative of money supply effects. Although changes in the money supply do not always manifest in inflationary pressures in the

short run, an adjustment effect indicates that monetary policy implementation should have lagged effects on inflation outcomes. As a result, policymakers should approach monetary formulation holistically and forward-looking, taking into account not only short-term stabilization objectives but also inflation over the long run. Moreover, the absence of immediate effects also highlights the need for complementary policy levers, notably fiscal policy and structural policies, to address short-term economic and inflationary fluctuations. Expectations for the future play a fundamental role in economic decision-making, with fiscal policy instruments such as targeted spending programs and tax incentives available to stimulate demand and keep the economy running when activity stagnates, as well as relying on changes in the money supply. Similarly, structural reforms addressing productivity, investment, and competition should increase the economy's ability to absorb variations in the money supply without creating inflationary pressures. A long-term positive and significant relationship between the exchange rate and inflation implies that the exchange rate can influence a country's overall price levels. Both local currency appreciation and depreciation relative to foreign currencies may eventually lead to inflation. Policymakers must consider such exchange rate movements when designing monetary and exchange rate policies. For example, higher depreciation of the domestic currency can encourage imported inflation as the prices of imported goods and materials increase, whereas appreciation can be deflationary as it reduces the prices of imports. These findings suggest that in the absence of short-term effects of the exchange rate on inflation, it would be imprudent for policymakers to use exchange rate adjustments as a quick-fix tool to manage inflation pressures. Therefore, the fact that the exchange rate is a variable observed in the short run will not generate the effect that if the exchange rate changes, it is immediately translated into changes in price levels in the domestic market as well as in the price of goods. As such, policymakers should adopt a more nuanced and future-oriented approach to exchange rate management, prioritizing exchange rate stability and its implications for inflation dynamics over a 5–10-year period, rather than over the short term. Additionally, given the absence of short-run exchange rate effects on inflation, it is worth noting that complementary policy measures in other areas are necessary to respond to short-term inflationary pressures. Monetary authorities might need to depend on alternative policy tools, such as short, bespoke macro-prudential measures or interest rate adjustments, to address transient swings in inflation. Exchange rate fluctuations can lead to inflation due to the inelasticity of demand for imported goods, for which targeted fiscal policy measures, like subsidies or tax policies, must be undertaken to reduce the impact of inflation linked to factors other than exchange rate movements in the short term.

In addition, the inverse relationship between the unemployment rate and inflation in the short term suggests that high levels of unemployment are linked to low levels of inflation. That would seem to be the case if consumer spending is down and demand for goods and services is weak because a large part of the population is out of work. The conventional view is that such a course may eventually be necessary, but that doing so in the near term would risk adding to inflationary pressures from generalized excess demand in the economy in the meantime. In the long run, the Phillips curve that relates the unemployment rate to prices emerges and indicates that relatively low levels of unemployment must be largely consistent with price stability over long time horizons. They should focus on structural reforms and labor market policies that reduce long-term unemployment and increase labor market flexibility, which will be essential for sustainable growth without stirring inflationary over-warming. Structural unemployment, on the other hand, requires more significant changes to the economy's productive capacity, with policies such as investing in education, training programs, and entrepreneurship, as well as facilitating labor market mobility, all contributing toward these goals over the longer term.

In addition, the negative influence of the unemployment rate on inflation highlights the need for a balanced approach toward macroeconomic policies that take into account both inflation and unemployment targets. The takeaway should be that policymakers can and should avoid designing policies for excessive short-term anti-inflation purposes if those policies risk deepening unemployment at the expense of longer-term growth opportunities. They should move toward a policy mix that is conducive to both price stability and full employment, recognizing the trade-offs and synergies among those goals. Finally, policymakers should place emphasis on the potential influence of

supply-side factors on the negative association seen between the unemployment rate and inflation. Elimination of structural bottlenecks, improvement of labor market efficiency, and promotion of investment in productive capacity will help to alleviate supply constraints and minimize the possibility of inflationary pressures developing when the economy is at or around full employment.

