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Do migrant workers introduce asymmetries in the Phillips curve?

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ABSTRACT

This study hypothesizes that an increase in migrant workers may introduce asymmetric effects into the Phillips curve relationship in dynamic and open economies. As the share of migrant workers increases, the traditional price level–unemployment–output trade-off could become asymmetric, potentially reshaping price dynamics through labor market imbalances. Malaysia and Singapore have been used as case studies to explore this evolving structural asymmetry. Time series analysis has been employed to carefully analyze the sample study over the period 1980 to 2021. The findings reveal that gross domestic product (GDP), has a positive effect on the consumer price index (CPI), and that this effect is significantly amplified by higher levels of migrant workers. Conversely, while rising unemployment typically exerts downward pressure on price level, this negative effect is weakened in the presence of a larger migrant workforce. These results suggest that migrant workers play a key role in reshaping price dynamics. Given the role of migrant workers in amplifying price pressures, policymakers must carefully balance price level and income growth in order to preserve real gains and support sustainable economic development.

1. Introduction

Maintaining price stability is essential for achieving meaningful and sustainable economic growth. The literature explores various factors contributing to price dynamics, particularly from two perspectives: the cost-push framework and the Phillips curve hypothesis. The cost-push view attributes rising prices to higher production costs—such as increased wages, raw material prices, or interest rate adjustments—which place upward pressure on the overall price level (Husaini et al., 2019; Husaini & Lean, 2021; Kohlscheen & Moessner, 2022). The Phillips curve, originating with Phillips (1958) and formalized in modern New Keynesian models, describes how labor-market conditions influence price behavior through wage-setting frictions and firms' pricing decisions. Beyond the conventional cost-push view, the Phillips curve represents a short-run aggregate-supply mechanism in which tighter labor markets raise production costs and encourage firms to pass these costs onto prices. At the same time, stronger labor-market conditions increase household income and spending, adding demand-driven pressure on the price level. These channels together explain why unemployment and overall economic activity are central determinants of price behavior in both traditional and contemporary Phillips-curve frameworks. While the theoretical Phillips Curve is defined in terms of inflation, empirical applications such as Nguyen et al. (2024) and Xuan (2025) commonly estimate long-run price dynamics using CPI levels within cointegration-based time-series models, where short-run

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adjustments capture inflationary behavior. The theoretical Phillips Curve is defined in terms of inflation, while empirical applications commonly estimate price dynamics using CPI levels within cointegration-based time-series models.

Therefore, managing price dynamics requires a comprehensive approach that accounts for both the cost-push framework and the Phillips curve hypothesis, reflecting how production cost pressures and labor-market conditions jointly shape price behavior. This approach is particularly relevant in rapidly developing economies, in which strong economic growth can cause actual output to exceed productive capacity, leading to overheating and upward pressure on prices. As such, economic planning must ensure that the supply of goods and services expands in tandem with demand to maintain price stability (Ahn & Lee, 2023; Chletsos et al., 2016; Tang & Lean, 2007).

With the world becoming more dynamic driven by population growth and continuous economic transitions, it is necessary to revisit the relevance of the Phillips curve in explaining price behavior. This is not merely a matter of revaluation, rather calling for theoretical innovation and expansion to ensure the hypothesis remains relevant in an evolving globalized context. Szafranek (2017) found that import prices contributed to the flattening of the Phillips curve. Building on this, Ahn and Lee (2023) studied the South Korean context and confirmed that increased globalization—through trade liberalization and foreign direct investment in global supply chains—had contributed to a flatter Phillips curve. Their findings suggest that unemployment became less responsive to price dynamics due to increased global integration. Similar trends were observed in the United States, where Ball and Mazumder (2011) identified globalization and technological advancement as key factors weakening the price level–unemployment trade-off. Matheson and Stavrev (2013) also found evidence of a flattened Phillips curve, attributing this change in part to global economic forces. These studies highlight the need to consider globalization when evaluating the price level–unemployment relationship in modern economies.

In this context, migrant workers may significantly influence the evolution of the Phillips curve in dynamic economies. Small, open economies often depend on migrant labor to support economic growth and maintain competitiveness (Lozej, 2019). Consequently, the role of migrant workers becomes central not only to output expansion, but also to shaping the price level–unemployment dynamics described by the Phillips curve. This influence operates through two key channels: (i) a production-capacity channel, and (ii) labor-market dynamics.

The first channel is the production-capacity effect. By expanding the effective labor supply, migrant workers support higher output without proportionate increases in marginal cost, allowing firms to meet rising demand with smaller upward movements in the price level (Giovanni, 2015; Lozej, 2019). This mechanism is particularly relevant in small, open economies, where foreign labor is essential for sustaining production capacity.

The second channel relates to labor market dynamics. An increase in the supply of migrant labor can moderate wage growth by easing labor shortages, thereby reducing the sensitivity of inflation to changes in domestic unemployment (Bentolila et al., 2008; Lozej, 2019). Additionally, migrant workers may introduce new skills and technical knowledge, potentially creating demand for more specialized roles. However, their willingness to accept lower wages may also suppress wage growth in certain occupations, intensifying competition and potentially displacing low-skilled native workers. Troshchenkov (2011) similarly argues that migrant labor can disrupt unemployment patterns by altering the equilibrium of the labor market.

Taken together, these channels suggest that an expanding migrant workforce may flatten the Phillips curve by weakening the traditional relationship between unemployment and price level, reflecting structural changes in labor market composition, wage-setting behavior, and aggregate demand. This study hypothesizes that as the share of migrant workers increases, the price level–unemployment–output relationship may become asymmetric, particularly in dynamic, open economies in which migrant labor plays a central role. Migrant workers help fill shortages in sectors where domestic labor supply is limited, often due to differences in education, skills, or job preferences between migrants and native workers (Fromentin, 2013). By expanding the labor supply and moderating wage pressures, migrant labor influences both employment and price dynamics, potentially altering the sensitivity of price levels to economic fluctuations and reshaping the Phillips curve itself.

Malaysia and Singapore are prominent examples of small and open economies with strong economic performance in the ASEAN region. Both countries consistently rank high on globalization indices relative to other Asian economies of similar size. Notably, Singapore—despite its smaller geographical footprint—maintains a gross domestic product that slightly surpasses that of Malaysia, an impressive feat given its relatively small population.

In both countries, labor shortages are not due to an absolute lack of workers, but rather reflect job mismatches and local reluctance to take on low-skilled roles. Migrant workers have become essential for filling these labor gaps and sustaining economic momentum (Testaverde et al., 2017; Harkins & Lindgren, 2018; Foley and Piper, 2024). Their role is not merely supportive, but is rather fundamental to the functioning of key sectors. As a result, foreign labor policy has become a strategic instrument for long-term national development planning, particularly in open economies. This highlights the importance of managing labor mobility as a core element of macroeconomic resilience (Bentolila et al., 2008; Gonzalez & Ortega, 2011).

Despite these shared characteristics, Malaysia and Singapore differ markedly in their policy approaches toward migrant labor and in the underlying structures of their economies, differences that have meaningful implications for labor market dynamics. Singapore has adopted a highly coordinated and regulated framework, using mechanisms such as dependency ceilings, levies, and sector specific permits to manage the inflow and distribution of migrant workers (Chia, 2011). This structured approach has allowed Singapore to flexibly adjust labor inputs in response to economic fluctuations while maintaining productivity and wage stability across industries. In contrast, Malaysia's migrant labor system is more fragmented and heavily concentrated in low skilled sectors such as agriculture, construction, and domestic work (Wahab, 2020). Policy inconsistencies and limited mobility between sectors restrict Malaysia's ability to reallocate migrant labor efficiently, resulting in more rigid labor adjustments. These divergent institutional settings shape how each country's labor market responds to macroeconomic shocks and inflationary pressures, demonstrating that similar dependence on foreign labor can yield distinct outcomes depending on national policy design and economic composition.

Table 1 reports changes in real GDP and migrant worker numbers in Malaysia and Singapore by decade. In Malaysia, GDP rose by approximately USD 26.7 billion, USD 61.58 billion, USD 68.30 billion, and USD 131.95 billion during the periods 1980–1989, 1990–1999, 2000–2009, and 2010–2019, respectively. These increases were accompanied by the employment of approximately 106 thousand, 492.8 thousand, 1011.6 thousand, and 3018.1 thousand migrant workers in the corresponding decades.

While Malaysia demonstrates a consistent positive correlation between GDP growth and migrant workers inflows, Singapore presents a more complex pattern. Between 1980 and 1989, GDP grew by approximately USD 30.89 billion, supported by 120.36 thousand migrant workers. However, in the 1990–1999 period, GDP rose by USD 57.97 billion, even as the migrant workforce declined by 319.45 thousand. Between 2000 and 2009, GDP expanded by USD 75.59 billion, accompanied by a dramatic increase of 453.16 thousand migrant workers. From 2010 to 2019, GDP increased by USD 102.32 billion, with 427.7 thousand additional migrant workers employed.

These figures underscore the strong reliance of both economies on migrant workers to drive GDP growth. However, when viewed through the lens of the Phillips curve, it becomes clear that long-term planning around migrant worker integration is essential. While their contribution to output is substantial, their role in shaping inflation dynamics cannot be overlooked. As such, both Malaysia and Singapore must carefully manage the economic and labor market implications of migrant workers in order to ensure that price stability is preserved while still sustaining growth.

