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Assessing the size of shadow economic activity in Malaysia based on the modified money demand model approach with structural break

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ABSTRACT

This paper aims to address those methodological issues by exclusively applying the newest modification to the Money Demand Model (MDM) in the form of the autoregressive distributed lag (ARDL) approach to estimate the Malaysian shadow economy (SE) from 1985 to 2020. Methodological errors and spurious regression issues hindered earlier studies on the Malaysian SE. Some studies included Malaysia in their analyses alongside other Asian countries with similar levels of development, without accounting for the distinct economic environments of these countries. This study accounts for the influence of economic uncertainty (EU) and structural breaks. The study finds that Malaysia's SE averaged 40.8% of its official gross domestic product (GDP), peaking in 1995–1996, after which it gradually declined and stabilized around 39.4% of GDP. This substantial size highlights the critical need for tailored economic policies to manage SE growth effectively. The findings not only provide a clearer understanding of the SE's trajectory but also emphasize the importance of addressing illicit activities, particularly in connection to public spending and corruption. Future research should prioritize examining these hidden activities to uncover how the shadow economy impedes Malaysia's progression toward becoming a developed nation and how informality affects broader economic progress.

Contribution/ Originality: This research addresses methodological flaws in assessing Malaysia's shadow economy, such as estimation errors and spurious regressions. By focusing solely on Malaysia and utilizing the updated Money Demand Model (MDM), incorporating economic uncertainty and structural breaks, it provides a clearer understanding of SE's trajectory and highlights the need for targeted policies.

1. INTRODUCTION

Economists widely recognized that shadow economic activities have taken a significant attention both in the literature and among policymakers (Berger, Pickhardt, Pitsoulis, Prinz, & Sardà, 2014; Din, 2016). Existing research

concerning emerging and less-developed countries has not extensively analyzed the shadow economy (SE). (Gerxhani, 2004; Hartati, Karim, & Bayu, 2015; Schneider, Buehn, & Montenegro, 2010). The existing literature on the SE has predominantly focused on transition economies, developing nations, and the more advanced countries in the world (Orsi, Raggi, & Turino, 2014; Schneider, 2011).

The economy of Malaysia has been the subject of numerous studies (see (Alm & Embaye, 2013; Eng & Wong, 2007; Habibullah & Eng, 2006; Kasipillai, Baldry, & Prasada Rao, 2000; Masron, Amir, & Ibrahim, 2011; Mohamed, 2012; Mohammad, 2004; Schneider et al., 2010; Schneider & Klinglmair, 2005; Suhaimi et al., 2016; Yusof Kasim & Jayasooria, 2001)). The studies share a common focus on the antecedent influences and underlying economic structure that contribute to the development of unofficial economic activities in the country. Even though earlier studies were important, they all had one or two problems: they used a certain econometric method that was known to have errors, the sample area was too small, and there were conducted based on certain activities in the economy. Additionally, some of these studies grouped the Malaysian economy within the study's sample alongside other economies of Asian developing countries at the same level of development. Therefore, methodological estimation errors and spurious regression problems plague these studies. For instance, Tan, Habibullah, and Yiew (2016) made a notable methodological mistake by reporting a negative coefficient for nominal income per capita, which is not appropriate for the model they used. The Money Demand Model (MDM) is an indirect way to look at money. It is important to show a statistically significant and positive coefficient for the measure variable, like the average income per person in nominal terms, and for the tax burden factor to give a good idea of size of the SE. A negative coefficient for nominal income per capita undermines its validity as a proxy for the Malaysian MDM, thus failing to provide a reliable estimate of the SE's true size (Gamal, Rambeli, Jalil, & Viswanathan, 2019; Hassan & Yu, 2010).

It is noted that authors in their evaluation of the Malaysian SE employed the normal MDM since the largest volume of the SE as reported after the mid of 1980 exhibited a variation ranging from 76% to 115% relative to the officially reported gross domestic product (GDP) (Tan et al., 2016). The volume in this case may be influenced by the assumption of equal money circulation rates in both economies. However, it is implausible that the scale of the SE in Malaysia surpassed the capacity of the recognized economy during that interval, which the writers identified as notably more significant compared to other years within the study timeframe (See for example, (Faal, 2003; Hassan & Yu, 2010; Tan et al., 2016)). This assertion could be applicable during periods of national conflict, as observed in less stable, less developed countries. On the other hand, a country lacking an effective documentation system for all economic activities could find this assertion acceptable. Furthermore, studies failed to account for exogenous shocks, such as fluctuations in the exchange rate, which can substantially influence the demand for local currency in terms of purchasing power deterioration.

Kasipillai et al. (2000) identified an inverse association between per capita GDP and its substantial influence on the Malaysian MDM, which was used as an indirect measure of the SE. They elucidated this inverse relationship by proposing that liquid cash, is regarded as a lesser-quality good. According to this interpretation, as income rises, individuals tend to reduce their demand for cash and instead invest in other asset types. However, this justification is more applicable during periods of hyperinflation. In the long term, it is not justifiable to ascribe this inverse connection to the idea that money is uniformly perceived as an inferior good in relation to GDP per capita, particularly when evaluating the extended performance of the Malaysian economy.

The studies failed to differentiate between the economic environment of Malaysia and other countries. Grouping these diverse countries into the same category has raised concerns about the accuracy of the assessed profile of the Malaysian SE. For instance, it is not appropriate to equate the economies of Japan and Malaysia in terms of size and development, nor is it reasonable to directly compare them with other Asian countries like Indonesia, Thailand, Singapore, the Philippines, and India. Such comparisons overlook the unique economic conditions and developmental stages of each country, leading to potentially misleading conclusions.

Research generally indicates that Malaysia, as a rapidly developing nation, is experiencing a significant increase in shadow economic activities. This could arise from inappropriate long-run economic policies that may enhance illegal activities. It might also be due to the misuse of power by the government officials and the changes in the labour market's policies. Such policies could lead business firms to conceal deliberately true income from the authorities by operating in the underground economic activities rather than the legal ones.[1]

There is a need to provide more detailed information on the characteristic and long run behaviour of the invisible economic activities in the Malaysian economy. This will allow us to quantify its overall magnitude in the endorsed economy. Assessing the scope of the Malaysian SE has been conducted applying different methodologies (see for instance, (Fethi, Fethi, & Katircioglu, 2006; Kasipillai et al., 2000; Schneider & Buehn, 2013)). But the most popular empirical methodology used as a means to estimate its scale indirectly in the country is the MDM approach. However, the approach is not without criticism (Gamal & Dahalan, 2015; Gamal & Dahalan, 2016; Gamal et al., 2019).

The MDM's methodology indicates that variations in key fiscal policy variables, through both tax and expenditure channels, are primary factors influencing individuals' decisions to engage in or withdraw from shadow economic activities. For instance, it assumes that the costly tax burden rate levied on the individuals, particularly with the intensive regulations, existence of bribery, and rampant corruption and inequality in imposing rational tax burden rate may become the main reasons for individuals to indulge in the shadow economic activities (Dell'Anno, 2016; Dreher & Schneider, 2010; Katsios, 2015). The MDM methodology suggests that the estimated elasticity coefficient of fiscal variables (such as taxation or expenditures) with respect to money demand can be used to gauge the amount of money individuals withhold and use for illegal transactions within the economy (Asaminew, 2010).

Earlier studies that employed the classical MDM to measure the SE in Malaysia relied on the presumption that the rapidity of money circulation is identical in both the formal and latent economies. This supposition, however, was flawed, leading to biased and inaccurate calculations of the Malaysian SE. Ahumada, Alvaredo, and Canavese (2009) and Ahumada, Alvaredo, and Canavese (2007) argued that this premise of equal rapidity of money circulation is valid only assuming the long-term responsiveness of money demand to changes in income levels is unity—a condition falls short of expectations in earlier research on Malaysia. As a result, the estimated outcomes were both inaccurate and unreliable. Similarly, the figures obtained may not fully capture the long-term performance of the official economy or accurately reflect the scope of activities within the Malaysian SE.

