Journal of Contemporary Macroeconomic Issue **https://doi.org/10.36923/jcmi.v5i1.569**
Vol. 5(1). PP: 16-47

Unmasking the Dynamics: Drivers of the Shadow Economy in SAARC Countries

Abdul Saboor[1], Muhammad Ramzan Sheikh[2]

[1] Research Scholar, School of Economics, Bahauddin Zakariya University, Multan, Pakistan
[2] Professor of Economics, School of Economics, Bahauddin Zakariya University, Multan, Pakistan

Abstract

The study aims to investigate the determinants of the shadow economy in SAARC countries during the period from 1995 to 2021. The study uses three proxies for the shadow economy as dependent variables, which are the ratio of reserve to narrow money (Shadow-1), the ratio of narrow to broad money (Shadow-2), and the ratio of currency in circulation to broad money (Shadow-3), while trade, tax, unemployment, government final consumption expenditure (GFCE), governance index (GI), and economic freedom index (EFI) are used as independent variables. The study applies the second-generation panel unit root test and the method of moments-quantile regression (MM-QR) technique. The findings of the study are that, as theoretically expected, the independent variables, trade, tax, unemployment, and government final consumption expenditure (GFCE), have positive and significant coefficients, while the governance index (GI) and economic freedom index (EFI) have a negative and significant effect on the shadow economy in SAARC countries. The study suggests that economic freedom and governance quality should be improved, and government size, tax, and unemployment should be decreased to control the shadow economy in SAARC countries.

Keywords: Shadow economy, unemployment, tax, trade, governance, economic freedom, MM-QR analysis

Information:

Received: 1 Jan 2024

Revised: 12 April 2024

Accepted: 15 May 2024

Published: 14 June 2024

Corresponding author's email: ramzansheikh@bzu.edu.pk

Copyright: © 2024, The Authors

This article is distributed under the Creative Commons Attribution 4.0 International License (CC BY 4.0): https://creativecommons.org/licenses/by/4.0/

Cite this article as

Saboor, A., & Sheikh, M. R. (2024). Unmasking the dynamics: Drivers of the shadow economy in SAARC countries. *Journal of Contemporary Macroeconomic Issues*, 5(1), 16–47. https://doi.org/10.36923/jcmi.v5i1.569

1. Introduction

In the early 1970s, the shadow economy attracted considerable academic attention. Although extensive research has examined its measurement and determinants (Manolas et al., 2013), accurately estimating its size remains challenging because participants deliberately conceal their activities. Reliable information about its magnitude and evolution is, however, important for economic policy. In addition, an understanding of both recorded and unrecorded production is necessary to assess economic fluctuations, design effective reforms, and support long-term development. The size of the shadow economy also matters for evaluating tax evasion and designing appropriate regulatory responses (Medina & Schneider, 2018). Empirical research has subsequently expanded across different countries and regions (Schneider & Williams, 2013; Schneider, 2015). The terms informal economy, black economy, grey economy, hidden economy, and cash economy are sometimes used interchangeably; however, they do not always describe identical activities. The shadow economy generally involves otherwise productive market activities that escape official reporting for regulatory, monetary, or institutional reasons. These may include the avoidance of tax payments and social-security contributions, non-compliance with administrative requirements, or responses to corruption and weak institutions. Therefore, it is important to distinguish the shadow economy from criminal activities and unpaid household production when interpreting empirical estimates (Medina & Schneider, 2018).

The shadow economy poses substantial challenges for governance and economic development. Although unrecorded activities may generate income and employment, they can also distort competition, weaken tax collection, and reduce the effectiveness of public policy. Furthermore, informal employment may limit workers' access to legal protections and social insurance. In SAARC economies, these issues are especially relevant because institutions, labour-market conditions, and the capacity to enforce regulations vary considerably across countries. Therefore, identifying the factors associated with shadow-economy indicators can inform more targeted policies while recognising differences in national circumstances (Medina & Schneider, 2018).

The primary objective of this study is to investigate the determinants of the shadow economy in SAARC countries during 1995–2021. For contextual comparison, Figure 1 presents shadow-economy estimates reported by Medina and Schneider (2018) for 1991–2015: 33.59% of GDP in Bangladesh, 26.93% in Bhutan, 23.91% in India, 27.44% in Maldives, 37.50% in Nepal, 33.10% in Pakistan, and 45.58% in Sri Lanka. These published estimates provide regional background; however, they are conceptually distinct from the monetary ratios used as dependent variables in the present econometric analysis.

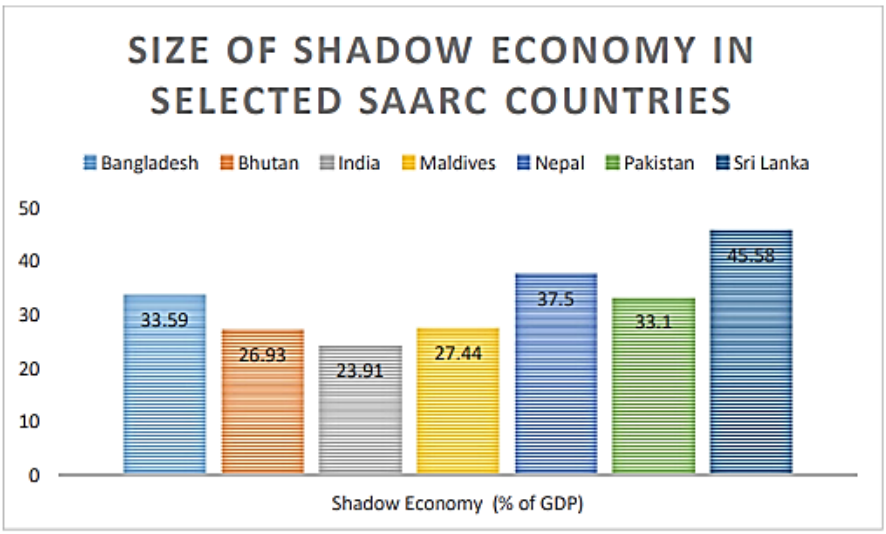


Figure 1: The Size of Shadow Economy in Selected SAARC Countries

Source: Medina and Schneider, 2018

The prevalence of unrecorded economic activity presents an important policy challenge for SAARC countries. To investigate the factors associated with its monetary indicators, this study analyses annual observations from 1995 to 2021 using the Method of Moments Quantile Regression (MMQR) approach. Moreover, the quantile framework permits the estimated associations to differ across the conditional distribution of each monetary proxy rather than restricting the interpretation to an average effect.