Based on these structural differences, we hypothesize that migrant workers influence price dynamics in two key ways. First, higher migrant labor participation is expected to moderate the sensitivity of the price level to unemployment and GDP, reflecting a flattening of the Phillips-type relationship. Second, given Singapore's more flexible and coordinated migrant-labor regime, the moderating effect of migrant workers on these relationships is expected to be stronger in Singapore than in Malaysia.

Building upon existing motivations in the literature, this study aims to extend the traditional Phillips Curve framework by incorporating the role of migrant workers and their impact on the curve's structure—an area that has received limited attention in previous research. Specifically, this study aims to: (1) investigate the direct impact of unemployment, gross domestic product (GDP), and migrant workers on the consumer price index (CPI); (2) examine the moderating effect of migrant workers on the relationship between GDP and CPI; and (3) explore the moderating effect of migrant workers on the relationship between unemployment and CPI.

This study makes three primary contributions. First, the study deepens the Phillips Curve hypothesis by analyzing migrant workers as a moderating factor in the unemployment–price level relationship. To our knowledge, this is the first study to explicitly incorporate migrant workers into the innovation of the Phillips Curve framework specifically in Malaysia and Singapore. Employing migrant workers as moderating factor will provide evidence for the asymmetric impact of unemployment on price level in the varying marginal effects of unemployment on price level at different levels of migrant workers. This is expected to provide more granular insights into the structural shifts in labor markets and the asymmetric nature of macroeconomic trade-offs shaped by migration.

Second, this paper extends the analysis of how GDP influences the price level by introducing migrant workers as a moderating factor. Migrant workers play a pivotal role in shaping inflationary dynamics by influencing labor market conditions, particularly through their effects on production capacity and wage structures (Arcangeliset al., 2015; Behrens & Sato, 2011). By moderating wage dynamics and expanding labor capacity, migrant workers introduce asymmetric effects into the price level–output relationship, as the magnitude of inflationary response varies across different levels of migrant labor (Ari et al., 2023; Blanchard, 2016; Haschka, 2024). Their presence can either amplify or attenuate the transmission of output growth into price dynamics by altering the income channel of economic expansion. This perspective offers deeper insights into the structural mechanisms underlying the GDP–price level nexus.

Third, this study uses Singapore and Malaysia as comparative case studies to examine the influence of migrant workers on the Phillips curve. Each country provides valuable examples due to their heavy reliance on migrant labor and their structurally open economies. Each actively attracts migrant workers to fill essential labor gaps. However, the two economies differ significantly in their institutional settings and policy frameworks. Singapore's well-regulated migrant labor system, anchored by levies and dependency quotas, contrasts with Malaysia's more segmented and less coordinated approach. These contrasting dynamics highlight that the role of migrant workers in shaping price level and employment outcomes is likely to be influenced by national policy choices, offering important lessons for other economies facing labor shortages and price pressures.

The remainder of the paper is structured as follows. The next section presents the theoretical framework and literature review. Section 3 introduces the proposed model. Section 4 discusses the data and methodology. Section 5 outlines the results and offers a detailed discussion. Section 6 concludes the paper.

Table 1

Decadal margins in migrant workers and real GDP in Malaysia and Singapore, 1980–2019

Period	Malaysia		Singapore	
	Migrant Worker (thousands)	GDP (Real USD billion)	Migrant Worker (thousands)	GDP (Real USD billion)
1980–1989	106	26.70	120.36	30.89
1990–1999	492.8	61.58	–319.45	57.97
2000–2009	1011.6	68.30	453.16	75.59
2010–2019	3018.1	131.95	427.7	102.32

Source: Ministry of Economy

2. Literature review

2.1. Theoretical framework

The Phillips Curve is a well-established concept in economics. Traditionally, it refers to the inverse relationship between inflation and unemployment. Extensive research has been conducted on this relationship from both theoretical and empirical perspectives (Karanassou et al., 2008; Rudd & Whelan, 2005). However, in today's evolving economic landscape, the growing presence of migrant workers has introduced additional complexities that may affect the structure and behavior of the Phillips Curve (Bentolila et al., 2008; Engler, 2009).

Migrant workers introduce asymmetries in the Phillips Curve by reshaping labor markets, wage dynamics, and inflationary patterns. By increasing the labor supply—particularly in certain sectors or skill categories—migrant workers can help alleviate labor shortages and reduce wage pressures (Nagurney, 2022). This potentially flattens the Phillips Curve. The skill composition of migrant workers is also a key factor. High-skilled migrant workers may enhance productivity and output, while low-skilled migrant workers may exert downward pressure on wages in specific segments of the labor market (Fassio et al., 2020; Peri & Sparber, 2009). Moreover, migrant labor can affect inflation through both cost-side and demand-side channels. On the cost side, the availability of lower-cost labor may reduce production expenses. On the demand side, increased consumption by migrant workers can raise aggregate demand (Dennis & Tatiana, 2021; Jorgensen & Lansing, 2022). These factors collectively contribute to a more elastic labor supply, which may lead to a flatter Phillips Curve, as price responses to changes in unemployment become less pronounced (Binyamini and Razin, 2007; Kriesler & Lavoie, 2007; Lombardi et al., 2020).

Migrant workers can significantly alter the composition and structure of the labor force. It is therefore reasonable to expect that these changes may impact employment opportunities, wage dynamics, and overall macroeconomic stability (Fromentin, 2013). The effects may vary across sectors and income groups, potentially creating disparities in the labor market or offering new employment opportunities. Fig. 1 illustrates the conceptual framework guiding this study, taking into account the theoretical considerations discussed above.

2.2. Existing literature

The Phillips Curve theory is widely used in the literature as a central framework, and describes the inverse relationship between inflation and unemployment (Karanassou et al., 2008; Rudd & Whelan, 2005). Enih and Seraj (2021) have provided empirical evidence of an inverse link between inflation and unemployment in Turkey, attributing it to the connection between inflation and wage growth. This relationship forms the basis of the downward-sloping Phillips Curve. Supporting this, Shaari (2018) examined data from 1990 to 2014 across high-income countries and confirmed the existence of the Phillips Curve in both the short and long run. These findings underscore the policy trade-off between inflation and unemployment, as efforts to curb inflation may result in higher unemployment, and vice versa. Adding another dimension to this relationship, Kumar and Orrenius (2016) applied the ARDL approach to U.S. state-level data from 1982 to 2013, finding strong evidence that the wage–price Phillips curve is nonlinear and convex, with declines in the unemployment rate below its historical average exerting significantly greater upward pressure on wages than equivalent increases above the average. However, in the long run, economists have argued that there is no stable trade-off between unemployment and inflation, leading to the concept of a vertical long-run Phillips Curve (Umaru et al., 2013).

Looking at the influence of migrant workers on labor supply and wages, Winter-Ebmer and Zweimüller (2000) have pointed out that migrant workers fill labor opportunities and contribute to a reduction in unemployment over time. Gross (2002), using a Vector Autoregression (VAR) framework for France, found that migrant inflows produce a small short-run increase in unemployment but a long-run reduction. However, because VAR models characteristically trace dynamic responses rather than estimating structural parameters, the magnitude and sign of long-run effects should be interpreted with caution. VAR impulse responses provide information about temporal adjustment paths, but do not provide causal or structural estimates of labor-market effects. Even so, the overall implication that migration influences labor-market slack over different horizons remain relevant for this study, as labor-market slack is central to Phillips curve dynamics.

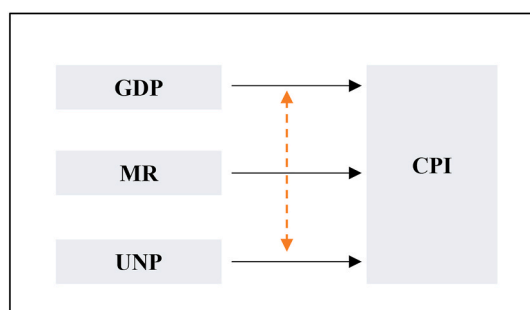


Fig. 1. Conceptual framework.

Islam and Khan (2015) have examined the long-run relationships between migrant workers, GDP per capita, and wages in the United States using Johansen cointegration and VECM techniques. Their results suggest that immigration exerts adverse labor-market effects, particularly on wages. However, these findings reflect the structural characteristics of the U.S. economy, and may not be generalized to small, open economies, where migrant labor fills sector-specific shortages rather than competing directly with domestic workers.

Jean and Jiménez (2011) used OECD panel data to show that changes in migrant-worker shares can alter unemployment dynamics, particularly when inflows shift the composition of the labor force. Galloway and Jozefowicz (2008a) similarly reported that variations in the foreign-born share contribute to fluctuations in regional unemployment in the Netherlands. These studies demonstrate that migrant labor plays a significant role in shaping unemployment outcomes. This is directly relevant to the present study, as any factor which modifies unemployment dynamics also has the potential to alter the way unemployment feeds into price behavior which is consistent with the Phillips-curve view that labor-market slack influences price pressure.

Dritsaki and Dritsaki (2024) employed a Panel Vector Autoregression (PVAR) to analyze the dynamic interactions between migration, GDP per capita, and unemployment across EU countries. Their findings indicate bidirectional causal relationships among these variables, suggesting that migration and labor-market conditions evolve jointly over time. However, these results should be interpreted with caution, as the PVAR framework identifies temporal causal links but does not provide statistically reliable long-run coefficients or signs which quantify the direction or magnitude of effects.