The motivation and novelty for focusing specifically on the estimation of the Malaysian SE stem from several key reasons. First, this study rectifies methodological inaccuracies and addresses issues related to spurious regression in earlier research that used cross-country data, often without accounting for economic differences between states (e.g., (Elgin & Oztunali, 2012; Schneider et al., 2010)). This study scrutinizes the distinct structural characteristics of the Malaysian economy and assesses the money demand-based space of the SE through a revised version of the MDM. By considering possible structural changes within the data, this approach overcomes the limitations of traditional MDM methods. Specifically, it considers that the elasticity coefficient of velocities for both shadow and official economies is different from the value of one, which corrects the accuracy of estimation process and obtains rational results.

Second, the study is valuable at the current time because the Malaysian government is looking for important fiscal reforms, particularly in changing the tax policy that is related to a higher money demand due to the recent effect of COVID-19 on the economy. This study connects the fiscal policy tool of taxation with the dynamics of monetary policy within the economy. The fiscal variable of taxation is employed and directly tied to money demand behavior,

[1] It is not solely illegal economic activities that can constitute the SE. While activities such as money laundering, smuggling, drug trafficking, human trafficking, sex work, capital flight, and illicit financial outflows are often associated with the SE, legal activities can also be included. For instance, a teacher who conducts private tutoring sessions outside of their official duties could augment the SE if the income generated from these activities is undisclosed to tax authorities (Greenidge, Holder, & Mayers, 2009).

reflecting various sources of taxation within Malaysia's economy. The indicator of the overall tax burden tracks individuals' increased demand for money, thereby gauging their participation in shadow economic activities. Third, in Malaysia, tax evasion is widespread, occurring both within the shadow economy and through formal economic activities (Mohamad, Zakaria, & Hamid, 2016). As people engage in shadow activities to avoid paying taxes, this trend can gradually undermine the tax base by diminishing the overall revenue collected by the government (Din, 2016; Gamal et al., 2019). As a result, this study considers all tax revenue sources as a single bundle to comprehensively capture the dynamic macroeconomic effects of taxation on the MDM in the country.

Fourth, failing to accurately quantify the SE as a substantial part of the formal economy can undermine the effectiveness of macroeconomic policy variables, economic growth, and strategic economic planning. This oversight may obscure the true scale of the SE, potentially resulting in misguided policy decisions (Gamal & Dahalan, 2015). Fifth, the growing of shadow economic activities, which typically operate without formal regulations, may encourage businesses seeking quicker profits to shift away from the formal economy, thereby posing competition to legitimate economic activities (Berger et al., 2014; Hernandez, 2009).

Indeed, individuals often engage in shadow economic activities because cash transactions are less traceable compared to other payment methods, allowing them to maximize their fiscal advantages (Gamal & Dahalan, 2015). Additionally, the hard money is considered the common factor for the payment of the whole economic activities, while a part of those activities may become unreported to the authorities or end up with illegal transactions (Alexandru, 2013). Because of the lack of full information on the Malaysian usage of money, and the limitations of the previous studies, misleading and inaccurate conclusions on the true magnitude of the Malaysian SE may result. It is currently essential to assess its overall scale for the period from 1985 to 2020 by employing the most recent revised version of the MDM approach, as developed by Ahumada et al. (2009). This could also assist the Malaysian government in gaining a clearer understanding of illegal economic activities, allowing it to revise its policies to curtail their growth. The study evaluates stationarity by applying unit root tests introduced by Zivot and Andrews (1992) and Perron (1997) which incorporate a single structural break, to perform stationarity analysis. To study the long-term cointegrating link between the Malaysian MDM and its causes, the Gregory and Hansen (1996) cointegration assessment, which accounts for structural changes, is utilized. The study checks if there a long-term cointegrating relationship between the factors in the estimation from by looking at how stable the residuals are at their current levels. Additionally, the Hansen (1992) test is used to examine parameter instability within the cointegration relationship. The autoregressive distributed lag (ARDL) bounds testing methodology, as introduced by Pesaran, Shin, and Smith (2001) is applied using the revised MDM model, including a structural break variable, to capture the long-term estimates of the SE. The study examines the behavior of the macroeconomic fiscal policy variable, particularly in relation to overall taxation, to accurately assess the extent of informal sector acts in Malaysia.[2] There is a lot of empirical research on the MDM as an indirect way to figure out how big the SE is through country-specific studies. However, no one has looked at how the EU's behavior affects the MDM model in Malaysia while taking structural breaks into account when figuring out how big the SE is. Consequently, since previous research has not included structural breaks and EU in their regression analyses of the MDM, this study is pioneering in integrating the impact of EU and its interaction with the MDM when assessing the extent of the Malaysian SE, considering the occurrence of a structural break. The EU variable is recognized as a potential determinant that can influence individuals' current and future decisions to adjust their money demand (Bahmani-Oskooee & Xi, 2014). This policy may redirect this change in money demand towards legal and illegal transactions. The EU variable may represent the long-term economic policy fluctuations in Malaysia, which could decrease trust in local currency and increase investment risks for businesses, possibly leading them to evade additional taxes when they perceive these costs as burdensome and

[2] Some studies use only a single type of taxation to represent fiscal pressure influencing changes in money demand within an economy. This approach may result in biased and uncertain estimates.

non-beneficial. For instance, Bahmani-Oskooee, Kutan, and Xi (2013) using quarterly data from 1991 to 2010, estimated the function of money demand in Malaysia by including economic and monetary uncertainty variables alongside traditional determinants, without considering the effect of potential structural breaks or the effect of EU on the behavior of the MDM throughout the study period. Within the framework of economic uncertainty and instability, individuals may turn to shadow economic activities to counteract the loss of purchasing power and avoid additional tax burdens (Duong, Gul, Nguyen, & Nguyen, 2017). This behavior may also lead to increased reliance on foreign currency rather than the local currency, exacerbating the government's fiscal deficit. This study incorporates the Malaysian EU variable to account for unexpected economic shocks and changes that occurred in Malaysia during the study period. These shocks and changes, resulting from economic and financial reforms as well as other domestic and external fluctuations, exert a substantial influence on money demand in Malaysia, which may end up in the SE sector.[3]

Building on the work of Bahmani-Oskooee et al. (2013) the EU variable significantly influences the overall demand for money.[4] The EU variable is constructed as a measure of Malaysian economic volatility using the generalized autoregressive conditional heteroskedasticity (GARCH) model (Gan, Lim, bin Mohd Hussin, & bin Muhammad, 2015). Following the procedures outlined by Umar and Dahalan (2016) and Gamal et al. (2019). The Toda and Yamamoto (1995) dynamic Granger causation assessment procedure is used to investigate the fundamental relationship between the Malaysian SE and aggregate tax yields, which act as a measure of the tax load. The remainder of this paper is ordered as follows: Section 2 provides a precise appraisal of the research on the Malaysian SE, emphasizing the limitations of previous research, key theoretical considerations, and principal hypotheses. Section 3 describes the data sources and methodology utilized in the study. Section 4 presents the practical results obtained and the rigorous diagnostic tests conducted. Finally, Section 5 summarizes the paper and discusses the inferences of the findings.

2. SUMMARY OF LITERATURE, LIMITIATIONS, THEORETICAL CONSIDERATIONS AND HYPOTHESES

Table 1 offers a summary of the current literature on the SE and estimates its magnitude in Malaysia, covering studies conducted before and during the research period. These studies have employed various methods, focusing on specific states or illegal activities using survey data in particular sectors (e.g., (Alm & Embaye, 2013; Berger et al., 2014; Din, 2016; Elgin & Oztunali, 2012; Eng & Wong, 2007; Gamal et al., 2019; Kasipillai et al., 2000; Mohamed, 2012; Suhaimi et al., 2016)). Nevertheless, many of these studies have encountered methodological issues. For example, some research included Malaysia in a broader sample of Asian countries without considering differences in economic environments, economic scale, and development levels. While these studies contribute to the discourse on the topic, their estimates remain debatable. Consequently, this paper seeks to specifically assess the scope of the Malaysian SE by applying the most recent modifications of the MDM, which takes into account economic uncertainty and structural breaks from 1985 to 2020.