Investigating the determinants of shadow-economy indicators in SAARC countries is important because the region encompasses diverse institutional arrangements, labour markets, and levels of economic development. The South Asian Association for Regional Cooperation comprises Afghanistan, Bangladesh, Bhutan, India, Maldives, Nepal, Pakistan, and Sri Lanka; however, Afghanistan is excluded from the empirical sample because the required data are unavailable. Consequently, the analysis covers seven countries. For policymakers and researchers, the comparison provides insight into how tax revenue, employment conditions, government expenditure, governance, economic freedom, and trade are associated with the monetary indicators employed in this study.

The study contributes to understanding the structural and institutional conditions associated with the selected monetary indicators in SAARC economies. In particular, it considers trade, tax revenue, unemployment, government final consumption expenditure, governance, and economic freedom within a common panel framework. These factors have been discussed extensively in the literature on informality (Medina & Schneider, 2018; Khan et al., 2021). However, their associations with monetary ratios need not be identical to their effects on the actual size of unreported production. The results should therefore be interpreted as evidence on the proposed proxies, with implications for the shadow economy considered cautiously.

In addition, the study provides a basis for regional comparison by examining observations from seven SAARC economies. Institutional quality, economic structures, and monetary arrangements differ across these countries; therefore, a panel-based analysis can contribute to an understanding of common patterns while acknowledging heterogeneity. The MMQR results identify variation across quantiles of the dependent monetary indicators. However, these estimates alone do not establish a separate causal effect for each country, and country-specific conclusions would require further disaggregated analysis.

Furthermore, the findings contribute to the literature on the determinants of unrecorded activity in emerging and developing economies. Previous studies have applied currency-demand, multiple-indicators multiple-causes (MIMIC), and panel estimators to different regions (Goel & Nelson, 2016; Medina & Schneider, 2018; Khan et al., 2021). Building on this work, the present analysis uses three monetary ratios and MMQR to assess distributional heterogeneity in SAARC countries. The resulting evidence may be relevant to researchers and public institutions considering the interaction between monetary patterns, governance, and informality, provided that the limits of these indirect measures are recognised.

The purpose of this study is to investigate the determinants of the shadow economy in SAARC countries, using annual data for 1995–2021 and excluding Afghanistan because of data limitations. The analysis employs Method of Moments Quantile Regression (MMQR). Three monetary indicators serve as dependent variables: the ratio of reserve money to narrow money (Shadow-1), the ratio of narrow to broad money (Shadow-2), and the ratio of currency in circulation to broad money (Shadow-3). Explanatory variables comprise trade, tax revenue, unemployment, government final consumption expenditure (GFCE), governance index (GI), and economic freedom index (EFI). By estimating associations across different quantiles, the analysis extends the examination of these relationships beyond their conditional mean. Nevertheless, the three ratios are indicators rather than validated direct estimates of shadow-economy output.

The remainder of the study is structured as follows. Section 2 reviews relevant literature and identifies the research gap. Section 3 discusses the concept and determinants of the shadow economy. Section 4 describes the models, data, and empirical methods. Section 5 presents and

interprets the econometric results. Section 6 discusses the conclusions and policy recommendations, while Section 7 identifies directions for future research.

2. Literature Review

This section reviews empirical evidence on the determinants of the shadow economy, with particular attention to institutional quality, taxation, unemployment, public expenditure, and trade. In addition, it considers the methods and country samples used in earlier research to clarify the contribution and limitations of the present analysis.

Manolas et al. (2013) examined the causes of the shadow economy (SE) in 19 OECD countries, utilizing panel data from 2003 to 2008. They employed the panel estimated generalized least squares (EGLS) methodology, considering shadow economy as the dependent variable. Independent variables included control of corruption, deregulations of the credit and labor markets, regulation of product market, government efficiency, and tax burden. The findings indicated adverse relationships between control of corruption, government efficiency, labor and credit market deregulations, and product market regulation with the SE. However, tax burden was directly linked to the SE in these economies.

Remeikiene et al. (2014) investigated the causes of the SE in Greece, employing time series data from 2005 to 2013. Their study utilized correlation and multiple regression analyses, treating shadow economy as the dependent variable. Independent variables included domestic credit, tax rate, payment of tax, total labor force, unemployment rate, and GDP. The study revealed negative impacts of domestic credit, tax payment, and GDP per capita on the SE, while tax rate, unemployment rate, and total labor force positively affected the SE in Greece. The study suggested a deeper analysis of Greece's current tax structure.

Acosta-Gonzalez et al. (2014) conducted an empirical study on the causes of SE in 38 OECD economies, utilizing panel data from 1991 to 2007. Their research employed genetic algorithms and the SIC method. Shadow economy was the dependent variable, and independent variables included capital gains and corporate taxes, domestic credit, bank secrecy, globalization index, urban population, ethnic fractionalization index, corruption index, and socialist origin of state. The results indicated negative associations with taxes on capital gains, bank secrecy, globalization index, urban population, and ethnic fractionalization index, while corporate taxes, corruption index, and socialist origin of state positively affected the shadow economy.

Gaspareniene et al. (2016) investigated the influence of SE causes on Ukraine's economy using time series data from 2005 to 2012. Their study applied correlation and multiple regression analyses, treating shadow economy level as the dependent variable. Independent variables included imports of goods and services, GDP per capita, labor force, tax rate, and unemployment rate. The study found negative impacts of imports, GDP per capita, and labor force on the SE, while tax rate and unemployment rate positively affected the SE in Ukraine's economy.

Din (2016) probed the factors of the SE in Malaysia using time series data from 1971 to 2013. The study utilized modified cash deposits ratio (MCDR) and DOLS approaches, considering shadow economy as the dependent variable. Independent variables included government consumption, GDP per capita, domestic credit, personal income tax, and service tax. The findings showed negative relationships between government consumption, GDP per capita, service tax, and the SE. However, domestic credit and personal income tax positively affected the SE in Malaysia. The research suggested implementing programs to decrease the SE, improve credit market access, and reform the financial sector in Malaysia.

Goel and Nelson (2016) delved into the factors of SE in 133 economies using panel data from 2006 to 2015. Their study applied the currency demand approach and the MIMIC method. Shadow economy was the dependent variable, while independent variables included GDP, democracy, inflation rate, government size, start-up procedures, start-up time, start-up cost, registration procedures, registration time, and tax payment. The results indicated harmful relationships between GDP, democracy, government size, and tax total with the SE. Inflation rate, registration

time, start-up procedures, start-up time, registration procedures, start-up cost, and tax payment were directly linked to the SE.

Davidescu (2017) inquired into the causes of SE in Romania's economy, using data from 2000 to 2013. Their research applied the MIMIC technique, treating shadow economy as the dependent variable. Indicator variables included the index of real GDP and the currency ratio M1/M2, while causal variables comprised the rate of unemployment, self-employment, government employment rate, and real interest rate. The results indicated negative associations between the index of real GDP, currency ratio M1/M2, and real interest rate with the SE. However, the rate of unemployment and self-employment rate positively affected the shadow economy in Romania's economy.