Dustmann and Frattini (2014), using British Labour Force Survey data across 17 UK regions from 1983 to 2000, reported no significant effect of immigration on employment, labor-force participation, or unemployment. This aligns with a broader body of evidence suggesting that labor markets often adjust to migrant inflows in ways that offset potential negative effects on native workers. Öztürk and Özdil (2020), examining OECD economies using panel ARDL techniques for 1990–2016, similarly found that migration contributes positively to long-run GDP, although short-run inflows may impose temporary adjustment costs. Feridun (2007), applying ARDL bounds testing and VECM-based causality for Sweden, identifies a long-run bidirectional link between immigration and GDP per capita but finds no evidence that immigration causes unemployment. Instead, higher unemployment appears to attract more migration. These studies indicate that migration is closely tied to macroeconomic performance, but does not consistently exert adverse pressures on unemployment. This variation underscores the claim that the impact of migrant labor depends heavily on national labor-market structures and adjustment mechanisms.

Tanrikulu (2021) investigated the impact of migration on the Turkish economy over the period 2012–2020 using the Engle–Granger cointegration method. The study analyses the relationship between migrant workers and key macroeconomic indicators, particularly inflation. The findings reveal that migration into Turkey has a positive long-term contribution to economic growth, primarily through increased demand for goods. However, in the short term, the inflow of Syrian migrants is associated with a rise in both inflation and unemployment, indicating initial pressures on the labor market and consumer prices. Salisu et al. (2024) analyzed the relationship between migration and inflation in selected OECD countries over the period 1995 to 2020, encompassing both stable and turbulent economic phases. Using a Panel Autoregressive Distributed Lag (PARDL) model, the study incorporated variables such as migration inflows, consumer price index (CPI), interest rates, and GDP. The findings showed that migration inflows exert an inflationary effect in the short run, but help reduce inflation in the long run. This indicates that the influence of migration on prices is dynamic and evolves over time. This effect also appears to be mediated by interest rate adjustments. These studies highlight that migration can generate both short-run price pressures and long-run stabilizing effects, reinforcing the view that the impact of migrant labor on inflation is inherently dynamic and depends on how quickly labor markets and policy frameworks adjust.

This study addresses a notable gap in the existing literature, particularly in relation to the works of Jean and Jiménez (2011), Gross (2002), and Frattini (2014), which primarily focus on the interaction between immigration and labor market outcomes through the lens of the traditional Phillips Curve. While previous research has largely focused on the linear relationship between unemployment and inflation, limited attention has been given to the asymmetric role of migrant workers in shaping both inflation dynamics and labor market behavior. This study offers a broader perspective by incorporating migrant labor into the Phillips Curve framework, thereby offering new insights into how migration-induced structural differences influence inflation and unemployment across varying labor market settings.

Moreover, this research contributes to the literature by introducing interaction terms to evaluate how different levels of migrant labor moderate the relationships between GDP and CPI, as well as unemployment and CPI. These moderating effects reveal asymmetric responses in inflation that depend on the scale of migrant labor integration. By capturing these asymmetries, the study offers a more dynamic and context-sensitive understanding of how migration intersects with core macroeconomic variables, thus refining inflation modeling and informing labor market policy in an increasingly globalized and structurally diverse economic environment.

3. Model, methodology and data

3.1. Model

This paper addresses the issue of migrant workers and their interaction with unemployment and GDP in affecting price level in Malaysia and Singapore. Theoretically, this study adopts the Phillips Curve framework as the baseline to explain the inverse relationship between unemployment (UNP) and the consumer price index (CPI), where lower unemployment is typically associated with higher inflation due to increased wage pressures and aggregate demand (Phillips, 1958). In dynamic time-series econometric applications of the Phillips Curve, consumer price index (CPI) level rather than the inflation rate is typically used when estimating long-run relationships. Cointegration-based models such as ARDL require variables to be entered in levels to obtain valid long-run equilibrium

estimates. While the theoretical construct focuses on inflation, empirical implementations commonly rely on CPI levels to represent price behavior. This approach is consistent with established empirical practice in macroeconomics (e.g., Nguyen et al., 2024).

GDP is included because fluctuations in overall economic activity influence price dynamics through both demand-side and cost-side channels. In periods of strong economic activity, rising household spending, investment, and business transactions create greater demand for goods and services, placing upward pressure on the price level (Blanchard & Johnson, 2013; Mankiw, 2019). At the same time, higher economic activity increases the utilization of labor, capital, and imported inputs, raising production costs and encouraging firms to pass these costs to consumers (Christopoulou & Vermeulen, 2012; Gordon, 2011). These demand- and cost-driven mechanisms justify the inclusion of GDP in price-level models.

The influx of migrant workers (MR) signifies a dynamic shift in the labor market structure of open economies. This external labor supply not only influences wage-setting behavior but also reshapes national production capacity. As a result, it challenges and transforms the traditional trade-off outlined by the Phillips Curve. In order to achieve objective of the study, the empirical framework is developed as follows:

$$CPI_t = \beta_0 + \beta_1 UNP_t + \beta_2 GDP_t + \beta_3 MR_t + \varepsilon_t \tag{1}$$

Where.

CPI = Consumer Price Index based year at 2015

UNP = numbers of unemployment

GDP = Gross domestic product constant at 2015, USD.

MR = numbers of migrant workers

We hypothesize that the impact of GDP on the consumer price index varies depending on the level of migrant workers. Therefore, we include an interaction term between GDP and migrant workers in Equation (2), as follows:

$$CPI_t = \beta_0 + \beta_1 UNP_t + \beta_2 MR_t + \beta_3 GDP_t + \beta_4 MR^*GDP_t + \varepsilon_t \tag{2}$$

Where MR*GDP represents the interaction term between migrant workers and GDP. This interaction term allows us to assess how the impact of GDP on inflation becomes asymmetric across different levels of migrant labor. This study captures the varying marginal effects of GDP on inflation by including this term, reflecting the structural asymmetries introduced by differing degrees of migrant workers participation. The partial derivatives of Equation (2) are used to estimate this effect, as shown below:

$$\frac{\partial CPI_t}{\partial GDP_t} = \beta_3 + \beta_4 MR$$

The signs of the coefficients β_3 and β_4 are critical for interpreting the interaction effect. If $\beta_3 > 0$ and $\beta_4 < 0$, GDP has a positive relationship with the consumer price index, but migrant workers mitigate this positive effect. If $\beta_3 < 0$ and $\beta_4 > 0$, GDP has a negative relationship with the consumer price index, while migrant workers reduce the strength of that negative relationship. If both $\beta_3 < 0$ and $\beta_4 < 0$, GDP is negatively associated with the consumer price index, and the presence of migrant workers reinforces this deflationary effect. Finally, if $\beta_3 > 0$ and $\beta_4 > 0$, GDP positively affects the consumer price index, and migrant workers amplify this inflationary impact.

We hypothesize that the impact of GDP on the consumer price index varies with the level of migrant workers. Therefore, we include an interaction term between migrant workers and unemployment in Equation (3), as follows:

$$CPI_t = \beta_0 + \beta_1 UNP_t + \beta_2 MR_t + \beta_3 GDP_t + \beta_4 MR^*UNP_t + \varepsilon_t \tag{3}$$

Where MR*UNP represents the interaction term between migrant workers and unemployment. This interaction term allows us to assess how the impact of unemployment on inflation becomes asymmetric across different levels of migrant labor. By including this term, the study captures the varying marginal effects of both migrant workers and unemployment on inflation, reflecting the structural asymmetries in labor market responses. These effects have been derived by taking the partial derivatives of Equation (3), as follows:

$$\frac{\partial CPI_t}{\partial UNP_t} = \beta_1 + \beta_4 MR$$

The signs of the coefficients β_3 and β_4 are important for interpreting the interaction. If $\beta_3 > 0$ and $\beta_4 < 0$, migrant workers have a positive relationship with the consumer price index, while unemployment weakens this positive effect. If $\beta_3 < 0$ and $\beta_4 > 0$, migrant workers have a negative relationship with the consumer price index, and unemployment reduces the strength of that negative effect. If both $\beta_3 < 0$ and $\beta_4 < 0$, migrant workers are negatively associated with the consumer price index, and unemployment reinforces this deflationary impact. Lastly, if $\beta_3 > 0$ and $\beta_4 > 0$, migrant workers have a positive relationship with the consumer price index, and unemployment further amplifies this inflationary effect.

3.2. Methodology

The methodology begins with testing for stationarity using unit root tests to determine the order of integration for each variable,

ensuring they are either integrated of order zero, I(0), or order one, I(1). The Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are employed to assess the stationarity of the variables at both their levels and first differences. Once stationarity is confirmed, the next step is to test for cointegration to determine whether a long-run equilibrium relationship exists among the variables. For this purpose, the ARDL Bounds Testing approach to cointegration is applied. Following the confirmation of cointegration, and as introduced by Pesaran et al. (2001), the study employs the Autoregressive Distributed Lag (ARDL) model to estimate the magnitude and direction of the impact of the exogenous variables on the endogenous variable. One of the statistical advantages of the ARDL approach is that, with appropriate modification of the lag orders, it is sufficient to address the issue of endogeneity bias (Ang, 2009; Pesaran & Shin, 1998).