[3]For instance, Din (2016) noted that the Malaysian economy has encountered numerous economic shocks during the study period, compelling policymakers to revise their strategies by implementing new policies through economic and financial reforms.

[4]Concerns about the current and future performance of the Malaysian economy, driven by the recent decline in the Malaysian Ringgit, may prompt individuals to safeguard their wealth by investing in real estate or other less risky assets. These conditions can subsequently affect their demand for cash, either increasing or decreasing it.

Table 1. A review of estimates of the Malaysian SE employing different methodologies.

No.	Writers	Duration	Applied method	Assessment profile (Average)
Research overall economy				
1.	Din (2016)[A]	1971-2013	MCDR	Displayed a reversed U-shaped form
2.	Gamal et al. (2019)[A]	1072-2012	TMDM	Had an average value of 42.53% of GDP
3.	Kasipillai et al. (2000)[A]	1971-1994	Tanzi-type model in the form of TMDM	Had an average value of 7.05% of GNP
4.	Mohamed (2012)[A]	1980-2009	Tax proportion and illicit prosecution statistics	Varied between 9% and 27% of GDP
5.	Tan et al. (2016)[A]	1972-2012	Tanzi-type model in the form of TMDM	Varied between 20% and 115% of GDP
6.	Eng and Wong (2007)[A]	1970-2005	TMDM	Varied between 27% and 48% of GDP
7.	Alm and Embaye (2013)[B]	1984-2006	TMDM	Had an average value of 30.4% of GDP
8.	Hassan and Schneider (2016)[B]	1999-2013	MIMIC	Had an average value of 35.3% of GDP
9.	Medina and Schneider (2017) and Medina and Schneider (2018)[B]	1991-2015	MIMIC	Had an average value of 31.5% of GDP
10.	Schneider (2004)[B]	1999-2003	MIMIC	Had an average value of 32.7% of GDP
11.	Schneider and Klinglmair (2005)[B]	1999-2000	MIMIC	Had an average value of 31.1% of GDP
12.	Schneider et al. (2010)[B]	1999-2007	MIMIC	Had an average value of 31.9% of GDP
13.	Tan et al. (2016)[B]	1975-2012	PMG estimation based on the TMDM model	Had an average value of 17% of GDP
Research focused on specific sectors, regional levels, or illicit activities				
14.	Mohammad (2004)[C]	2002	Study of the facilities sector	Had an average value of 4.2% of GDP
15.	Baharudin, Othman, Pah, Chellamuthu, and Musa (2011)[C]	2004-2006	Study-illegal employment- enterprise's sector	Had an average value of 13% of GDP
16.	Yap, Sarmidi, Nor, and Said (2017)[C]	2006-2013	MIMIC in the form of a state level study	Had an average value of 25.61% of GDP
17.	Elgin and Oztunali (2012)[C]	1955-2008	Two-sector dynamic general equilibrium form	Had an average value of 47.4% of GDP

Note: A indicates that the study was conducted independently; B signifies that the country was included in a study along with other countries; C denotes that the study was focused on specific sectors, regional levels, or illicit activities.
Source: Gamal et al. (2019).

While previous studies have made commendable efforts in assessing the SE in Malaysia, they were not without limitations. One significant issue is the reliance on the conventional MDM, which presumes a uniform rapidity of money circulation in both the indorsed and unregistered one. This study, however, challenges this supposition by proposing that the velocity of money differ between these two sectors. Moreover, past research often overlooked the unique structural conditions and external factors affecting the Malaysian economy during their study periods. This study currently addresses this deficit by incorporating a structural break indicator into the model, which accounts for these variances. Previous studies failed to address the impact of external factors and economic uncertainty on Malaysia's monetary aggregate demand, particularly during times of economic crises. This oversight introduces bias and undermines the credibility of their conclusions, ultimately affecting the assessment of the shadow economy. In contrast, our research remedies this limitation by incorporating an uncertainty indicator into the Malaysian Money Demand Model (MDM), enabling a more accurate estimation of the country's shadow economy. Additionally, many previous studies focused only on specific fiscal components of taxation, leading to biased and inaccurate estimates of the SE. In contrast, this study considers the entire range of aggregate tax revenues to examine how fluctuations in tax revenues impact the scope of the SE in Malaysia. This comprehensive approach aims to better understand the effects of tax changes on individuals' cash demand. Prior research also reported implausible ratios of the Malaysian SE to its official economy, likely due to errors in statistical analysis. This deficiency necessitates a re-evaluation of the SE size in Malaysia using an advanced time-series data-based modified MDM. Many earlier studies, using the Multiple Indicators Multiple Causes (MIMIC) framework, reported similar profiles for the SE, despite differences in time periods and methodologies, which is deemed unlikely. Therefore, the current study aims to accurately quantify the Malaysian SE over an extended period, enhancing the precision of annual estimates.

The theoretical literature on the MDM approach generally supports a positive correlation between tax revenues and the demand for cash. This suggests that increased tax burdens incentivize entities to be involved in tax elusion practices via illicit economic operations (Dell'Anno & Halicioglu, 2010; Gamal et al., 2019). Asaminew (2010) posits that researchers can discern the extent of paper currency's use in hidden transactions within an economy by assessing the tax responsiveness of money demand. Furthermore, taxation, as a financial variable, is highly responsive to conditions that drive individuals toward participating in the shadow economy, mainly because of the substantial charges associated with tax avoidance (Makochekanwa, 2012).

The association between GDP, reflecting the swift economic expansion in Malaysia, and the demand for cash is generally assumed to be positive (Macias & Cazzavillan, 2009). This is because GDP in nominal terms often captures increased economic activities, including new investments, which tend to raise the demand for money (Asaminew, 2010). In the economies of developing nations, a substantial amount of new investment frequently takes place within the informal or shadow economy (Dabla-Norris, Gradstein, & Inchauste, 2008; Gamal et al., 2019). Consequently, GDP is a crucial variable in the model as it considerably affects the total demand for money across the economy.

The assumed relationship between the SE and money demand is typically positive. When faced with economic shocks or fluctuations, individuals tend to increase their demand for cash as they engage in shadow activities to avoid additional taxes and protect their purchasing power from inflationary pressures (Duong et al., 2017). By operating within the SE and utilizing cash transactions, they circumvent formal financial systems, thereby minimizing tax liabilities and reducing the impact of economic instability on their finances.

Previous research has consistently demonstrated that increased interest rates on savings accounts of deposits tend to decrease the demand for currency across various countries (e.g., (Gulzar, Junaid, & Haider, 2010; Schneider & Hametner, 2014; Tanzi, 1980, 1983; Yasmin & Rauf, 2004)). The interest rate on savings accounts of credits represents the cost associated with saving money rather than capitalizing it in alternative opportunities. Therefore, fluctuations in this rate can either encourage or discourage individuals from keeping cash on hand, directly impacting the overall demand for currency (Cagan, 1958).

Consistent with prior research, the model incorporates the interest rate on savings accounts because of its potential influence— whether positive or negative—on the Malaysian MDM model. Concerning inflation, its expected effect on money demand is negative. Within the context of the shadow economy, a higher inflation rate may prompt individuals to gravitate towards informal markets, where there is less competition from buyers in the formal market. This shift boosts the circulation of goods and services in informal sectors, thereby enlarging the SE in comparison to the recognized sector (Gamal et al., 2019).

Drawing from the conceptual linkages between the dependent variable (Malaysian MDM and its explanatory factors (such as revenue generated from indirect taxation, GDP, economic uncertainty, interest rates on savings accounts, and the inflation rate, which represents the rate at which the overall prices for goods and services increase, thereby diminishing the purchasing power of money), this study posits the subsequent null hypotheses proposed:

(1) Increases in indirect tax revenue do not contribute to the expansion of the SE in Malaysia.
(2) Accelerated economic growth, measured by GDP, does not drive the expansion of illicit economic operations in Malaysia.
(3) Greater economic uncertainty does not encourage choices made by individuals to participate in Malaysia's shadow economic practices.
(4) Lower interest rates on savings deposits do not affect individuals' choices to be involved in the SE in Malaysia.
(5) An elevated inflation rate in the Malaysian economy does not exert any influence on the proliferation of shadow economic activities.