Medina and Schneider (2018) investigated SE in 158 nations worldwide using panel data from 1991 to 2015. Their study applied the CDA approach and MIMIC methods, considering shadow economy as the dependent variable. Causal variables included unemployment rate, size of government, rule of law, control of corruption, fiscal freedom, and government stability. Indicator variables included currency, labor force participation rate, and GDP per capita growth. The study revealed positive impacts of unemployment rate and government size on the shadow economy. However, openness of trade, GDP per capita, fiscal freedoms, rule of law, control of corruption, government stability, labor force, and GDP per capita growth negatively affected the SE.

Berdiev and Saunoris (2018) analyzed the impact of globalization on the shadow economy in 119 countries using panel data from 2000 to 2007. Their study applied the MIMIC technique and the dynamic general equilibrium model, treating shadow economy as the dependent variable. Independent variables included economic globalization, political globalization, social globalization, GDP per capita, education, credit market regulations, labor market regulations, and government size. The study found negative associations with political globalization, social globalization, GDP per capita, and credit market regulations, while economic globalization, education, government size, and labor market regulations positively affected the shadow economy.

Mughal and Schneider (2018) investigated the interaction and size of the shadow economy with the official economy in Pakistan using time series data from 1973 to 2015. Their study applied Autoregressive Distributed Lag (ARDL), Engel Granger, and currency demand approaches, considering shadow economy as the dependent variable. Independent variables included tax to gross domestic product (GDP) ratio, unemployment rate, public administration and defense expenditure, public administration and defense expenditure per capita, GDP per capita, inflation rate, and household consumption per capita. The findings indicated adverse connections with GDP per capita but positive relationships with tax to GDP ratio, unemployment rate, public administration and defense expenditure, public administration and defense per capita, inflation rate, and household consumption per capita in Pakistan's economy.

Navickas et al. (2019) explored the determinants of the unofficial economy in Eastern European countries using panel data from 2003 to 2016. Their study applied the MIMIC method, considering shadow economy as the dependent variable. Independent variables included tax burden on income, unemployment rate, corruption, income inequality, self-employed individuals, business freedom, and tax burden on consumption. The results showed negative impacts of the tax burden on income and business freedom on the shadow economy. However, the unemployment rate, corruption, income inequality, self-employed individuals, and tax burden on consumption positively affected the shadow economy.

Angour and Nmili (2019) explored tax evasion and the shadow economy in Morocco's economy. They analyzed data from 1985 to 2016 using the MIMIC methodology. The study considered gross domestic product (GDP) per capita and money supply as indicator variables, while unemployment rate, inflation rate, urbanization rate, tax burden, openness rate, public spending index, and Agricole added value were treated as causal variables. The results indicated that GDP per capita, inflation rate, urbanization rate, openness rate, public spending index, and Agricole added value were inversely related to the shadow economy, whereas money supply, unemployment rate, and tax burden showed a direct association with the shadow economy in Morocco.

Lahlou et al. (2020), the formation and size of the shadow economy in Morocco were examined using time series data from 1988 to 2018. The study employed CDA and MIMIC methods, considering variables such as GDP per capita, agriculture value-added per capita, interbank interest rate, private credit, financial market access index, tax revenue, and unemployment rate. The findings revealed a negative correlation between interbank interest rate and financial market access index with the shadow economy, while per capita GDP, agriculture value-added per capita, tax revenue, private credit, and unemployment rate were positively associated with it.

Khan et al. (2021) investigated the role of shadow economy determinants in non-OIC and OIC countries using panel data from 1991 to 2015 and applying the GMM technique. Variables like GDP growth rate, money supply, government expenditure, GDP per capita, employment rate, tax, international trade, unemployment rate, political stability, regulation quality, rule of law, trade freedom, economic freedom, and business freedom were analyzed. The study found that GDP growth rate, money supply, employment rate, international trade, political stability, regulation quality, rule of law, economic freedom, and business freedom negatively impacted the shadow economy, whereas government expenditure, tax, unemployment rate, and trade freedom had a positive influence.

Elmirzaev and Elmurodov (2021) investigated factors contributing to the shadow economy in 35 Asian countries using data from 1991 to 2015 and employing panel regression analysis. Variables such as GDP per capita, inflation rate, trade openness, tax revenue, GDP per capita growth, individual internet usage, unemployment rate, and government indicators were examined. The study revealed a negative association between GDP per capita, tax revenue, trade openness, and governance indicators with the shadow economy. Conversely, the rate of unemployment and individual internet usage were positively correlated. The study suggested that transforming undocumented activities into documented ones, ensuring political stability, adhering to the rule of law, embracing technological advancements, and improving regulatory quality could enhance the economy and reduce the shadow economy.

Garcia and de Freitas Sanches (2021) explored shadow economy determinants in Portugal's economy using time series data from 1983 to 2015. The study utilized Newey West correction and multiple regression analysis techniques, considering variables such as social security expenditure, unemployment rate, indirect rate, real GDP growth rate, and self-employment rate. The results indicated that social security expenditure and real GDP growth rate negatively affected the shadow economy, while the rate of unemployment, indirect tax, and self-employment rate had a positive impact.

Tran et al. (2022) examined the role of fiscal deficit, government spending, and shadow economy in 32 Asian countries using panel data from 2000 to 2017. DOLS and FMOLS methods were applied, and variables such as trade openness, government expenditure, fiscal deficit, GDP per capita, unemployment rate, and inflation rate were analyzed. The study found that GDP per capita and trade openness had a negative influence on the shadow economy, while government expenditure, fiscal deficit, unemployment rate, and inflation rate positively impacted it. The study suggested that governments should consider fiscal policy adjustments, as an increase in government spending also led to an increase in the shadow economy.

Abu Alfoul et al. (2022) investigated shadow economy determinants in 132 countries using panel data from 1991 to 2017 and the extreme bounds analysis (EBA) method. Variables like law, internal conflict index, bureaucracy quality index, monetary freedom, corruption index, inflation level, and poverty level were considered. The study revealed a negative association between law, internal conflict index, bureaucracy quality index, monetary freedom, and corruption index with the shadow economy, while inflation level and poverty level were positively associated. The authors suggested that policymakers should create a transparent and democratic environment to reduce overregulation and bureaucracy.