The ARDL error correction model is as follows:

$$\Delta CPI_t = \alpha_1 + \sum_{i=1}^p \delta_i \Delta CPI_{t-i} + \sum_{j=0}^q \Omega_j UNP_{t-j} + \sum_k^r \Upsilon_k \Delta MR_{t-k} + \sum_{t=0}^s \rho_t \Delta GDP_{t-i} + \pi_1 CPI_{t-1} + \pi_2 UNP_{t-1} + \pi_3 MR_{t-1} + \pi_4 GDP_{t-1} + \varepsilon_t \tag{4}$$

Where p, q, r and s are the optimal lag lengths for each variable. The coefficient π_1, π_2, π_3 and π_4 measure the long run relations, $\delta_i, \Omega_i, \Upsilon_k$ and ρ_i represent the short-run dynamics, ε_t is the error term. To capture the long-run relationship, the model was restricted by the lagged level variables, $CPI_{t-1}, UNP_{t-1}, MR_{t-1}$ and GDP_{t-1} in Equation (4).

The F test was employed to ascertain the existence of a long-run relationship in the model. The null hypothesis $H_0 = \pi_1 = \pi_2 = \pi_3 = \pi_4 = 0$ that is no cointegration among the variables. The F test statistics are then compared with the critical value provided by Narayan (2005). We would have enough statistical evidence to reject the null hypothesis if the value of the F-statistic exceeded the upper critical bounds, while we would not have enough statistical evidence to reject the null hypothesis if the value of the F-statistic were below the respective lower critical bound. The F-statistic would be inconclusive if the statistical value falls between the upper critical bound and the lower critical bound. Subsequently, a series of diagnostic tests are conducted to validate the ARDL model. We then adopt the modified version of Granger causality test developed by Toda and Yamamoto (1995).

3.3. Data

The sample period data span 1980 until 2021. The Consumer Price Index, Migrant Workers, Gross Domestic Product, and unemployment data have been obtained from Department of Statistic Malaysia (DOSM), Department of Statistic Singapore (DOS) and the World Bank's World Development Indicator. Table 2 reports the descriptive statistics for all variables.

4. Empirical result

4.1. Unit root test

First, we employ the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests to assess the stationarity of the variables. As reported in Table 3, all variables are found to be stationary at their first differences. We then proceed with the Bounds Test to examine the existence of a long-run cointegration relationship among the variables.

4.2. Bounds test

Table 4 presents the results of the Bounds Test. Statistically, the test results for all models are significant at the 5 percent confidence level. Therefore, we have concluded that all models exhibit strong evidence of long-run cointegration.

4.3. ARDL long run estimation for Malaysia

Table 5 presents the ARDL long-run estimation results for Malaysia. Model 1 captures the direct impact of unemployment (UNP), gross domestic product (GDP), and migrant workers (MR) on the consumer price index (CPI). The results show that both MR and GDP

Table 2
Descriptive statistics.

	Malaysia				Singapore			
	CPI	GDP	UNP	MR	CPI	GDP	UNP	MR
Mean	4.3516	18.8346	5.8835	6.7552	4.4384	25.5161	3.8686	6.0908
Maximum	4.8126	19.8043	6.5971	8.9227	4.7398	26.5390	4.7855	6.9521
Minimum	3.7235	17.6392	5.2062	5.1930	4.0511	24.2097	3.0987	2.7081
Std. Dev.	0.3216	0.6804	0.2977	1.3459	0.1995	0.7215	0.7608	1.9597
Skewness	-0.2041	-0.2549	0.0743	0.4865	0.0328	-0.2279	-2.9863	-1.2559
Kurtosis	1.8007	1.7929	3.2052	1.5666	1.9662	1.8140	16.1738	5.4503
Observations	41	41	41	41	41	41	41	41

Note: All values are in natural logarithm.

Table 3
Unit root tests.

Malaysia				
Augmented Dickey Fuller (ADF)			Phillip Perron (PP)	
A: Level				
	Intercept	Trend & Intercept	Intercept	Trend & intercept
CPI	-2.0052	-2.2852	-2.4362	-2.6836
GDP	-1.9510	-0.5471	-1.8495	-0.7286
MR	-0.1709	-1.7647	-0.2242	-1.8804
UNP	-0.9204	-1.9346	-1.0629	-2.1068
B: First Differences				
CPI	-5.4577***	-5.4035***	-5.5198***	-5.4282***
GDP	-5.0224***	-5.3320***	-5.0300***	-5.3320***
MR	-5.8885***	-5.8534***	-5.8877***	-5.8530***
UNP	-5.7874***	-5.8119***	-5.7689***	-5.7972***
Singapore				
Augmented Dickey Fuller (ADF)			Phillip Perron (PP)	
A: Level				
	Intercept	Trend & Intercept	Intercept	Trend & intercept
CPI	-0.3119	-3.3131	-1.4865	-2.8793
GDP	-1.2768	-2.341236	-1.902359	-2.163161
MR	-4.3153***	-5.9303***	-4.3605***	-5.9303***
UNP	-2.3366	-2.1702	-5.4527***	-5.5935***
B: First Differences				
CPI	-4.9558***	-4.7284***	-4.9549***	-4.7304***
GDP	-7.7251***	-7.8067***	-7.7394***	-7.9552***
MR	-7.0999***	-6.9921***	-27.0272***	-25.5130***
UNP	-0.6119	-1.0265	-28.8720***	-28.9839***

Notes: Asterisks (***) , (**) and (*) denotes rejection at significance level of 1 % , 5 % and 10 % . CPI is the consumer price index, GDP is gross domestic product, MR is migrant workers, UNP is unemployment.

Table 4
Results of ARDL bound test.

Malaysia			
Bounds Test	Model 1 (1,2,0,0)	Model 2 (1,2,0,0,0)	Model 3 (4,1,1,1,1)
F-Stat	5.9215***	4.4401**	4.3071**
Singapore			
Bounds Test	Model 1 (2,1,3,2)	Model 2 (2,1,2,2,0)	Model 3 (2,1,3,2,0)
F-Stat	3.9447**	3.8143**	3.9575**
Critical Value			
	Lower Bound,		Upper Bound
	I(0)		I(1)
10 %	2.37		3.2
5 %	2.79		3.67
2.5 %	3.15		4.08
1 %	3.65		4.66

Notes: Asterisks (***) , (**) and (*) denotes rejection at significance level of 1 % , 5 % and 10 % .

are statistically significant with positive coefficients, while UNP is significant with a negative coefficient. Based on the ceteris paribus assumption, the findings can be interpreted as follows:

- A 1 percent increase in MR is expected to raise CPI by approximately 0.03 percent, holding all other variables constant.
- A 1 percent increase in GDP is expected to raise CPI by approximately 0.42 percent, holding all other variables constant.
- A 1 percent decrease in UNP is expected to raise CPI by approximately 0.10 percent, holding all other variables constant.

GDP exhibits the greatest impact on CPI in terms of magnitude. Additionally, the error correction term (ECT) is statistically significant, with a coefficient of -0.3521 at the 1 percent significance level. The negative and significant ECT coefficient confirms the

Table 5
ARDL long run estimation for Malaysia.

	Model 1 (1, 2, 0, 0, 0)	Model 2 (1, 2, 0, 0, 0)	Model 3 (4, 1, 1, 1, 1)
Long Run Coefficient			
Constant	-3.1999***	-3.4202***	-3.8014***
GDP	0.4207***	0.4200***	0.4302***
UNP	-0.0900***	-0.0863***	-0.4924***
MR	0.0299***	0.0204***	0.0191***
GDP*MR	-	0.0103***	-
UNP*MR	-	-	0.0104***
Short Run Coefficient			
Δ GDP	0.0783	0.0226	0.0691
Δ UNP	-0.0081	-0.0285	0.0038
Δ MR	0.0063	0.0105	0.0057
Δ GDP*MR	-	-0.0052	-
Δ UNP*MR	-	-	-0.0238
ECT	-0.3521***	-0.3646***	-0.3402***
Diagnostic Test			
Jarque-Bera	1.1287	0.9572	0.3296
Breusch-Godfrey Serial Correlation LM Test (1)	0.7688	0.6570	2.8631
Breusch-Godfrey Serial Correlation LM Test (2)	0.8270	0.7371	1.8312
ARCH (1)	1.8201	1.9846	2.9918
ARCH (2)	1.0313	1.0661	1.6756
Ramsey Test	1.2785	3.3036	0.1686

Notes: Asterisk *** and ** indicates significant at 1 % and 5 % levels, respectively. JB denotes as Jarque-Bera statistic for residual normality test. Breusch-Godfrey denotes as Breusch-Godfrey Serial Correlation LM test. ARCH is the ARCH Heteroskedasticity test. RESET refers to Ramsey RESET specification test.

existence of a long-run equilibrium relationship among the variables, consistent with the bounds test results (Table 4). This further indicates that approximately 35.21 percent of the short-run deviations from the long-run equilibrium are corrected each month, implying that the system would return to equilibrium within roughly 4.23 months.

Model 2 captures the interaction effect of migrant workers (MR) on the relationship between gross domestic product (GDP) and the consumer price index (CPI). The results show that GDP is statistically significant with a positive coefficient at the 1 percent significance level. Additionally, the interaction term (GDP*MR) is also significant and positively signed at the 1 percent level. These findings suggest the presence of an asymmetric relationship, where the positive effect of GDP on CPI intensifies as the level of migrant workers increases. To illustrate this asymmetric effect in mathematical terms, we have computed the marginal impact using the coefficients reported in Table 5 as follows:

$$\frac{\partial CPI}{\partial GDP} = 0.4200 + 0.0103MR$$

The marginal effect of GDP on CPI has been evaluated at the minimum, mean, and maximum levels of migrant workers (MR), revealing an asymmetric pattern. Specifically, a 1 percent increase in GDP has been estimated to raise CPI by 0.47 percent when MR is at its minimum level (0.18 million). This positive effect becomes progressively stronger as the level of migrant workers increase, rising to 0.49 percent at the mean level of MR (0.858 million) and 0.51 percent at the maximum level (7.5 million)—highlighting the asymmetric influence of migrant workers on the output–price level relationship. This asymmetric effect is clearly illustrated in Fig. 2, which shows how the marginal impact of GDP on CPI increases progressively across the minimum, mean, and maximum levels of migrant workers.