In addition, in the short run, the substantial positive impact of oil prices on inflation suggests that any changes in oil prices may be readily reflected in higher prices for goods and services. ASEAN countries are especially concerned, as oil imports are vital for their economies. While policymakers need to consider the inflationary risks stemming from volatile oil prices, they can take preemptive measures in the near term to minimize the inflationary effects of oil price shocks, including potential monetary or targeted fiscal policy responses. In contrast, over the long term, the strong positive impact of oil prices on inflation reflects the structural nature of this relationship and suggests the need to address structural contributors to inflationary pressures. They should ensure their economies are more resilient to oil price volatility by boosting energy efficiency, diversifying energy sources, and reducing reliance on imported oil. Improving the energy efficiency of manufacturing processes and consumption of oil and gas, investing more in renewable energy sources, and adopting sustainable development practices are essential to prevent the depletion of oil resources in the foreseeable future.

For example, when assessing oil price changes, policymakers should consider how they affect the purchasing ability of different segments of society. Rising oil prices can hit low-income households and vulnerable populations hardest, who spend a greater percentage of their income on energy-related costs. Targeted social safety nets such as cash transfers or energy subsidies can alleviate the negative impact of oil price shocks on the most vulnerable groups, helping to ensure that the burden of adjustment is equitably distributed throughout the population. Central banks may also wish to consider how shocks to oil prices permeate inflation expectations when formulating monetary policy decisions. Effectively communicating with the public about the central bank's inflation targeting framework and how it deals with oil price shocks may help stabilize inflation expectations and mitigate the possibility of second-round effects, such as wage-price spirals, that can amplify inflationary pressures.

The study's findings suggest that ASEAN policymakers should adopt a forward-looking, integrated approach to inflation management. The significant long-term impact of money supply on inflation underscores the necessity for disciplined monetary policies that align money growth with real economic activity. Given the absence of short-term effects, central banks must be cautious in interpreting immediate monetary changes and focus on long-term stability. The exchange rate's long-term influence on inflation calls for stable currency management to avoid imported inflation, while short-term reliance on exchange rate adjustments should be avoided. The negative relationship between unemployment and inflation highlights the need for structural labor market reforms that promote employment without fueling inflation. Additionally, the strong short-term impact of oil prices on inflation necessitates immediate fiscal measures such as targeted subsidies and long-term strategies focused on energy diversification and efficiency to enhance the capacity to absorb oil price shocks. A balanced mix of monetary, fiscal, and structural policies is essential to achieve sustained price stability and inclusive economic growth in ASEAN countries.

6. CONCLUSION

The selected countries' analysis reflects important relationships between macroeconomic variables and inflation in ASEAN. The study utilizes an ARDL analysis of panel data over the period of 1980-2020, and the results indicate that the observed long-run positive and significant relationship between money supply and inflation emphasizes the need for sound monetary policy to ensure price stability in the long run, which motivates policymakers to take proactive measures in managing the money supply. In addition, the lack of short-run impact of the money supply on inflation highlights the importance of a nuanced approach to monetary policymaking, considering both short-run stabilization goals and long-run inflation aspirations. The long-run results reveal that there is a strong positive association between the exchange rate and inflation, pointing towards the inflationary impact of exchange rate shocks,

which policymakers need to ponder. Moreover, the short-run and long-run inverse association between inflation and the unemployment rate reflects the need for achieving full employment as a precondition for price stability, and stresses that structural reform of labor markets should be high on policymakers' agendas. Finally, the major positive impact of oil prices on inflation in Japan, especially in the short term, means that, in addition to short-run economic policy responses, maintaining vigilance regarding inflationary pressure by managing the effect of volatile oil prices will require long-term steps regarding energy efficiency and sustainable development, among other things.

Funding: This study received no specific financial support.
Institutional Review Board Statement: Not applicable.
Transparency: The authors state that the manuscript is honest, truthful, and transparent, that no key aspects of the investigation have been omitted, and that any differences from the study as planned have been clarified. This study followed all writing ethics.
Data Availability Statement: Upon a reasonable request, the supporting data of this study can be provided by the corresponding author.
Competing Interests: The authors declare that they have no competing interests.
Authors' Contributions: All authors contributed equally to the conception and design of the study. All authors have read and agreed to the published version of the manuscript.

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