The reviewed studies cover OECD countries, OIC and non-OIC economies, and developing-country samples, using time-series and panel data over different periods. They employ methods including MIMIC, currency-demand approaches, and GMM. Several studies associate

unemployment, corruption, and selected tax measures with larger shadow-economy estimates, whereas higher institutional quality and economic freedom are frequently associated with smaller estimates (Medina & Schneider, 2018; Khan et al., 2021; Alfoul et al., 2022). However, the reported effects of trade, inflation, government expenditure, and taxation vary with the sample, definitions, and empirical method (Berdiev & Saunoris, 2018; Tran et al., 2022). In this context, the present study examines three monetary aggregates as indirect indicators and applies MMQR to investigate variation across their conditional distributions. Its methodological contribution concerns the distributional analysis of the selected proxies; it should not be understood as establishing that monetary ratios measure informal output without additional validation.

Taken together, the literature reveals three gaps relevant to the present study. First, findings concerning trade, taxes, and public expenditure are not uniform across countries or estimators (Berdiev & Saunoris, 2018; Tran et al., 2022). Second, much of the research summarises average associations, whereas an MMQR specification permits the relationships to differ across the distribution of a monetary indicator (Machado & Silva, 2019). Third, monetary ratios are indirect measures whose interpretation can be affected by monetary institutions and financial behaviour (Schneider & Buehn, 2018). Consequently, the present analysis asks whether macroeconomic and institutional factors have similar directions of association across three proxies and whether those associations differ between lower and upper quantiles. The study does not claim that using an alternative estimator alone validates these proxies as measurements of unrecorded output.

3. Shadow Economy (SE): Concept and Determinants

This section discusses the definition and principal determinants of the shadow economy. Three influential perspectives are the dualist, structuralist, and legalist approaches (International Labor Organization [ILO], 1972; Portes et al., 1989; Khan et al., 2021). The dualist perspective treats informal activity as partly separate from the formal economy, whereas the structuralist perspective emphasises institutional, political, and economic relationships between the two sectors. In contrast, the legalist perspective highlights incentives created by the costs of formal registration and regulation. Therefore, the shadow economy is best understood as a heterogeneous phenomenon rather than a uniform category of activity.

Defining the shadow economy presents a challenge for researchers involved in its measurement. A commonly employed definition encompasses all economic activities that are currently unregistered but are included in the estimated Gross Domestic Product (GDP) (Frey and Pommerehne, 1984; Feige, 1994; Schneider, 1994). Furthermore, Smith (1997) defines the shadow economy as the "market-based production of goods and services, whether legal or illegal, that escapes detection in the official estimates of GDP."

The principal mechanisms discussed in the literature are presented below. These mechanisms provide theoretical context for the explanatory variables included in the empirical models, although not every factor can be measured directly in the current dataset.

3.1. Social Security and Tax Contribution Burdens

The total tax burden is distorted, impacting leisure activities and potentially increasing demand for labor in the shadow economy. The incentive to reduce the tax burden and work in the shadow economy intensifies with the disparity between total labor costs in the formal economy and after-tax earnings. The survival of the shadow economy relies heavily on social security payments, a significant component of the total tax burden (Schneider, 2005; Medina & Schneider, 2018).

3.2. Quality of Institutions or Corruption

The growth of the informal sector is significantly influenced by the quality of governmental institutions. More critical than the actual tax burden and regulations is how efficiently and fairly the government enforces laws and the tax code. This affects people's decisions to work in the unregulated sector. A robust legal system that safeguards property rights and enforceability enhances the benefits of being official. However, a corrupt bureaucracy is associated with substantial informal activities. Effective taxation, funding essential government services, indicates sound policy. Official production correlates inversely with taxation and benefits from productive

government services, whereas the shadow economy exhibits the opposite relationship due to inadequate support for a market economy by political institutions (Dreher and Schneider, 2010; Schneider & Williams, 2013; Hassan and Schneider, 2016).

3.3. Regulations

Regulations such as trade barriers or labor market regulations limit individual choices in the formal economy. Economies with extensive regulations increase labor costs in the formal sector, motivating individuals to engage in unofficial activities. Such economies often exhibit a significant contribution from the informal economy to the total gross domestic product due to insufficient enforcement of regulations, burdening individuals and firms and pushing them towards the shadow economy (Medina & Schneider, 2018).

3.4. Public Sector Services

A burgeoning shadow economy often reduces national revenue, leading to a decline in the quality and quantity of mass production. Consequently, tax rates for individuals and firms increase, while the quality of public goods and administration deteriorates. This deterioration encourages greater participation in the shadow economy. States with minimal tax rates, limited regulations, and a strong rule of law with consistent anti-corruption measures experience fewer shadow economy practices (Medina & Schneider, 2018).

3.5. Tax Morale

The size of the shadow economy indirectly depends on the effectiveness of the public sector, as it significantly impacts tax morale. A psychological agreement on taxation compliance arises when essential rights and duties between taxpayers and authorities are respected. Taxes are paid honestly when taxpayers believe they will result in public goods and services. How taxpayers are treated by authorities plays a crucial role; treating taxpayers as equal partners in a tax contract, rather than subordinates, fosters honest tax payments. Internalized tax morale and entrenched social norms reduce the likelihood of individuals resorting to the shadow economy (Kirchler, 2007; Medina & Schneider, 2018).

3.6. Deterrence

Surprisingly, empirical research on deterrence, despite its emphasis in policies combating the shadow economy and the clear stance of conventional economic theory on taxpayer non-compliance, is scarce. Limited data on legal proceedings and audits, especially for OECD countries, hinder our understanding. The lack of uniform fines and penalties proportional to the offense severity and individual income, coupled with reluctance to disclose data on shadow economic activities, weakens deterrence efforts. Existing data suggest fines and penalties do not deter the shadow economy significantly, although subjective deterrence policies are negatively associated. Interestingly, shadow economy activities tend to diminish deterrence rather than deterrence affecting the shadow economy (Medina & Schneider, 2018).

3.7. Development of the Official Economy

The shadow economy is significantly influenced by the development of the official economy. Higher unemployment rates amplify the motivation to work in the shadow economy, assuming other factors remain constant (Schneider & Williams, 2013).

3.8. Self-Employment

Higher self-employment rates increase informal activities in the shadow economy, assuming other factors remain constant (Medina & Schneider, 2018).

3.9. Unemployment

Higher unemployment rates raise the likelihood of working in the informal economy, assuming other factors remain constant (Medina & Schneider, 2018).

3.10. Size of the Agricultural Sector

A larger agricultural sector increases the potential for operating in the shadow economy, assuming other factors remain constant (Medina & Schneider, 2018).

3.11. Use of Cash

Increased use of cash raises the shadow economy. This is typically measured as cash per capita or M0/M1, M1/M2 outside the banking sector (Medina & Schneider, 2018).

3.12. Share of Labor Force

A lower official labor force participation rate results in a larger shadow economy, assuming other factors remain constant (Medina & Schneider, 2018).

3.13. GDP per Capita

The shadow economy is linked to additional economic activities migrating from the official economy, indicating reduced economic growth if all other factors remain constant (Schneider & Williams, 2013).