Model 3 captures the interaction effect of migrant workers (MR) on the relationship between unemployment (UNP) and the

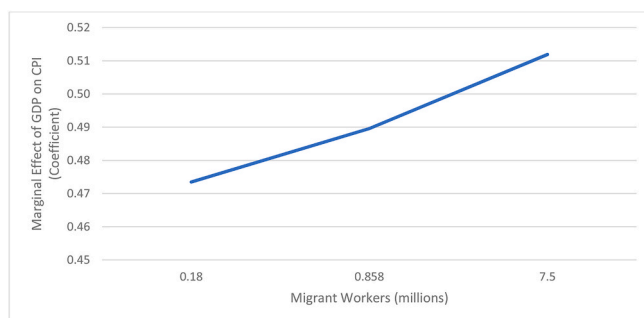


Fig. 2. Asymmetric marginal effects of GDP on CPI across different levels of migrant workers in Malaysia.

consumer price index (CPI). The results show that UNP is statistically significant with a negative coefficient at the 1 percent significance level. Furthermore, the interaction term (MR*UNP) is also significant and positively signed at the 1 percent level. These findings suggest the presence of an asymmetric relationship, where the negative impact of rising unemployment on CPI diminishes as the level of migrant workers increases. In other words, responsiveness of price level to unemployment becomes weaker at higher levels of migrant workers, reflecting structural asymmetries in labor market dynamics. To illustrate this asymmetric relationship mathematically, we have computed the marginal effect using the coefficients reported in Table 5 as follows:

$$\frac{\partial \text{CPI}}{\partial \text{UNP}} = -0.4924 + 0.0104\text{MR}$$

The marginal effect of unemployment (UNP) on the consumer price index (CPI) has been evaluated at the minimum, mean, and maximum levels of migrant workers (MR), revealing an asymmetric pattern. Specifically, a 1 percent increase in UNP is estimated to reduce CPI by 0.44 percent when MR is at its minimum level (0.18 million). However, as the level of migrant workers increase, the negative impact of unemployment weakens, declining to 0.42 percent at the mean level of MR (0.858 million) and 0.40 percent at the maximum level (7.5 million). This asymmetric response highlights how migrant workers alter the sensitivity of price level to labor market slack. This asymmetric effect is clearly illustrated in Fig. 3, which shows how the marginal impact of unemployment on CPI becomes progressively weaker as the level of migrant workers increases.

Table 5 also reports the short-run coefficients for completeness. In Malaysia, none of the short-run terms are statistically significant at conventional levels. This indicates that immediate price adjustments to changes in GDP, unemployment, or migrant workers are limited and impermanent. As such, the long-run coefficients remain the primary basis for economic interpretation, and the overall conclusions of the study rely on the long-run relationships established in the ARDL framework.

The CUSUM and CUSUM of Squares tests, as shown in Figs. 4–6, confirm that all models are stable. Furthermore, the diagnostic tests, including Jarque-Bera, Breusch-Godfrey LM, ARCH, and Ramsey RESET, indicate that the proposed models exhibit a good overall fit.

4.4. Toda-Yamamoto causality test for Malaysia

To uncover more findings on the nexus between CPI, GDP, UNP and MR, we employed the Toda-Yamamoto (TY) Granger causality test. Table 6 presents the results of the Toda-Yamamoto Granger causality test for Malaysia. Among all the tested relationships, only one unidirectional causality has been found to be statistically significant at the one percent level. The results indicate that changes in the CPI Granger-cause changes in the UNP. This finding implies that fluctuations in CPI contain information about future movements in unemployment dynamics.

4.5. ARDL long run estimation for Singapore

Table 6 presents the ARDL long-run estimation results for Singapore. Model 1 captures the direct impact of unemployment (UNP), gross domestic product (GDP), and migrant workers (MR) on the consumer price index (CPI). The results indicate that both MR and GDP are statistically significant with positive coefficients, while UNP is significant with a negative coefficient. Based on the ceteris paribus assumption, the findings can be interpreted as follows:

- A 1 percent increase in UNP is expected to raise CPI by approximately 0.02 percent, holding other variables constant.
- A 1 percent increase in GDP is expected to raise CPI by approximately 0.29 percent, holding other variables constant.
- A 1 percent decrease in MR is expected to raise CPI by approximately 0.01 percent, holding other variables constant.

Similar to the findings in Malaysia, GDP has the greatest impact on CPI in terms of magnitude. Additionally, the error correction term (ECT) is statistically significant, with a coefficient of -0.1712 at the 1 percent significance level. The negative and significant ECT coefficient confirms the existence of a long-run cointegrating relationship among the variables, consistent with the results of the bounds test (Table 4). It further implies that approximately 17.12 percent of the short-run deviations from the long-run equilibrium are corrected each month, indicating that the CPI in Singapore adjusts to changes in the explanatory variables within about 2.05 months.

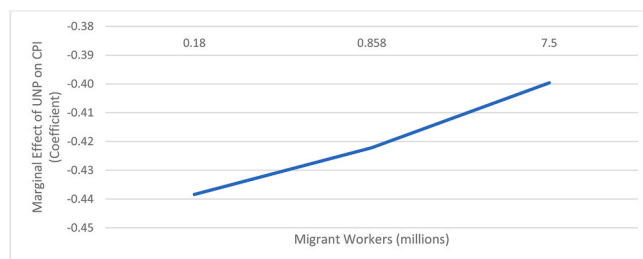
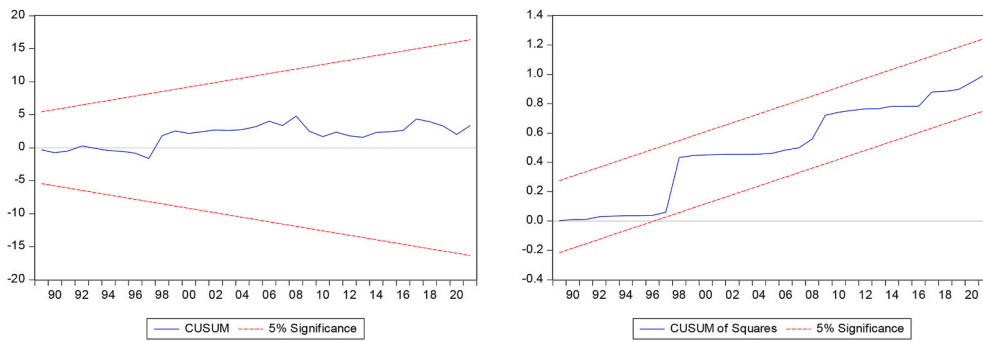


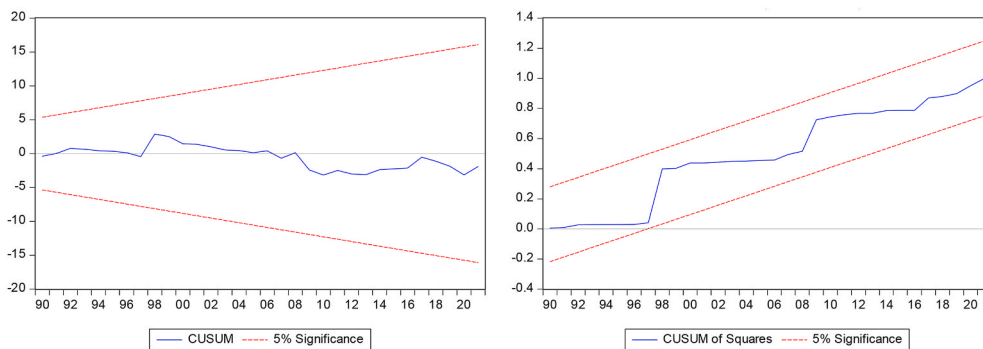
Fig. 3. Asymmetric marginal effects of unemployment on CPI across different levels of migrant workers in Malaysia.



Note: The Y-axis represents the CUSUM or CUSUMSQ test statistic, while the X-axis indicates the corresponding years.

Fig. 4. CUSUM and CUSUM Square for Malaysia (Model 1)

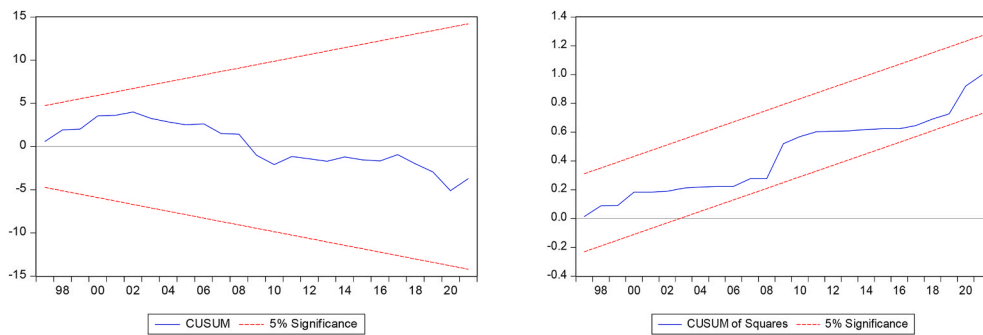
Note: The Y-axis represents the CUSUM or CUSUMSQ test statistic, while the X-axis indicates the corresponding years.