3. METHODOLOGY

3.1. Data and Model Specification

The International Monetary Fund provided statistical data for the variables, while the Malaysian Ministry of Finance provided reports on Malaysian aggregate tax revenues. To estimate the Malaysian SE, the basic model is derived from the latest version of the Money Demand Model (MDM) as outlined by Macias and Cazzavillan (2009) which itself is derived from the research of Ahumada et al. (2007) and Ahumada et al. (2009) with certain modifications as follows:

$$M1_t = \alpha_0 TR_t^{\beta 1} G_t^{\beta 2} EU_t^{\beta 3} exp^{(\gamma_i h_t)} \quad (1)$$

Where $M1_t$ represents the total money supply, including circulated cash and bank deposits available on demand at time t, TR_t denotes Malaysian aggregate tax incomes at time t, G_t signifies the GDP at market prices (GDPMP) at time t, EU_t reflects Malaysian economic uncertainty at time t, h_t reflects the opportunity cost associated with maintaining paper currency, i_t is the interest rate applicable to deposits accounts over a specified period t, and π_t represents the inflation rate at period t, i.e. $h_t = (\gamma_1 i_t + \gamma_2 \pi_t)$. Taking the natural logarithm of setting both sides of expression (1) equal and replacing the value of h_t, it can be rewritten as follows with α_0 denotes the intercept, and ε_t represents the disturbance term.

$$lnM1_t = \alpha_0 + \beta_1 lnTR_t + \beta_2 lnG_t + \beta_3 \ln EU_t + \gamma_1 i_t + \gamma_2 \pi_t + \varepsilon_t \quad (2)$$

The anticipated influences of the coefficients for the explanatory factors are illustrated as follows:

$$\beta_1, \beta_2 \text{and} \beta_3 > 0, \gamma_1, \gamma_2 < 0$$

3.2. Analysis of Stationarity and Cointegration with Structural Breaks

Most macroeconomic variables exhibit unit roots or are non-stationary by nature (Bahmani-Oskooee & Fariditavana, 2016; Gujarati, 2009). The analysis commences with a stationarity assessment for all variables incorporated into the estimation equation. Conducting tests for unit root of these variables is a prerequisite for investigating cointegration relationships (Gregory & Hansen, 1996). In this study, tests for unit root were performed

using the procedures of Zivot and Andrews (1992) and Perron (1997) each applied in their respective models. These tests were conducted separately to provide robust insights into the characteristics of the variables within the MDM model.

The paper utilizes the residual-based technique constructed by Gregory and Hansen (1996) where the null hypothesis, which assumes no cointegration, is evaluated in contrast to the alternative hypothesis that suggests cointegration with the incidence of a one-structural break, to assess the long-term association between the Malaysian MDM and its factors (Kumar, Webber, & Fargher, 2013). Based on Equation 2, the following three extended models are used to investigate the cointegrating relationship among all underlying factors entered into the Malaysian MDM:

Model 1: cointegration with a dummy variable for level shifts,

$$\ln M1_t = \mu_1 + \mu_2 DU_{tk} + \alpha_1 \ln(TR)_t + \alpha_2 \ln G_t + \alpha_3 \ln EU_t + \alpha_4 i_t + \alpha_5 \pi_t + \varepsilon_t \quad (3)$$

Model 2: cointegration with a dummy variable for level shifts and a trend component,

$$\ln M1_t = \mu_1 + \mu_2 DU_{tk} + \mu_1 t + \alpha_1 \ln(TR)_t + \alpha_2 \ln G_t + \alpha_3 \ln EU_t + \alpha_4 i_t + \alpha_5 \pi_t + \varepsilon_t \quad (4)$$

Model 3: cointegration with a regime shift dummy (full break), where both level and slope coefficients are altered,

$$\begin{aligned}\ln M1_t = {} & \mu_1 + \mu_2 DU_{tk} + \mu_1 t + \alpha_1 \ln(TR)_t + \alpha_{11} \ln(TR)_t DU_{tk} + \alpha_2 \ln G_t + \alpha_{22} \ln G_t DU_{tk} + \alpha_3 \ln EU_t \\ & + \alpha_{33} \ln EU_t DU_{tk} + \alpha_4 i_t + \alpha_{44} i_t DU_{tk} + \alpha_5 \pi_t + \alpha_{55} \pi_t DU_{tk} + \varepsilon_t \end{aligned} \quad (5)$$

The location of the unknown structural break is identified endogenously by determining the largest absolute mark of the augmented Dickey–Fuller (ADF) test statistic or by selecting the point that minimizes the t-statistic of the test relative to the critical values for cointegration, as reported by Gregory and Hansen (1996).[5] To validate the strength of the cointegration inference, the errors obtained from the chosen cointegrating form are verified for stationarity at the level, as endorsed by Engle and Granger (1987). Additionally, the Hansen (1992) procedure is employed to assess parameter instability in the coefficients of the cointegrating model.

3.3. Estimation of Long-Term and Short-Term Effects

The ARDL examination technique is applied to evaluate both the long-term and short-term estimates, with the MDM acting as a proxy for the indirect estimation of Malaysian SE, taking into account the structural break date. The Malaysian MDM frames the ARDL specification as follows:

$$\begin{aligned}\Delta \ln M1_t = {} & \beta_0 + DUM_j + \sum_{i=1}^{n} \beta_1 \Delta \ln M1_{t-j} + \sum_{i=0}^{n} \beta_2 \Delta \ln TR_{t-i} + \sum_{i=0}^{n} \beta_3 \Delta \ln G_{t-i} + \sum_{i=0}^{n} \beta_4 \Delta \ln EU_{t-i} \\ & + \sum_{i=0}^{n} \beta_5 \Delta i_{t-i} + \sum_{i=0}^{n} \beta_6 \Delta \pi_{t-i} + \delta_7 \ln TR_{t-1} + \delta_8 \ln G_{t-1} + \delta_9 \ln EU_{t-1} + \delta_{10} i_{t-1} + \delta_{11} \pi_{t-1} + e_t \end{aligned} \quad (6)$$

Where Δ denotes the first-transformation machinist while n indicates the lag command. $\Delta \ln M1_{t-j}$ captures variations in the lagged regress and variable. β_0 is the intercept component, and e_t is the innovation. While, DUM_j accounts for the effect of the structural break. The parameters δ_s specify the long-term, while β_3 represents the short-term dynamics of the ARDL system. Equation 6 estimates the short-term dynamic error correction from (ECF), as shown below:

[5] The Gregory and Hansen test is conducted using the RATS version 10 econometric software package.

$$\Delta \ln M1_t = \beta_0 + DUM_j + \sum_{i=1}^{n} \beta_1 \Delta \ln M1_{t-j} + \sum_{i=0}^{n} \beta_2 \Delta \ln TR_{t-i} + \sum_{i=0}^{n} \beta_3 \Delta \ln G_{t-i} + \sum_{i=0}^{n} \beta_4 \Delta \ln EU_{t-i}$$
$$+ \sum_{i=0}^{n} \beta_5 \Delta i_{t-i} + \sum_{i=0}^{n} \beta_6 \Delta \pi_{t-i} + \lambda ECF_{t-1} + u_t \quad (7)$$

In the dynamic *ECF* (e.g., Equation 7), the term with a one-period lag ECF_{t-1} corresponds to the errors attained from the long-term expression (e.g., Equation 6), while λ indicates the rate of amendment towards equilibrium. Lastly, the model underwent a series of diagnostic tests to assess its functionality and stability.

3.4. Assessing the Malaysian SE

The calculation of the Malaysian SE follows the methodology outlined by Gamal and Dahalan (2016). Using the MDM, we estimated the predicted ln*M1* with the fiscal variable $\ln \widehat{M}1_t^{WT}$ and *lnM1* excluding the fiscal variable $\ln \widehat{M}1_t^{WOT}$. The extent of the illicit money (IM1) was calculated by performing multiplication of lnM1 by the difference among the two; $\ln \widehat{M}1_t^{WT}$ and $\ln \widehat{M}1_t^{WOT}$. Legal money, denoted as *ln(LM1)*, is computed as the difference between the authentic value of *lnM1* and the estimated value of illicit paper currency, ln(IM1).