The preceding discussion identifies several potentially relevant mechanisms, including regulation, taxation, institutional quality, labour-market conditions, and monetary behaviour. The empirical models incorporate the variables available consistently for the seven-country sample. However, not all determinants identified in the literature can be included, and the resulting estimates should not be interpreted as an exhaustive account of shadow-economy activity.

Conceptual expectations for the empirical analysis follow these mechanisms. Unemployment and tax-related pressures may be associated with stronger incentives for unreported activity, whereas institutional quality and economic freedom may reduce incentives to operate outside formal rules (Kirchler, 2007; Medina & Schneider, 2018). The relationships involving trade and public consumption may be ambiguous, however, because they also reflect macroeconomic conditions and the composition of economic activity. For this reason, the empirical findings are considered alongside competing theoretical explanations rather than as predetermined causal effects.

4. Model, Data and Methodology

This section sets out the three empirical models, defines the variables, identifies the data sources, and explains the econometric methods applied to the seven-country SAARC panel.

4.1. Model Specification

The analysis specifies three models to investigate factors associated with selected monetary indicators of the shadow economy. Because unrecorded activity cannot be observed directly and definitions differ across studies, the analysis employs three indirect proxies: reserve money relative to narrow money (Shadow-1), narrow money relative to broad money (Shadow-2), and currency in circulation relative to broad money (Shadow-3). The explanatory variables are identical across the three specifications. However, changes in these ratios may reflect financial deepening, monetary-policy operations, deposit preferences, or payment technologies, as well as possible changes in informal activity. Consequently, the estimated relationships are interpreted first as relationships with monetary indicators rather than as direct measures of the shadow economy (Schneider & Buehn, 2018).

Measurement and comparability require particular attention. Reserve money, narrow money, broad money, and currency in circulation are shaped by formal banking transactions and central-bank operations as well as cash use (Cagan, 1958; Schneider & Buehn, 2018). Accordingly, an increase in M0/M1, M1/M2, or currency/M2 does not necessarily imply an increase in the share of hidden production. A stronger interpretation would require comparison with independently estimated shadow-economy series, checks for changes in monetary definitions, and sensitivity analysis for financial-sector development. These extensions are proposed as validation and robustness checks rather than reported as analyses already performed.

4.2. Model-1: Ratio of Reserve to Narrow Money (M0/M1)

SHADOW1 = *f* (TRADE, TAX, UNEMP, GFCE, GI, EFI) **(1)**

The econometric form of the model-1:

$$SHADOW1_{it} = \eta_0 + \eta_1 TRADE_{it} + \eta_2 TAX_{it} + \eta_3 UNEMP_{it} + \eta_4 GFCE_{it} + \eta_5 GI_{it} + \eta_6 EFI_{it} + \mu_{it} \quad \textbf{(2)}$$

4.3. Model-2: Ratio of Narrow to Broad Money (M1/M2)

SHADOW2 = *f* (TRADE, TAX, UNEMP, GFCE, GI, EFI) **(3)**

The econometric form of the model-2:

$$SHADOW2_{it} = \eta_0 + \eta_1 TRADE_{it} + \eta_2 TAX_{it} + \eta_3 UNEMP_{it} + \eta_4 GFCE_{it} + \eta_5 GI_{it} + \eta_6 EFI_{it} + \mu_{it} \quad \textbf{(4)}$$

4.4. Model-3: Ratio of Currency in Circulation to Broad Money (C/M2)

SHADOW3 = *f* (TRADE, TAX, UNEMP, GFCE, GI, EFI) **(5)**

The econometric form of the model-3:

$$SHADOW3_{it} = \eta_0 + \eta_1 TRADE_{it} + \eta_2 TAX_{it} + \eta_3 UNEMP_{it} + \eta_4 GFCE_{it} + \eta_5 GI_{it} + \eta_6 EFI_{it} + \mu_{it} \quad \textbf{(6)}$$

Where:

SHADOW1= ratio of reserve to narrow money

SHADOW2= ratio of narrow to broad money

SHADOW3= ratio of the currency in circulation to broad money

TRADE = Trade (% of GDP)

TAX = Tax revenue (% of GDP)

UNEMP = Unemployment, total (% of total labor force) (modeled ILO estimate)

GFCE = General government final consumption expenditure (% of GDP)

GI = Governance index

EFI = Economic freedom index

4.2. Data: Definition and Sources

This section provides an overview of the definitions and sources of the data utilized in our study. The data were sourced from a variety of reputable outlets. Data for various variables were gathered from the central banks of South Asian Association for Regional Cooperation (SAARC) countries, excluding Afghanistan, spanning from 1995 to 2021. Information on exchange rates, trade, tax revenue, total unemployment rate, and general government final consumption expenditure was obtained from the World Development Indicators (WDI). Governance indicators data were sourced from the Worldwide Governance Indicators (WGI). To calculate the Governance Index (GI), we averaged the values of six governance indicators. The Economic Freedom Index (EFI) data were acquired from The Heritage Foundation.

For monetary aggregates such as Reserve Money (M0), Narrow Money (M1), Broad Money (M2), and Currency in Circulation (CC), data were collected from the following sources:

- Bangladesh Bank
- Royal Monetary Authority of Bhutan
- Handbook of Statistics on Indian Economy (Reserve Bank of India)
- Maldives Monetary Authority
- Nepal Rastra Bank

- Handbook of Statistics on Pakistan Economy (State Bank of Pakistan)
- The Central Bank of Sri Lanka

4.3. For Bangladesh:

Initially, variables were recorded in crore Bangladeshi Taka. Subsequently, these figures were converted from crore to billion Bangladeshi Taka by dividing by 100. Finally, the data were converted from billion Bangladeshi Taka to billion US Dollars by applying the relevant dollar exchange rate[1].

4.4. For Bhutan:

The variables were initially recorded in million Bhutanese Ngultrum. Then, these figures were converted from million to billion Bhutanese Ngultrum by dividing by 1000. Finally, the data were converted from billion Bhutanese Ngultrum to billion US Dollars using the applicable dollar exchange rate.

4.5. For India:

Initially, variables were recorded in crore Indian Rupees. Subsequently, these figures were converted from crore to billion Indian Rupees by dividing by 100. Finally, the data were converted from billion Indian Rupees to billion US Dollars using the relevant dollar exchange rate.

4.6. For Maldives:

Initially, variables were recorded in million Maldivian Rufiyaa. These figures were then converted from million to billion Maldivian Rufiyaa by dividing by 1000. Finally, the data were converted from billion Maldivian Rufiyaa to billion US Dollars by applying the appropriate dollar exchange rate.