Note: The Y-axis represents the CUSUM or CUSUMSQ test statistic, while the X-axis indicates the corresponding years.

Fig. 5. CUSUM and CUSUM Square for Malaysia (Model 2)

Note: The Y-axis represents the CUSUM or CUSUMSQ test statistic, while the X-axis indicates the corresponding years.



Note: The Y-axis represents the CUSUM or CUSUMSQ test statistic, while the X-axis indicates the corresponding years.

Fig. 6. CUSUM and CUSUM Square for Malaysia (Model 3)

Note: The Y-axis represents the CUSUM or CUSUMSQ test statistic, while the X-axis indicates the corresponding years.

CPI responds comparatively more quickly to changes in exogenous variables in Singapore than in Malaysia.

Model 2 captures the interaction effect of migrant workers (MR) on the relationship between GDP and CPI. GDP is statistically significant at the 1 percent level, and the interaction term (GDP*MR) is also significant and positively signed at the 1 percent level. These findings suggest the presence of an asymmetric relationship, where the positive impact of GDP on CPI intensifies as the level of migrant workers increase. In other words, the responsiveness of price level to output becomes uneven across different levels of migrant worker presence. To illustrate this asymmetric relationship mathematically, we have computed the marginal effect using the

Table 6
Toda-Yamamoto (TY) granger causality test for Malaysia.

From	To			
	CPI	GDP	UNP	MR
CPI	–	0.2566	12.6108***	0.6578
GDP	0.5923	–	2.0632	0.3546
UNP	0.0282	1.4685	–	1.2349
MR	0.2707	0.0380	0.2352	–

Notes: Asterisk *** and ** indicates significant at 1 % and 5 % levels, respectively.

coefficients reported in Table 6 as follows:

$$\frac{\partial CPI}{\partial GDP} = 0.2470 + 0.0497MR$$

The marginal effect of GDP on CPI has been evaluated at the minimum, mean, and maximum levels of migrant workers (MR), revealing a clear asymmetric pattern. Specifically, a 1 percent increase in GDP is estimated to increase CPI by 0.38 percent when MR is at its minimum level (0.015 million). At the mean (0.441 million) and maximum levels of MR (1.044 million), the same increase in GDP is expected to raise CPI by 0.55 percent and 0.59 percent, respectively. This pattern mirrors the findings observed in Malaysia; however, the positive effect of GDP appears more elastic in Singapore. The asymmetric effect is clearly illustrated in Fig. 7, which demonstrates that the marginal impact of GDP on CPI becomes increasingly pronounced as the level of migrant workers increases.

Model 3 captures the interaction of MR on UNP to cause CPI. UNP is significant with negative 1 % critical value. Moreover, the interaction term (MR*UNP) is statistically significant with a positive coefficient at the 1 percent significance level. These results suggest the presence of an asymmetric relationship, where the negative impact of rising unemployment on CPI diminishes as the level of migrant labor increases. In other words, the sensitivity of price level to changes in unemployment becomes uneven across different levels of migrant worker presence. To mathematically illustrate this asymmetric relationship, we have computed the marginal effect using the coefficients reported in Table 6, as follows:

$$\frac{\partial CPI}{\partial UNP} = - 0.2511 + 0.0209 MR$$

The marginal effect of unemployment (UNP) on the consumer price index (CPI) has been evaluated at the minimum, mean, and maximum levels of migrant workers (MR), revealing an asymmetric pattern. Specifically, a 1 percent increase in UNP is estimated to reduce CPI by 0.19 percent when MR is at its minimum level. At the mean and maximum levels of MR, the same increase in UNP is expected to reduce CPI by 0.12 percent and 0.10 percent, respectively. This pattern is consistent with the marginal effects observed in Malaysia; however, the response of CPI to unemployment in Singapore is more elastic, indicating greater sensitivity to labor market conditions. This asymmetric effect is clearly illustrated in Fig. 8, which demonstrates how the marginal impact of unemployment on CPI becomes progressively weaker as the level of migrant workers increase.

Table 7 also reports the short-run coefficients for completeness. For Singapore, GDP and MR show statistically significant short-run effects, while unemployment and the interaction terms do not. These results indicate that some immediate price adjustments occur; however, these short-run effects are temporary and do not persist. Consistent with the ARDL interpretation, the long-run coefficients remain the primary basis for economic inference, while the overall conclusions of the study continue to rest on the long-run relationships.

The CUSUM and CUSUM of Squares tests, as shown in Figs. 9–11, each confirm the stability of all models. Furthermore, the diagnostic tests, including the Jarque-Bera test, Breusch-Godfrey LM test, ARCH test, and Ramsey RESET test, indicate that the proposed models exhibit a good overall fit.

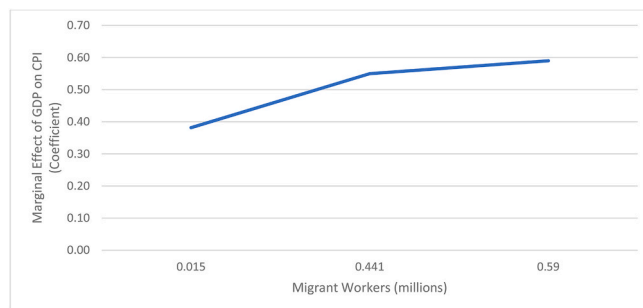


Fig. 7. Asymmetric marginal effects of GDP on CPI across different levels of migrant workers in Singapore.

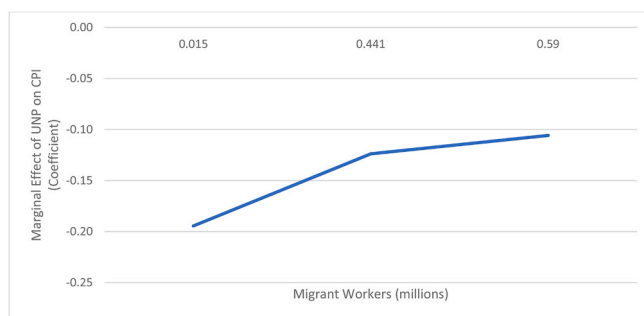
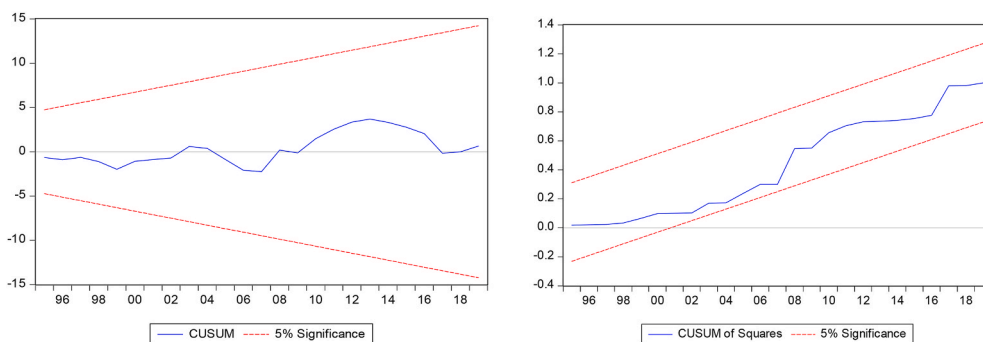


Fig. 8. Asymmetric marginal effects of unemployment on CPI across different levels of migrant labor in Singapore.

Table 7
ARDL long run estimation for Singapore.

	Model 1 (2,1,3,2)	Model 3 (2,1,2,2,0)	Model 4 (2,1,3,2,0)
Long Run Coefficient			
Constant	-2.9651***	-4.2628***	-3.8939***
GDP	0.2894***	0.2470***	0.2918***
UNP	-0.0242***	-0.0083***	-0.2511***
MR	0.0095***	0.0255***	0.0088***
GDP*MR	-	0.0497***	-
UNP*MR	-	-	0.0209***
Δ GDP	0.1571**	0.1218**	0.2219***
Δ UNP	0.0020	-0.0006	-0.0007
Δ MR	0.0037**	0.0041***	0.0051***
Δ GDP*MR	-	-0.0040	-
Δ UNP*MR	-	-	-0.0943
ECT	-0.1712***	-0.3026***	-0.1631***
Diagnostic Test			
Jarque-Bera	0.6885	0.8951	1.6585
Breusch-Godfrey Serial Correlation LM Test (1)	0.4006	0.6017	1.0151
Breusch-Godfrey Serial Correlation LM Test (2)	0.2324	0.2911	0.5393
ARCH (1)	0.0562	0.4316	0.1635
ARCH (2)	0.1694	0.3060	0.2591
Ramsey test	1.6298	1.8768	1.7156

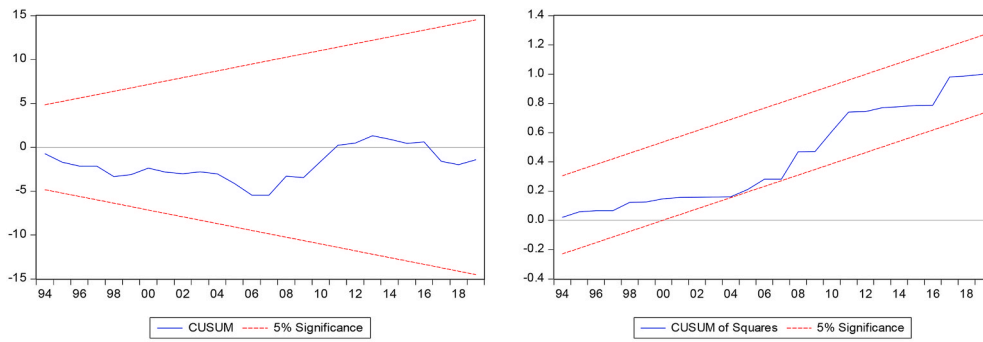
Notes: Asterisk *** and ** indicates significant at 1 % and 5 % levels, respectively. JB denotes as Jarque-Bera statistic for residual normality test. Breusch-Godfrey denotes as Breusch-Godfrey Serial Correlation LM test. ARCH is the ARCH Heteroskedasticity test. RESET refers to Ramsey RESET specification test.