The ratio of income (GDP) to the actual amount of legal money expresses the income elasticity of money demand. The magnitude of the Malaysian SE is subsequently determined by carrying out the multiplication of the amount of illicit paper cash by the rapidity of money circulation.

In this paper, the calculation of the SE should be adjusted according to the method proposed by Ahumada et al. (2007) and Ahumada et al. (2009) as illustrated by the following conditional form:[6]

$$SE_t / LegGDP_t = \left(IC_t / LC_t\right)^{1/\beta} = \left(SE_t / LegGDP_t\right)^{1/\beta} \quad (8)$$

3.5. Toda and Yamamoto (1995) Causality Test

The causality procedure of Toda and Yamamoto (1995) is hired to examine the causal association between the Malaysian *SE* and Malaysian aggregate tax incomes. The TY approach offers the benefit of not necessitating previous expertise of the cointegration characteristics of a certain expression (Zapata & Rambaldi, 1997). It maintains a typical asymptotic χ^2 distribution and facilitates the standard procedure for selecting lags, even in the absence of cointegration or when the conditions for stability and rank are not met, given that the order of integration remains within the specified lag limits of the system (Toda & Yamamoto, 1995). Additionally, this method allows for the estimation of vector autoregressions (VARs) using data at its original levels, facilitating the testing of general constraints regardless of whether the processes are integrated or cointegrated of any order (Toda & Yamamoto, 1995).

The procedure uses an adapted Wald (*WALD*) test to impose restrictions on the parameters of the *VAR* expression with lag length *k*. This test adheres to an asymptotic χ^2 distribution once estimating a *VAR* system with $k+d_{max}$ lags, while d_{max} represents the highest suspected command of integration within the system. Our analysis presents the causality assessment equations between the Malaysian *SE* and Malaysian *TR* in the following way:

$$\ln MSE_t = \alpha + \sum_{i=1}^{k+d} \beta_i \ln MSE_{t-i} + \sum_{i=1}^{k+d} \gamma_i \ln TR_{t-j} + u_{MSEi} \quad (9)$$

$$\ln TR_t = \alpha + \sum_{i=1}^{k+d} \theta_i \ln TR_{t-i} + \sum_{i=1}^{k+d} \delta_j \ln MSE_{t-j} + u_{TRi} \quad (10)$$

[6]Equation 8 adjusts our calculation of the Malaysian SE when the income elasticity coefficient deviates from one, which is the expected scenario in this study.

From form 9, $lnTR_t$ causes $lnMSE_t$, if H_o is rejected, indicating a causal relationship. Similarly, from Equation 10, $lnMSE_t$ causes $lnTR_t$ if H_o is rejected. It is crucial to emphasize that the validity of the causality findings depends on the robustness of the inferences and the stability of the estimated VAR specification. Accordingly, diagnostic procedures for the estimated VAR form, along with the stability of the VAR roots, will be presented.

4. EMPIRICAL RESULTS

4.1. Outcomes of the Stationarity Analysis and Cointegration Assessment

The assessment of stationarity for the underlying variables is conducted using the Zivot and Andrews (1992) test and Perron's unit root test, both of which accommodate a single structural break data, to create the order of integration for all pertinent factors. The results of the Zivot-Andrews stationarity procedure for both levels and first differences, with the extreme order specified as k=1 according to the Schwert (1989) are displayed in Table 2.

Table 2. Outcomes of the Zivot-Andrews unit root test for levels and first differences.

Variable	$t_{\hat{a}}$	*t-crit.*	I(*d*)	TB	Model	$t_{\hat{a}}$	*t-crit.*	I(*d*)	TB	Model
Ln(M1)	-4.60**	4.93	I(0)	1995	A	-7.04**	4.93	I(1)	1992	A
Ln(GDP)	-3.11**	4.42	I(0)	1999	B	-5.51**	5.08	I(1)	2009	B
Ln(TR)	-3.93**	4.93	I(0)	1993	A	-4.64**	4.42	I(1)	1991	A
(I)	-4.25**	4.93	I(0)	1999	A	-5.67**	4.93	I(1)	1999	A
(π)	-4.08**	4.42	I(0)	1994	B	-7.24**	4.42	I(1)	1989	B
Ln(Uncer)	-4.01**	5.08	I(0)	1998	C	-5.45**	5.08	I(1)	2000	C

Note: 1. ** signify significance at the 5% levels, respectively. 2. A, B, and C correspond to changes in the constant, changes in the trend alone, and changes in both the constant and the trend, respectively.

The outcomes demonstrate that all checked factors under examination are non-stationary at the level I(0), with differing time breakpoints observed at the 5% significance level. However, the variables attained stationarity following the application of their first differences, with distinct time breakpoints also observed at the 5% significance level. Perron's unit root examination further validated these stationarity findings.

With the determined order established as k=1 based on the Schwert (1989) Table 3 displays the results of Perron's unit root test for both levels and first differences. The results show that all examined variables are non-stationary at their level I(0), with different time breakpoints at the 5% significance level, except for the inflation rate, which was non-stationary at the 1% significance level. However, the variables are integrated of order one, I(1), at the 5% significance level, with the exception of GDP, which was identified as stationary at the 10% significance level.

Table 3. Outcomes of the perron unit root test for levels and first differences.

Variable	$t_{\hat{a}}$	t-crit.	I(d)	TB	Model	$t_{\hat{a}}$	t-crit.	I(d)	TB	Model
Ln(M1)	-4.19**	-5.59	I(0)	1993	C	-9.51**	-5.59	I(1)	1990	C
Ln(GDP)	-4.05**	-5.59	I(0)	1995	C	-5.50*	-5.23	I(1)	1998	C
Ln(TR)	-4.59**	-5.59	I(0)	1990	C	-5.74**	-5.59	I(1)	1987	C
(I)	-4.36**	-5.59	I(0)	1998	C	-6.26**	-5.59	I(1)	1987	C
(π)	-5.34***	-5.45	I(0)	1985	B	-10.55**	-5.59	I(1)	1993	C
Ln(Uncer)	-3.29**	-5.23	I(0)	1997	A	-15.95**	-4.83	I(1)	2009	C

Note: 1. ***, **, and * indicate significance levels at 1%, 5%, and 10%, respectively. **2**. A, B, and C refer to variations in the constant, variations in both the constant and trend, and variations in the trend alone, respectively.

Table 4 details the experimental findings of the Gregory-Hansen cointegration test procedure. It indicates that Model 1 is the most suitable choice. In precise terms, the ADF test shows a t-statistic of -5.13, which is significant at the 5% level for the dummy level shift model (Model 1).

Consequently, the insignificant hypothesis of no cointegration in Gregory-Hansen Model 1, which incorporates a structural breakpoint in MDM form, is refused. Thus, the Malaysian MDM in GH-1, as specified in Equation 3, is verified to exhibit cointegration. This finding also indicates a structural breakpoint in 1994.[7]

Table 4. Outcomes from the Gregory-Hansen cointegration test.

Model classification	*SB*	*ADF-stat.*	*t*-crit.	Refuse of H_0
GH-1(Eq.3)	1994	-5.13(1)**	-4.92	Yes.

Note: 1. ** indicates significance at the 5% level. 2. The figure in parentheses following the statistics indicates the ideal lag length chosen automatically by the Akaike information measure (AIM) (1979).

To confirm the existence of a long-term cointegration link between Malaysian MDM and its factors, the residuals from the Gregory-Hansen cointegrating form of Model 1 are verified for stationarity, specifically whether they follow an I(0) process. This procedure evaluates the null hypothesis that the residuals contain a unit root, contrary to the alternative that they are statistically stationary. Table 5 presents the results.

Table 5. Results of the residuals test based on the cointegrating Gregory-Hansen model 1.