4.7. For Nepal:

Variables were initially recorded in millions of Nepalese Rupees. These figures were converted from millions to billions of Nepalese Rupees by dividing by 1000. Finally, the data were converted from billion Nepalese Rupees to billion US Dollars using the relevant dollar exchange rate.

4.8. For Pakistan:

Initially, variables were recorded in million Pakistani Rupees. Subsequently, these figures were converted from million to billion Pakistani Rupees by dividing by 1000. Finally, the data were converted from billion Pakistani Rupees to billion US Dollars using the applicable dollar exchange rate.

4.9. For Sri Lanka:

Variables were initially recorded in million Sri Lankan Rupees. These figures were converted from millions to billions of Sri Lankan Rupees by dividing by 1000. Finally, the data were converted from billion Sri Lankan Rupees to billion US Dollars using the relevant dollar exchange rate. Table 1 outlines the definitions of monetary aggregates, namely reserve money, narrow money, and broad money, as defined by their respective central banks (CD).

[1] All the data for these variables are converted from their Local Currency Units (LCU) to US Dollars for comparative analysis. This conversion involves dividing the data by their respective exchange rates, making them suitable for relative comparison.

Table 1: Monetary Aggregates Definitions in SAARC Countries

Country	M_0	M_1	M_2
Bangladesh	Net foreign assets + net domestic assets	M_0 + demand deposits (DD)	M_1 + time deposits (TD)
Bhutan	Currency in circulation (CC) + Banks' deposits + excess reserve CD	M_0 + DD	M_1 + TD + foreign currency deposits
India	CC + other deposits with + bankers' deposits	M_0 + DD	M_1 + time deposits
Maldives	CC + liabilities to other depository corporation + liabilities to another sector	M_0 + DD with CD + DD of public non-financial company	M_1 + quasi money
Nepal	CC + currency with ODC + deposit with banks	M_0 + DD	M_1 + savings and call deposits + TD
Pakistan	CC + other deposit with CD + currency in tills of scheduled banks + Banks' deposits with CD	M_0 + DD	M_1 + TD + residents foreign currency deposit
Sri Lanka	Currency Outstanding + Commercial Bank Deposit	M_0 + DD	M_1 + TD and Saving Deposit

Source: by the author

These monetary proxies are used as indicators for the calculation of the size and development of the shadow economy, but they do not measure the shadow economy. The definitions and formulas of variables are given as:

4.10. Shadow Economy

We have used three proxy variables: Shadow-1, Shadow-2, and Shadow-3.

4.11. Shadow1

Shadow1 is used to calculate the size and development of the shadow economy by taking the ratio of reserve to narrow money.

$$Shadow\ 1 = \frac{M_0}{M_1}$$

$$Shadow\ 1 = \frac{\text{Reserve Money}}{\text{Narrow Money}}$$

4.12. Shadow2

Shadow2 is used to calculate the size and development of the shadow economy by taking ratio of narrow to broad money.

$$Shadow\ 2 = \frac{M_1}{M_2}$$

$$Shadow\ 2 = \frac{\text{Narrow Money}}{\text{Broad Money}}$$

4.13. Shadow3

Shadow3 is used to calculate the size and development of the shadow economy by taking ratio of the currency in circulation to broad money.

$$Shadow\ 3 = \frac{CC}{M_2}$$

$$Shadow\ 3 = \frac{\text{Currency in Circulation}}{\text{Broad Money}}$$

4.14. Reserve money (M0):

"A large amount of currency held by central banks and major financial institutions to use for international transactions."

$M_0 = CC + R$

4.3. Methodology

In this section, we explain the different econometric techniques used in this study.

4.3.1. Panel Unit Root Test

Panel unit-root testing has received considerable attention in recent econometric research. First-generation panel unit-root tests typically assume cross-sectional independence, an assumption that may be violated when countries experience common economic and financial shocks. Such dependence can distort test performance and inference (O'Connell, 1998). Therefore, second-generation procedures have been developed to accommodate cross-sectional correlation, including the cross-sectionally augmented IPS (CIPS) test discussed by Cerasa (2008) and Westerlund et al. (2016).

Second-generation unit-root procedures were developed to address cross-sectional dependence. In particular, the cross-sectionally augmented IPS (CIPS) statistic averages individual cross-sectionally augmented Dickey–Fuller statistics. By incorporating cross-sectional averages, this approach allows for dependence arising from common factors, although the adequacy of its assumptions remains important for empirical interpretation (Cerasa, 2008; Westerlund et al., 2016). The null hypothesis is that the series contains a unit root; therefore, rejection provides evidence against non-stationarity under the test specification.

$$CIPS = M^{-1} \sum_{i=1}^{M} CADF_i \qquad \textbf{(7)}$$

4.3.2. Cross Section Dependence Test

The analysis tests for cross-sectional dependence in the regression residuals. In particular, it considers the Breusch–Pagan LM statistic and Pesaran-type CD and LM statistics. These procedures assess whether cross-sectional units are independent, although their finite-sample and asymptotic properties differ (Breusch & Pagan, 1980; Çinar & Nur, 2018).

4.4. Breusch & Pagan LM Test (1980)

Breusch and Pagan (1980) developed an LM test based on the sum of squared pairwise correlations between cross-sectional regression residuals. The statistic is computed from the estimated residual correlations, as indicated in the equation below. Under the null hypothesis, the residuals exhibit no cross-sectional dependence. The test is conventionally evaluated using a chi-square reference distribution under the relevant assumptions.

$$CD_{LM_{(1)}} = \sum_{i=1}^{M-1} \sum_{j=i+1}^{M} \hat{q}_{ij}^2 \quad \textbf{(8)}$$

Here, the squared correlations represent the estimated pairwise associations between cross-sectional residuals. The null hypothesis (H0) states that there is no cross-sectional dependence. Under the relevant asymptotic conditions, with a fixed number of cross-sectional units and a sufficiently large time dimension, the LM statistic follows a chi-square distribution with M(M − 1)/2 degrees of freedom (Breusch & Pagan, 1980).

4.5. Pesaran CD Test

The Pesaran-type CD statistic evaluates the average correlation among residuals from different cross-sectional units. Its reference distribution and interpretation depend on the panel dimensions and the maintained assumptions, as expressed in Equation (9).

$$\boldsymbol{CD_{LM(2)}} = \sqrt{\frac{1}{M(M-1)}} \sum_{i=1}^{M-1} \sum_{j=i+1}^{M} \left(T\rho\hat{q}_{ij}^2 - 1\right) \quad \textbf{(9)}$$

The null hypothesis is cross-sectional independence. The test statistic is assessed against the appropriate asymptotic reference distribution; therefore, a statistically significant result indicates evidence of dependence among country-specific disturbances (Çinar & Nur, 2018).