Note: The Y-axis represents the CUSUM or CUSUMSQ test statistic, while the X-axis indicates the corresponding years.

Fig. 9. CUSUM and CUSUM Square for Singapore (Model 1)

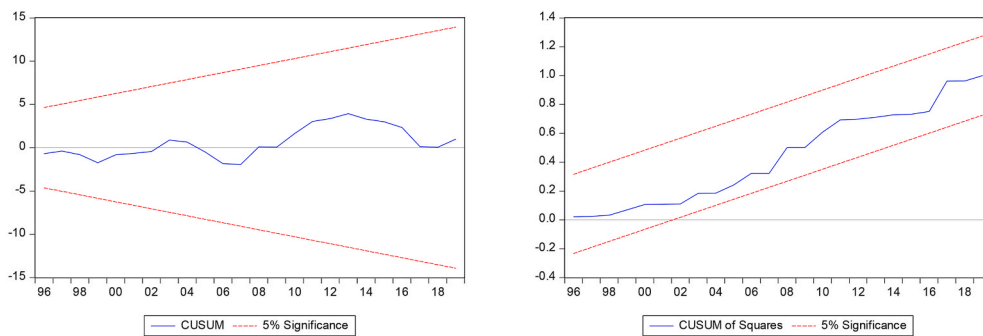
Note: The Y-axis represents the CUSUM or CUSUMSQ test statistic, while the X-axis indicates the corresponding years.



Note: The Y-axis represents the CUSUM or CUSUMSQ test statistic, while the X-axis indicates the corresponding years.

Fig. 10. CUSUM and CUSUM Square for Singapore (Model 2)

Note: The Y-axis represents the CUSUM or CUSUMSQ test statistic, while the X-axis indicates the corresponding years.



Note: The Y-axis represents the CUSUM or CUSUMSQ test statistic, while the X-axis indicates the corresponding years.

Fig. 11. CUSUM and CUSUM Square for Singapore (Model 3)

Note: The Y-axis represents the CUSUM or CUSUMSQ test statistic, while the X-axis indicates the corresponding years.

4.6. Toda-Yamamoto causality test for Singapore

We employed the Toda-Yamamoto (TY) Granger causality test to uncover more findings on the nexus between CPI, GDP, UNP and MR. Table 8 presents the results of the Toda-Yamamoto Granger causality test for Singapore. Among all the relationships examined, two unidirectional causal links are statistically significant at the one percent level. The results indicate that changes in GDP Granger-cause changes in CPI, suggesting that economic activity precedes movements in the price level. Additionally, changes in the CPI Granger-cause changes in MR, implying that price dynamics may influence migrant workforce levels.

5. Discussions

Four important findings are discussed in the following section. First, as reported in Table 5 (Model 1) and 7 (Model 1) for Malaysia and Singapore, GDP growth contributes to higher price level. This relationship reflects a fundamental macroeconomic mechanism whereby expanding output increases employment and household income, subsequently boosting aggregate demand and placing upward pressure on prices (Dennis & Tatiana, 2021; Jorgensen & Lansing, 2022). This result is consistent with previous empirical findings for both countries, including those by Furuoka et al. (2023) and Furuoka (2007).

This study extends the literature by demonstrating that migrant workers play a pivotal role in facilitating economic expansion through the provision of essential labor across key sectors, thereby enhancing output capacity, as evidenced by the results in Table 5 (Model 2) for Malaysia and Table 7 (Model 2) for Singapore. Building upon the established price level–output nexus, the presence of migrant workers does not uniformly dampen price pressures. Instead, it introduces asymmetric effects that strengthen the positive impact of GDP growth on the price level as the proportion of migrant workers rises. This implies that the sensitivity of the price level to output becomes more pronounced in economies that rely more heavily on migrant labor, such as Malaysia and Singapore.

The mechanism behind the intensified GDP–inflation relationship, particularly in the presence of migrant workers, can be more precisely understood through the income effect, which arises from productivity gains and structural labor cost differences between migrant and local workers. This can be contextualized within the labor market structures of Malaysia and Singapore. Tellingly, employers in both countries face considerable mandatory obligations when hiring local workers, such as contributions to respective

Table 8
Toda-Yamamoto (TY) granger causality test for Singapore.

From	To			
	CPI	GDP	UNP	MR
CPI		2.5928	0.1316	13.13241***
GDP	13.3554***		0.4018	2.2665
UNP	1.2939	0.0641		2.2688
MR	0.3153	1.4206	1.3342	

Notes: Asterisk *** and ** indicates significant at 1 % and 5 % levels, respectively. JB.

retirement and social security schemes, including Malaysia's Employees Provident Fund (EPF), Social Security Organization (SOCSSO), and Employment Insurance System (EIS), and Singapore's Central Provident Fund (CPF) (Asher, 2002; Yew, 2014; Zin, 2012). These requirements substantially raise the labor costs associated with local employment. In contrast, migrant workers are often employed under less costly regulatory conditions. In Malaysia, employers of migrant workers incur lower costs through minimal insurance schemes, lower levies, and limited labor protections, while in Singapore, although employers pay sector-specific migrant workers levies, migrant workers do not qualify for CPF contributions (Asher, 2002). As a result, from the perspective of firms, migrant worker carries a lower cost of employment per unit of productivity, effectively reducing overhead costs and increasing production efficiency.

Such asymmetry in labor costs leads firms to optimize input combinations in favor of migrant worker, thereby expanding output while containing costs. The efficiency gains achieved through cost management do not remain confined within firms; instead, they circulate throughout the broader economy. Higher firm profits and increased returns to capital contribute to productivity-driven economic growth, while the combined contributions of both migrant and local workers boost total national income (Ji et al., 2022). This expanded income allows firms to reinvest in production or distribute earnings through higher wages, dividends, and consumption, reinforcing the circular flow of income that sustains economic expansion (Peri, 2012).

Consumption demand accelerates as income increases across the economy. Migrant workers themselves contribute to this demand through their local spending, even as they remit part of their earnings abroad. The aggregate rise in income and spending contributes to stronger price pressures, particularly when demand begins to outpace the economy's ability to expand supply further.

Second, as reported in Table 5 (Model 1) for Malaysia and 7 (Model 1) for Singapore, an increase in unemployment reduces price level, consistent with the traditional Phillips curve framework, which links higher unemployment to weaker demand and lower wage pressures. This finding aligns with earlier empirical evidence from both countries, as demonstrated by Furuoka et al. (2023) and Furuoka (2007). However, the results of this study challenge the symmetry of this classical mechanism. Our empirical evidence reveals that although the unemployment–price level relationship remains negative, its magnitude diminishes as the level of migrant workers increase. This indicates an asymmetric adjustment in which the negative effect of rising unemployment is progressively weakened in the presence of more migrant workers, suggesting that labor market responses to slack are not uniform across labor force compositions.

This asymmetric adjustment is rooted in the structural dynamics of labor markets in both Malaysia and Singapore. In both countries, there is a persistent reluctance among local workers to engage in low-skilled and physically demanding occupations such as domestic housekeeping, cleaning services, factory line work, construction labor, and private security (Foley & Piper, 2024; Wahab, 2020). These jobs are often viewed as undesirable due to low wages, long hours, and limited prospects for upward mobility (Baranowska-Rataj et al., 2023; Wahab, 2020). In Malaysia, this aversion is further reinforced by a relatively generous framework of government support, including fuel subsidies, public health care, affordable housing schemes, and targeted cash transfers (Zin, 2012). These programs reduce the urgency for citizens to accept lower-end employment, especially when alternative informal income opportunities or state benefits offer a better perceived return. Similarly, in Singapore, where the standard of living is higher and the median wage far exceeds that of low-skilled occupations, locals tend to avoid such roles in favor of more stable and better-remunerated jobs, often in the public sector or knowledge-based industries (Ye, 2014).

Low-skilled jobs remain economically essential despite being socially undesirable. They form the backbone of critical sectors like manufacturing, construction, logistics, hospitality, and household care—functions without which the rest of the economy cannot operate smoothly (Awad et al., 2018). The refusal of locals to fill these roles has created a structural labor gap which has been systematically filled by low-skilled migrant workers, mostly from Indonesia, Bangladesh, Nepal, India, and Myanmar (Wahab, 2020). These migrants are often employed under fixed-term contracts with fewer benefits, lower overhead costs, and higher job turnover expectations (Awad et al., 2018; Idris & Ismail, 2006). Their availability allows firms to maintain continuous operations at lower cost and higher efficiency, contributing significantly to national output and productivity.