Checked item	ADF-stat.	t-crit.5%	PV	Conclusion	*I(d)*
ε	-4.03**	-2.95	0.004	Refuse of H_0	Stationary I(0)

Note: 1. ** indicates significance at the 5% level. 2. The test is carried out with a constant alone, and the ideal lag length is determined according to the Akaike information measure (AIM) (1979).

The test results indicate that the errors within residuals component in the specified model remain stationary at the level, as the ADF test statistic (4.03 in absolute terms) surpasses the critical value of 2.95 at the 5% significance level. This finding supports the occurrence of a long-term relationship amongst the variables under examination. Given the cointegration of the stated variables over time, this study employs Hansen (1992) test to jointly assess the constancy of the long-term elasticities for the cointegration relationship within the MDM in Malaysia. Hansen (1992) argued that a joint significance test provides a more reliable indication of parameter stability compared to individual tests. A smaller number of significant test statistics for individual parameter instability may arise when there are a higher number of degrees of freedom, *m*. Hansen (1992) test facilitates a comprehensive assessment of the insignificant hypothesis, which posits that the cointegrating coefficients are stable, in contrast to the alternative hypothesis suggesting that the coefficients are unstable. Table 6 displays the result of Hansen's stability test. The joint test statistic of 1.84 with seven degrees of freedom ($m+1$) exceeds the critical value of 1.69 and is statistically significant at the 10% threshold. However, the p-value of 0.06 is greater than the 0.05 threshold, rendering the finding statistically insignificant and indicating that the insignificant proposition of stability cannot be refused. Thus, the parameters in the long-term cointegrating form of the Malaysian MDM are stable.

[7]The break date of 1994 attributes the higher consumer price index of the Malaysian economy that has suddenly increased due to the demand pressures that the economy has been subjected to compared to previous periods (Ministry of Finance, 1994).

Table 6. Joint stability test result.

Model classification	L_c_*Stat.*	*PV*	Conclusion
GH-1(Eq.3)	1.84	0.06	Consistency of estimated parameters

Note: 1. The Gregory-Hansen model 1 was tested to examine the variables, as represented in Equation 3.
Source: Hansen (1992).

4.2. Long Run and Short Run Estimates

To estimate the long-term and short-term effects in the Malaysian MDM, the ARDL model was employed. Table 7 provides the estimated outcomes derived from the ARDL model. The findings demonstrate that most explanatory factors, including the dummy variable for structural breaks, significantly affect the Malaysian MDM model. However, the interest rate variable is statistically insignificant at all significance levels. The results generally align with economic theory, with variables such as the Gross Domestic Product at market prices, Malaysian aggregate tax revenues, and the dummy variable showing statistical significance at the 5% confidence level. Additionally, both the inflation variable and economic uncertainty are significant at the 10% level of confidence. The findings reveal that the coefficient for the dummy variable representing structural time breaks indicates a 17% decline in money demand, on average, for each 1-point change in time. An increase of 1% in income level corresponds to a 0.64% rise in the demand for money. Likewise, a 1% rise in the tax burden drives a 0.81% increase in money demand. Furthermore, the findings indicate that for each 1-point increase in the inflation rate, the money demand declines by 9%.

The results show that the coefficient for economic uncertainty is highly elastic (2.92 > 1) and statistically significant. This suggests that a 1-point rise in the economic uncertainty index is associated with a 2.92% reduction in the demand for money. Increased negative expectations about future economic performance lead to a reduction in the demand for cash as investors shift their preference from holding local cash to saving in financial assets or overseas currencies, such as the US Dollar. Furthermore, the shadow sector may use some of the cash for illicit transactions instead of official ones. This behavior reflects investors' efforts to alleviate the hazards accompanying uncertain economic conditions by holding their assets in safer, lower-risk financial forms.

The familiar R-squared value demonstrates that approximately 32% of the aberration in the Malaysian MDM can be clarified by the identified explanatory factors. Additionally, the negative and statistically significant *ECF* coefficient at the 5% level specifies that 0.73% of the instability is revised in the current period based on the data behaviour from the previous period.

Table 7. ARDL estimates of both long-term and short-term effects.

Panel A: Estimates of long-term coefficients						
Cons	***Dum1994***	**Ln(G)**	**Ln(TR)**	**(I)**	**(π)**	***Ln(EUncer)***
-4.45	-0.17(-4.56)**	0.64(3.88)**	0.81(6.89)**	-.07(-1.01)	-0.9(-1.52)*	-2.92(-1.37)*
Panel B: Estimates of short-term coefficients						
Lag length						
Determinants		0	1		2	
ΔLn(M1)		0.29(1.33)				
ΔLn(G)					-0.38(-0.66)	
ΔLn(TR)			-0.05(-0.14)			
Δ (I))			-0.15(-0.15)			
Δ (π)					-0.57(-0.85)	
Δ*LnEUncer(-1)*		-15.78(-1.03)				
Intercept		0.05				
Dum1994		-0.58(-0.17)				
Panel C: Diagnostic statistics						
ECF(-1)		x^2_{SC} (1)	x^2_{ff}(1)	x^2_H(1)	x^2_N(2)	Adj_R^2
-0.73(-2.33)		0.24[0.63]	1.42[0.24]	0.01[0.92]	102.52[0.00]	0.32

Note: The figures enclosed in parentheses in Panels A and B denote the t-ratios. In panel C, x^2_N, x^2_H, x^2_{ff}, and x^2_{SC} represent the Lagrange multiplier statistics for assessing, normality, heteroskedasticity, functional form mis-specification, and residual correlation, respectively. These statistics adhere to a χ^2 distribution with degrees of freedom specified in parentheses and corresponding probability standards presented in brackets. At the 5% significance level, the χ^2 critical values are 3.84 for 1-degree of freedom and 5.99 for 2-degrees of freedom. The ARDL form is assessed with an extreme lag of 2, as determined by the Schwert (1989) measure.
** and * mean significance at the 5% and 10% levels, respectively. Dum1994 refers to the dummy variable representing the structural break.

The ECF formula satisfies all diagnostic procedures, with the exception of the normality test, thereby verifying the model's validity. Additionally, examining the stability of the Malaysian MDM can yield crucial insights into the efficacy of monetary policy. To achieve this, the CUSUM and CUSUMSQ tests, formulated by Brown, Durbin, and Evans (1975) were applied. Figures 1 and 2 illustrate the graphical representations of the CUSUM and CUSUMSQ statistics. These figures reveal deviations from their critical lines, indicating the presence of instability starting in early 1993. This period corresponds with a slowdown in the global economy, which constrained foreign direct investment inflows, continuing through to early 2007, when the global financial crisis began.

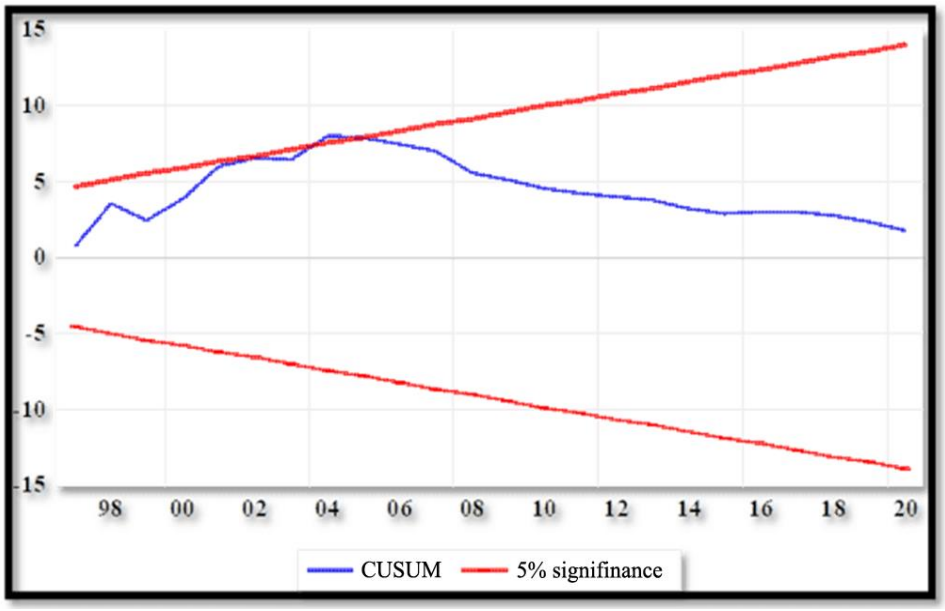

Figure 1. Graph of CUSUM statistics for the Malaysian MDM form.

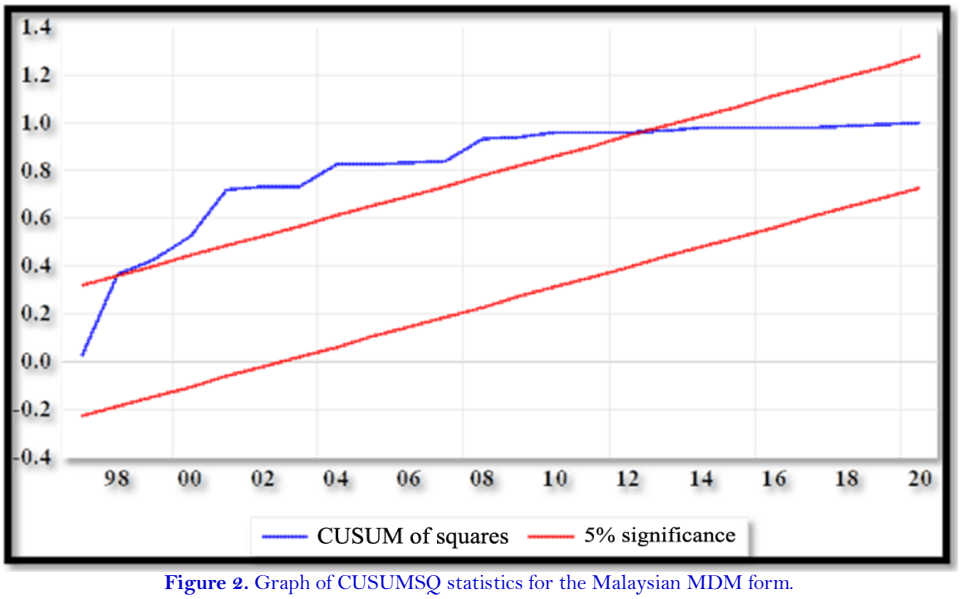

Figure 2. Graph of CUSUMSQ statistics for the Malaysian MDM form.

The instability in the Malaysian MDM is likely attributable to both internal and external shocks experienced during periods of economic hardship. Factors contributing to this instability include local and global inflation pressures, interest rate volatility, fluctuations in global oil prices, and variations in exchange rates affecting the local currency. These fluctuations may exacerbate the growth of underground economic activities. The results recommend that the pertinent authority should pay serious attention to managing the Malaysian currency during periods of unexpected instability, as implementing such policies could help stabilize the value of the national currency.

4.3. Malaysian Shadow Economy

Shadow economic activities are known to heavily rely on cash payments. Using the MDM approach, the long-run profile of the Malaysian SE is assessed through the ARDL technique, incorporating the uncertainty and structural change date attained from the Gregory-Hansen model (GH-1) as specified in Equation 3. Ahumada et al. (2009) introduced a conditional measure that adjusts the estimates. Figure 3 demonstrates a depiction of the outcomes.

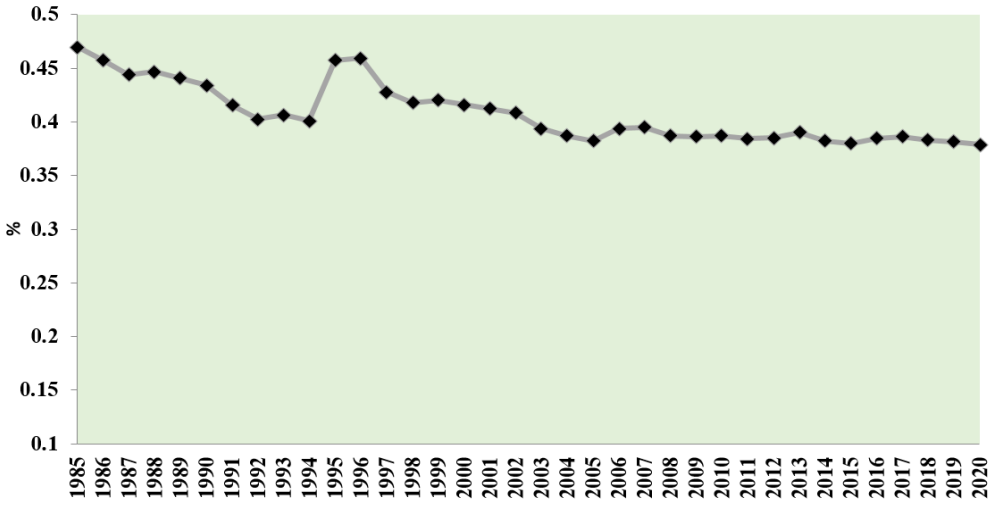

Figure 3. Long term estimates of Malaysian SE: 1985-2020.

The findings provide that the esteemed profile of the Malaysian SE increased from approximately Malaysian Ringgit 46.685 billion (USD 2.145 billion) in 1985 to MYR 488 billion (USD 113.5 billion) in 2020. As a rate of the official GDP, the extent of the Malaysian SE averaged 40.8% throughout the assessment period of this study. It varied from 47% of GDP in 1985 to 37.9% of GDP in 2020. As seen in Figure 3, the peak of the valued magnitude of the SE in Malaysia occurred at the beginning of 1985 and during the Malaysian economic boom of 1995–1996. Subsequently, it gradually declined and stabilized at an average of around 39.4% of GDP.

The typical assessed profile of the Malaysian SE was smaller than the estimates informed by Gamal et al. (2019) and Elgin and Oztunali (2012) yet larger than those found by Din (2016), Schneider (2004), Kasipillai et al. (2000), Schneider and Klinglmair (2005), Schneider et al. (2010), Eng and Wong (2007) and Alm and Embaye (2013). Additionally, it exceeded the average sizes reported by Mohammad (2004) and Baharudin et al. (2011) for individual sectors. Variations in methodologies employed, the explanatory variables used, and the time periods covered in these studies may explain the differences in the estimated magnitude of the Malaysian SE.

Concerning for the existing corruption, the observed magnitude of the SE may mirror various forms of prohibited activities, including tax evasion, which could result from collusion between tax officials and taxpayers. According to the Tax Justice Network (2011) Malaysia ranks fourth amongst the ASEAN-5 economies, with total tax evasion amounting to USD 11.2 billion. This figure may indicate widespread financial fraud among business owners seeking quick profits while evading taxes through practices such as falsifying invoices. Additionally, the increasing prevalence of informal employment in the enterprise sector contributes to tax evasion, further fueling shadow economic activities. Illegal activities, including those conducted in night markets and involving money laundering, drug trafficking, and smuggling, also exacerbate tax evasion. Although Malaysia has made significant strides in improving transparency and governance, the huge magnitude of the illegal sector identified in this study raises concerns. Existing corruption could perpetuate this sizable informality, potentially impeding Malaysia's progress towards becoming a developed country. The profile of the SE reflects the concentration of capital among a certain class of decision-makers and the suboptimal use of economic resources. Ideally, these resources should be directed towards expanding investments and enhancing employment and the productive potential of the state's economy. The expansion of the SE may also indicate a failure of both the market and the administration to adequately deliver goods and services to the public. If

this failure continues, it could increase the budget deficit and result in the government's financial incapacity to meet its obligations to the nation. A significant shadow economy, coupled with a budget deficit, can limit the government's ability to diversify its revenue sources, potentially forcing it to rely on external public debt. This reliance could put the country in a precarious financial situation and increase its political dependency due to the prolonged burden of external debt. Addressing the negative effects of the SE is crucial and requires robust measures to curb its growth.