Reliance on migrant labor goes a step further in Singapore. The country has welcomed semi-skilled and high-skilled migrants, especially in the fields of engineering, IT, finance, and healthcare (Ye, 2014; Yeoh & Lam, 2016). These skilled migrants are attracted through streamlined immigration pathways and are viewed not just as labor inputs but as strategic assets capable of delivering broader multiplier effects, including technological spillovers, innovation, and knowledge transfer to the domestic workforce (Chou, 2021). In this context, migrant labor is not merely a substitute for domestic employment gaps, serving additionally as a catalyst for economic transformation, deepening productivity and innovation potential while further reinforcing the link between GDP growth and price level through the income effect.

Third, as reported in Table 5 for Malaysia and Table 7 for Singapore, both countries exhibit similar findings regarding the weakening of the traditional unemployment–price level relationship by migrant workers, yet an intriguing divergence emerges. Empirical evidence from this study indicates that at higher migrant-workers levels, the marginal effects of GDP and unemployment on

price level remain significantly stronger in Singapore than in Malaysia. This notable divergence can be traced to distinct institutional contexts and policy settings within each country.

Singapore's price level responsiveness is directly linked to its highly flexible and strategically managed migrant labor policies, specifically through its sophisticated use of foreign-worker levies and quotas. Foreign-worker levies refer to mandatory fees imposed on employers hiring migrant workers, varying across sectors and skill levels. Quotas, formally known as Dependency Ratio Ceilings (DRCs), restrict the proportion of migrant workers firms can employ relative to their total workforce (Ministry of Manpower Singapore, 2024). By dynamically adjusting these levies and quotas, the Singapore government can promptly influence employers' labor-cost calculations and hiring decisions in order to swiftly calibrate migrant workforce availability in line with economic fluctuations.

A clear demonstration of this flexibility occurred during Singapore's recovery from the COVID-19 pandemic. The government temporarily reduced foreign-worker levies and eased quotas for sectors such as construction and manufacturing, enabling firms to promptly expand production through migrant labor without substantial disruptions to wage structures (Subhani, 2024). This responsiveness ensured wage and price adjustments remained dynamic and closely linked to real economic conditions. Given Singapore's predominantly market-based pricing system and minimal use of broad subsidies, these labor market adjustments are promptly fed into consumer price levels, preserving a robust inflation sensitivity amid economic expansion periods. This is despite the moderating influence typically associated with migrant labor.

By contrast, Malaysia's labor market remains comparatively rigid, characterized by significant segmentation and extensive regulatory constraints. Migrant workers in Malaysia predominantly occupy informal or low-wage sectors such as agriculture (e.g., palm oil plantations), construction, manufacturing assembly lines, and domestic services (Wahab, 2020). Due to limited legal protections, weak bargaining power, and constrained mobility, wage-induced price pressures from migrant employment remain structurally subdued, regardless of changes in overall unemployment or GDP growth.

Further reducing price level responsiveness, Malaysia extensively employs comprehensive subsidies and explicit price-control mechanisms (BNM Annual Report, 2024; Islam et., 2017). These policies include broad-based fuel subsidies, regulated prices for cooking oil, sugar, rice, and price ceilings on essential items and utilities (Islam et al., 2017; Kaur, 2025). A recent illustrative case occurred during the global energy crisis triggered by the Ukraine-Russia conflict in 2022, when Malaysia significantly increased subsidy spending to maintain stable consumer prices for petrol, diesel, electricity, cooking oil, and staple foods. Such extensive subsidies substantially dilute the direct transmission of economic fluctuations into consumer price changes (Liu et al., 2024b; Husaini et al., 2023). Thus, price level responses to variations in GDP growth or unemployment remain notably muted, despite the substantial reliance on migrant labor.

Forth, the Toda-Yamamoto Granger causality test reveals important asymmetries in how Malaysia and Singapore adjust to price pressures, particularly through the role of migrant workers in the labor market. In Singapore, the findings (reported in Table 8) show that changes in the consumer price index Granger-cause changes in the level of migrant workers, indicating that inflation triggers structural labor adjustments. The economic mechanism behind this relationship suggests that as production costs rise with increases in the price level, firms seek to preserve profit margins and maintain cost efficiency (Ang et al., 2018). To achieve this, they increasingly rely on migrant labor, which is often more flexible and lower-cost than local workers (Erumban & Al-Mejren, 2024; Thangavelu, 2016). Migrant workers therefore serve as an adaptive buffer, allowing firms to moderate wage growth and manage labor costs in response to inflation. This is consistent with Singapore's deliberate labor policy framework, which actively facilitates the use of foreign labor through regulated quota systems and sector-specific strategies to maintain competitiveness and absorb market fluctuations (Goh et al., 2017).

In contrast, the results for Malaysia (reported in Table 6) show that changes in price level Granger-cause changes in unemployment, without significant adjustments in the migrant workforce. This suggests that price pressures in Malaysia are primarily absorbed within the domestic labor market, often resulting in job losses or underemployment among local workers rather than through labor composition shifts involving migrants. This asymmetry may reflect Malaysia's more restrictive and segmented migrant labor policies, which confine foreign workers to specific low-skilled sectors with limited mobility across industries (Hii & Lau, 2025). Furthermore, Malaysia's greater reliance on government interventions, such as subsidies and price controls, has reduced the need for firms to adjust labor inputs in response to rising costs (Awad et al., 2018). As a result, Malaysia's labor-market response to price-level movements remains anchored in domestic employment shifts, unlike Singapore's more flexible adjustment through migrant labor.

6. Conclusion and policy implication

This study provides statistical confirmation of the Phillips curve hypothesis in both Malaysia and Singapore, where a negative relationship between unemployment and price level is observed. However, we extend the traditional Phillips curve framework by incorporating the role of migrant workers and examining their moderating effects on this relationship. The results reveal that GDP growth increases the consumer price index, and that this positive effect becomes asymmetrically stronger as the level of migrant workers rises. Conversely, while rising unemployment typically reduces price level, this negative effect weakens asymmetrically in economies with a higher prevalence of migrant workers. These findings highlight the income effect associated with migrant workers, where increased productivity and lower relative labor costs raise aggregate income, sustain consumption, and support demand—even during periods of labor market slack. By altering the sensitivity of price level to changes in output and unemployment, migrant workers introduce structural asymmetries that effectively flatten the Phillips curve in both countries. These insights contribute to the Phillips curve literature by showing how labor market composition and the presence of foreign labor reshape price dynamics. Policymakers must therefore account for these asymmetric effects to ensure that price level remains aligned with income growth and long-term economic sustainability.

Migrant workers play a vital role in sustaining economic growth in both Malaysia and Singapore. Their participation in labor-intensive sectors such as construction, manufacturing, and services addresses structural gaps created by domestic labor market preferences and job mismatches. Given this reality, controlling inflation by limiting migrant labor inflows would be counterproductive, as it would risk disrupting essential sectors, weakening productivity, and slowing economic expansion.

Although monitoring price level remains a fundamental policy objective, relying solely on conventional tools such as interest rate adjustments to moderate demand can be blunt, especially during periods of robust growth. A more sustainable and targeted approach involves addressing the income effect driven by migrant labor. This study shows that migrant workers amplify the positive impact of GDP growth by contributing to higher aggregate income and consumption. Therefore, managing price level risk requires policies that strengthen national saving mechanisms and improve the capacity of the economy over time.

A forward-looking strategy is to mandate compulsory savings contributions for migrant workers. In Malaysia, recent policy developments have introduced mandatory contributions to the Employees Provident Fund (EPF) for foreign workers, starting at an initial rate of two percent of monthly wages. While this rate is low, it is deliberately set to minimize pressure on employers' cash flow and preserve firm-level productivity, particularly in sectors that are highly dependent on migrant labor. Over time, this contribution rate could be gradually increased to a level that meaningfully supports national investment and mitigates price level pressures stemming from rising incomes.

In contrast, Singapore does not currently require migrant workers to contribute to the Central Provident Fund (CPF). CPF participation is limited to Singapore citizens and permanent residents. Migrant labor in Singapore therefore does not directly feed into national savings institutions, even while significantly contributing to output and income. Given Singapore's similar reliance on migrant labor, the country could consider following Malaysia's lead by introducing a mandatory savings scheme for foreign workers, potentially structured through CPF or a dedicated parallel mechanism. This would not only improve the long-term financial security of migrant workers, but also support macroeconomic stability by expanding national savings and investment capacity.

Introducing such a policy would ensure that each additional migrant worker contributes not only to short-term output gains but also to the long-term sustainability of the economy by reinforcing the savings–investment channel. By channeling a portion of migrant workers' income into national savings and investment, the economy can expand its capacity in line with demand. Such a capacity expansion would help to absorb the additional pressure generated by migrant-induced consumption, thereby moderating the marginal upward effect on the price level associated with each additional migrant worker. In doing so, the policy reduces the risk of price-level increases outpacing real growth and limits overreliance on conventional monetary tightening measures. At the same time, this would support a more inclusive financial system by linking migrant labor to long-term national development goals while securing financial benefits for the workers themselves.

More broadly, this model offers a valuable reference point for other labor-importing economies with similar characteristics. Countries that rely heavily on migrant labor and face inflationary risks linked to rapid income expansion can adopt or adapt this strategy to maintain price stability without sacrificing growth. Integrating migrant workers into national savings frameworks would represent a pragmatic step toward inclusive and sustainable economic development.

CRedit authorship contribution statement

Jallynna Usun: Writing – original draft, Visualization, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Dzul Hadzwan Husaini:** Writing – review & editing, Validation, Supervision, Methodology, Formal analysis, Data curation, Conceptualization. **Shazali Abu Mansor:** Writing – review & editing, Supervision.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Data availability

Data will be made available on request.

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