4.4. TY Dynamic Granger Causality Test Results

Before estimating a VAR model, the Toda and Yamamoto (TY) Granger causality procedure is essentially analyzing the stationarity of the examined variables included in the VAR equation and to sets the appropriate lag measurement order before estimating a VAR model[8]. The residuals from the estimated VAR model must also undergo diagnostic tests for normality, heteroskedasticity, autocorrelation, and VAR stability. These tests are distributed as Chi-squared statistics with varying degrees of freedom. As shown in Panel A of Table 8, the Jarque-Bera test for assessing residual normality within the VAR framework, carried out with 4 degrees of freedom, yielded a test statistic value of 11.40, which is less than the critical value of 13.28. This outcome does not achieve statistical significance at the 1% level, leading to the inference that the residuals of the assessed VAR equation follow a normal distribution.

The joint test for heteroskedasticity in the VAR residuals, which yielded a value of 50.5 with 36 degrees of freedom, is below the critical value of 53.28 and does not achieve statistical significance at the 5% level. This result suggests that there is no indication of heteroskedasticity in the estimated VAR framework specification.

The LM autocorrelation statistic of 4.4 with 4 degrees of freedom is below the critical value of 9.49 at the 5% significance level. Therefore, the null hypothesis of no serial correlation in the VAR residuals cannot be refused, suggesting that the residuals from the valued VAR form do not exhibit serial correlation. Table 8 presents the validation results for the estimated VAR specification.

Table 8. Diagnostic tests of assessed VAR specification.

Panel A: Diagnostic tests	x^2_N (4)	x^2_H (36)	x^2_{SC} (4)	
	11.40[0.02]*	50.47[0.06]**	4.04[0.35]**	
Panel B: Roots of AR polynomial for VAR stability test				**Modulus**
	0.64 - 0.29			0.71
	0.64 - 0.29			0.71
	0.19 +0.64			0.67
	0.19 +0.64			0.67

Note: In panel Aa, x^2_N , x^2_H , and x^2_{SC} represent the Lagrange multiplier statistics for assessing, normality, heteroskedasticity, and residual correlation, respectively. These statistics adhere to a χ^2 distribution with degrees of freedom specified in parentheses and corresponding probability standards presented in brackets. At 1%, and 5% significance levels, the χ^2 critical values are 13.28 and 9.493.84 for 4-degrees of freedom, respectively. The critical value of χ^2 for 36 degrees of freedom at the 5% significance level is 53.28. * and ** mean the 1% and 5% significance levels, respectively. The ideal lag order for the VAR specification is specified according to the Akaike Information measure (AIM). The modulus being less than one indicates stability for the VAR.

Panel B of Table 8 reveals that the modulus values for all inverse roots of the characteristic autoregressive (AR) polynomial, considering two lags, are below one. This finding advocates that the valued VAR form specification is stable and valid for making causality decisions using the TY procedure, as the inverse roots of the estimated VAR specification lie within the limited circle. Figure 4 illustrates this conclusion.

[8] The ideal lag was set to be two according to the Akaike information measurement (AIM). Stationarity investigation for the examined variables, specifically the Malaysian SE and Malaysian aggregate tax revenues, confirmed that these variables exhibit integration of order one, I(1), at the 5% significance level. The detailed findings can be supplied upon demand.

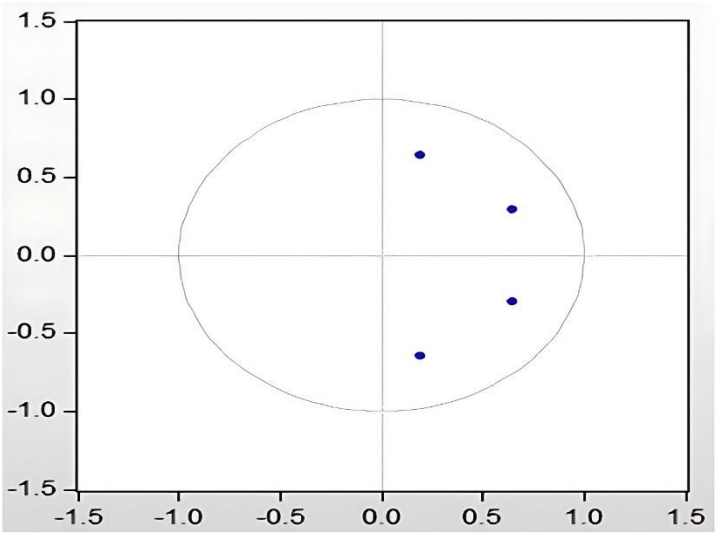

Figure 4. Inverse roots of the characteristic AR polynomial.

After getting the yearly estimates of the Malaysian SE from the MDM, the analysis does a causality test to see if there is a link between the estimated size of the Malaysian SE and the country's overall taxation. The outcomes of the TY Granger causality assessment verify that there is a causal link between the Malaysian SE and aggregate tax incomes, with causality flowing from aggregate tax revenues to the SE. Table 9 displays the outcomes of the test procedure.

Table 9. Outcomes of the TY causality procedure.

Proposition	*Wald-statistics*	*P-value*	Conclusion
TR does not have a causal impact on MSE	6.95	0.031	Causal relationship from *TR* to *MSE*
MSE does not have a causal impact on TR	0.376	0.828	No causal relationship from *MSE* to *TR*

Note: 1. The determination of the best lag figure is constructed on the Akaike information measure (AIM). 2. TR and MSE represent aggregate tax revenues and the Malaysian SE, respectively. MSE and TR refer to the Malaysian shadow economy and aggregate tax revenues, respectively.

The results indicate no causality from the Malaysian SE to Malaysian aggregate tax revenues, suggesting that the relationship runs from the development of aggregate tax revenues to the growth of the SE. This finding supports the argument that the heavy tax burden imposed on individuals can incentivize them to retain more cash and participate in illicit economic practices. The findings underscore the importance of a significant and challenging segment of the Malaysian SE, which should prompt the government to reassess its economic strategies to reduce the SE's current prominence and discourage illicit activities.

5. CONCLUSION

This study utilized the MDM to estimate the Malaysian SE from 1985 to 2020, incorporating structural breaks and the effects of economic uncertainty. It also considered Malaysian aggregate tax revenues a key fiscal policy variable that could influence shadow economic activities through changes in money demand. The analysis estimated that, on average, the Malaysian SE represented approximately 40.8% of official GDP, with the highest level observed during 1995–1996. Subsequently, the SE declined gradually and stabilized at around 39.4% of GDP. The TY causation procedure confirmed a causal association from Malaysian aggregate tax revenues to the SE. The findings suggest that increases in the tax burden imposed by policymakers contribute to the expansion of the SE, thereby weakening fiscal and monetary policies. This ongoing trend of illegal activities is likely to exacerbate the growth of the SE in Malaysia in the future. For the policy action, it can be said that the study inferences provide a valuable benchmark for the Malaysian government to reconsider and refine economic policies, particularly fiscal policies related to additional tax load and collection, to mitigate the current extent of the SE. Great emphasis should be placed

on monitoring financial fraud, often associated with the allocation of government contracts to private firms due to privatization policies. Implementing effective tax reforms could incentivize people to contribute to the formal economy and deter engagement in illegal activities, thereby reducing the size of the SE. Additionally, the findings underscore the need for the government to focus on stabilizing the use of the Malaysian currency amid unforeseen economic instability. The shadow economy represents a significant drain on a nation's wealth, diverting economic value to a select group of powerful individuals. The alignment of actual spending with planned expenditures directly influences the persistence of the shadow economy, posing a major obstacle to achieving sustainable development goals. Consequently, this study argues that the government needs to develop a comprehensive socio-economic model aimed at controlling illicit activities, which should also encompass security considerations. Lastly, this study suggests that future research should focus on examining the hidden and illicit activities within the shadow economy, particularly in relation to public expenditure allocations, given the prevalence of corruption in the country. Such an approach could provide crucial insights into how the shadow economy impedes Malaysia's progress towards joining the ranks of developed nations and the mechanisms through which informality operates within the economy.

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