4.6. Pesaran LM Test

The conventional LM and bias-adjusted LM approaches have different small-sample and asymptotic properties. Accordingly, the interpretation of the tests should reflect the number of countries, the available time periods, and potential serial dependence. The null hypothesis is the absence of cross-sectional correlation among residuals. The adjusted statistic is expressed in Equation (10), and its statistical significance is evaluated under the applicable assumptions (Çinar & Nur, 2018).

$$LM_{(adj)} = \sqrt{\frac{2}{M(M-1)}} \sum_{i=1}^{M-1} \sum_{j=i+1}^{M} \frac{(T_p - K)\hat{q}_{ij}^2 - u_{Tpij}}{v_{Tp_{ij}}} \quad \textbf{(10)}$$

4.3.3. Slope Homogeneity/ Heterogeneity Test

4.4. Delta Test Pesaran and Yamagata

ÃÃSwamy (1970) described the structure to find "if coefficient of slope cointegration equations are homogenous." It was further improved by Pesaran and Yamagata (2008), and and adj; two delta tests were developed

$$\tilde{\Delta} = \sqrt{M}\left(\frac{M^{-1}S - K}{\sqrt{2K}}\right) \sim X_K^2 \quad \textbf{(11)}$$

$$\tilde{\Delta}_{adj} = \sqrt{M}\left[\frac{M^{-1}S - K}{(T,K)v}\right] \sim M(0,1) \quad \textbf{(12)}$$

ÃÃÃÃÃWhere cross-section unit number denoted by M, Swamy test statistic denoted by S, independent variables denoted by K. If the null hypothesis is not rejected then cointegrating coefficient consider homogenous. Both and adj are applicable for small and large sample, where " adj" is mean variance bias adjusted form of "". Therefore, needs error not to autocorrelated.

4.5. HAC Robust Delta Adjusted Test by Blomquist and Westerlund 2013

Blomquist and Westerlund (2013) extended slope-homogeneity testing to allow for heteroskedasticity and serial correlation through heteroskedasticity- and autocorrelation-consistent (HAC) inference. Consequently, the HAC-adjusted versions may be informative when the classical independence and constant-variance assumptions are not plausible for the panel (Blomquist & Westerlund, 2013; Pesaran & Yamagata, 2008).

Δ_{HAC} and $\Delta_{HAC\ (adj)}$

$$\Delta_{HAC} = \sqrt{M}\left(\frac{M^{-1}S_{HAC}^{-K}}{\sqrt{2K}}\right) \sim X_K^2 \quad \textbf{(13)}$$

$$\Delta_{HAC(adj)} = \sqrt{M}\left[\frac{M^{-1}S_{HAC}^{-K}}{(T,K)v}\right] \sim M(0,1) \quad \textbf{(14)}$$

4.3.4. Cointegration Tests

This subsection introduces the panel cointegration procedures used to assess the existence of long-run relationships among the variables. The study considers three approaches: (i) the Kao test, (ii) the Pedroni test, and (iii) the Westerlund test. The assumptions underlying these methods should be considered when interpreting results from a potentially cross-sectionally dependent panel (Kao, 1999; Westerlund, 2007).

4.4. Kao Test

The Kao procedure is used to examine whether variables in a panel share a long-run relationship. Its null hypothesis is the absence of cointegration, while rejection provides evidence consistent with cointegration under the test assumptions. The residual-based procedure uses residuals obtained from the estimated long-run relationship (Kao, 1999). Therefore, conclusions should be based on the reported test statistics and their significance rather than on acceptance of the null hypothesis.

4.5. Pedroni Test

The Pedroni approach evaluates the null hypothesis of no cointegration in a non-stationary panel using residual-based statistics. Its seven statistics are commonly grouped into within-dimension (panel) and between-dimension (group-mean) measures. The framework allows heterogeneity in parts of the long-run relationship and short-run adjustment, subject to the maintained assumptions. Accordingly, rejection of the null hypothesis should be interpreted in conjunction with the other cointegration procedures rather than as an isolated guarantee of a common equilibrium relationship.

$$\bar{y}_t = \frac{1}{N}\sum_{i=1}^{N} t\,, y_i \quad \textbf{(15)}$$

These statistics are based on estimated residuals and should be interpreted in accordance with the relevant test assumptions and the panel's dependence structure (Neal, 2014).

4.6. Westerlund Test

The Westerlund approach tests for cointegration through error-correction-based statistics and provides an additional perspective on long-run adjustment in panel data. The null hypothesis is no cointegration, while rejection is consistent with evidence of an error-correcting relationship under the maintained specification. Because inference may be sensitive to cross-sectional dependence, serial correlation, and sample size, the results should be evaluated alongside the other reported tests rather than treated as definitive in isolation (Westerlund, 2007).

4.3.5. Method of Moments Quantile Regression (MM-QR)

Quantile regression can be applied to panel data to investigate heterogeneity across the conditional distribution of an outcome. Unlike conventional conditional-mean regression, quantile approaches permit different patterns of association at lower, central, and upper quantiles. Consequently, the method can provide information on how macroeconomic and institutional variables relate to monetary indicators under different distributional conditions (Koenker & Bassett, 1978; Machado & Silva, 2019).

Machado and Silva (2019) developed a method-of-moments framework for quantile regression that accommodates individual effects and allows covariate associations to differ across conditional quantiles. Similarly, Ike et al. (2020) applied MMQR in a panel setting. Compared with an approach focusing solely on conditional means, the quantile framework helps identify whether the direction and magnitude of associations differ between relatively low and high values of a monetary

indicator. Nevertheless, such heterogeneity does not, by itself, establish a causal effect or validate the selected monetary ratio as a direct measure of informal output.

$$Y_{it} = \alpha_i + \beta X_{it} + (\delta_i + \gamma Z_{it})\, \mu_{it} \quad \textbf{(16)}$$

The parameters in Equation (16) represent individual effects and the location and scale components of the conditional distribution, following the MMQR specification. Subscripts i and t denote cross-sectional units and time periods, respectively. The functions of the covariates are defined according to the estimated model (Machado & Silva, 2019).

$$Z_l = Z_l\,(X),\ l = 1, 2, 3, \ldots, k \quad \textbf{(17)}$$

The explanatory-variable vector and the disturbance term are specified within the MMQR location-scale framework. The interpretation of the estimated coefficients depends on the distributional and exogeneity assumptions outlined by Machado and Silva (2019). Therefore, quantile-specific findings should be reported as conditional associations unless the study establishes a defensible causal identification strategy. The subsequent expression develops the quantile representation of the model.

$$Q_y\,(\tau \mid X_{it}) = [\alpha_i + q\ \delta_i(\tau)] + \beta X_{it} + \gamma Z_{it}\, q(\tau). \quad \textbf{(18)}$$

Our models can be expressed in MMQR form as:

4.4. Model-1: Ratio of Reserve to Narrow Money (M0/M1)

General form of the MMQR equation is:

$$Q_{SHADOW1_{it}}(\tau \mid \gamma_i, \delta_t, X_{it}) = \gamma_i + \delta_t + \eta_{1,\tau} TRADE_{it} + \eta_{2,\tau} TAX_{it} + \eta_{3,\tau} UNEMP_{it} + \eta_{4,\tau} GFCE_{it} + \eta_{5,\tau} GI_{it} + \eta_{6,\tau} EFI_{it} + \mu_{\tau,it} \quad \textbf{(19)}$$

At τ=0.10:

$$Q_{0.10}(SHADOW1) \mid = \gamma_{0.10} + \eta_{1,0.10} TRADE_{it} + \eta_{2,0.10} TAX_{it} + \eta_{3,0.10} UNEMP_{it} + \eta_{4,0.10} GFCE_{it} + \eta_{5,0.10} GI_{it} + \eta_{6,0.10} EFI_{it} + \mu_{0.10,it} \quad \textbf{(20)}$$

At τ=0.25:

$$Q_{0.25}(SHADOW1) \mid = \gamma_{0.25} + \eta_{1,0.25} TRADE_{it} + \eta_{2,0.25} TAX_{it} + \eta_{3,0.25} UNEMP_{it} + \eta_{4,0.25} GFCE_{it} + \eta_{5,0.25} GI_{it} + \eta_{6,0.25} EFI_{it} + \mu_{0.25,it} \quad \textbf{(21)}$$

At τ=0.50:

$$Q_{0.50}(SHADOW1) \mid = \gamma_{0.50} + \eta_{1,0.50} TRADE_{it} + \eta_{2,0.50} TAX_{it} + \eta_{3,0.50} UNEMP_{it} + \eta_{4,0.50} GFCE_{it} + \eta_{5,0.50} GI_{it} + \eta_{6,0.50} EFI_{it} + \mu_{0.50,it} \quad \textbf{(22)}$$

At τ=0.75:

$$Q_{0.75}(SHADOW1) \mid = \gamma_{0.75} + \eta_{1,0.75} TRADE_{it} + \eta_{2,0.75} TAX_{it} + \eta_{3,0.75} UNEMP_{it} + \eta_{4,0.75} GFCE_{it} + \eta_{5,0.75} GI_{it} + \eta_{6,0.75} EFI_{it} + \mu_{0.75,it} \quad \textbf{(23)}$$

At τ=0.90:

$$Q_{0.90}(SHADOW1) \mid = \gamma_{0.90} + \eta_{1,0.90} TRADE_{it} + \eta_{2,0.90} TAX_{it} + \eta_{3,0.90} UNEMP_{it} + \eta_{4,0.90} GFCE_{it} + \eta_{5,0.90} GI_{it} + \eta_{6,0.90} EFI_{it} + \mu_{0.90,it} \quad \textbf{(24)}$$

4.5. Model-2: Ratio of Narrow to Broad Money (M1/M2)

General form of the MMQR equation is:

$$Q_{SHADOW2_{it}}(\tau \mid \gamma_i, \delta_t, X_{it}) = \gamma_i + \delta_t + \eta_{1,\tau} TRADE_{it} + \eta_{2,\tau} TAX_{it} + \eta_{3,\tau} UNEMP_{it} + \eta_{4,\tau} GFCE_{it} + \eta_{5,\tau} GI_{it} + \eta_{6,\tau} EFI_{it} + \mu_{\tau,it} \quad \textbf{(25)}$$

At τ=0.10:

$$Q_{0.10}(SHADOW2) \mid = \gamma_{0.10} + \eta_{1,0.10} TRADE_{it} + \eta_{2,0.10} TAX_{it} + \eta_{3,0.10} UNEMP_{it} + \eta_{4,0.10} GFCE_{it} + \eta_{5,0.10} GI_{it} + \eta_{6,0.10} EFI_{it} + \mu_{0.10,it}$$

(26)

At τ=0.25:

$$Q_{0.25}(SHADOW2)|=\gamma_{0.25}+\eta_{1,0.25}TRADE_{it}+\eta_{2,0.25}TAX_{it}+\eta_{3,0.25}UNEMP_{it}+\eta_{4,0.25}GFCE_{it}+\eta_{5,0.25}GI_{it}+\eta_{6,0.25}EFI_{it}+\mu_{0.25,it}$$

(27)

At τ=0.50:

$$Q_{0.50}(SHADOW2)|=\gamma_{0.50}+\eta_{1,0.50}TRADE_{it}+\eta_{2,0.50}TAX_{it}+\eta_{3,0.50}UNEMP_{it}+\eta_{4,0.50}GFCE_{it}+\eta_{5,0.50}GI_{it}+\eta_{6,0.50}EFI_{it}+\mu_{0.50,it}$$

(28)

At τ=0.75:

$$Q_{0.75}(SHADOW2)|=\gamma_{0.75}+\eta_{1,0.75}TRADE_{it}+\eta_{2,0.75}TAX_{it}+\eta_{3,0.75}UNEMP_{it}+\eta_{4,0.75}GFCE_{it}+\eta_{5,0.75}GI_{it}+\eta_{6,0.75}EFI_{it}+\mu_{0.75,it}$$

(29)

At τ=0.90:

$$Q_{0.90}(SHADOW2)|=\gamma_{0.90}+\eta_{1,0.90}TRADE_{it}+\eta_{2,0.90}TAX_{it}+\eta_{3,0.90}UNEMP_{it}+\eta_{4,0.90}GFCE_{it}+\eta_{5,0.90}GI_{it}+\eta_{6,0.90}EFI_{it}+\mu_{0.90,it}$$

(30)

4.6. Model-3: Ratio of Currency in Circulation to Broad Money (C/M2)

General form of the MMQR equation is:

$$Q_{SHADOW3_{it}}(\tau\mid\gamma_i,\delta_t,X_{it})=\gamma_i+\delta_t+\eta_{1,\tau}TRADE_{it}+\eta_{2,\tau}TAX_{it}+\eta_{3,\tau}UNEMP_{it}+\eta_{4,\tau}GFCE_{it}+\eta_{5,\tau}GI_{it}+\eta_{6,\tau}EFI_{it}+\mu_{\tau,it}$$

(31)

At τ=0.10:

$$Q_{0.10}(SHADOW3)|=\gamma_{0.10}+\eta_{1,0.10}TRADE_{it}+\eta_{2,0.10}TAX_{it}+\eta_{3,0.10}UNEMP_{it}+\eta_{4,0.10}GFCE_{it}+\eta_{5,0.10}GI_{it}+\eta_{6,0.10}EFI_{it}+\mu_{0.10,it}$$

(32)

At τ=0.25:

$$Q_{0.25}(SHADOW3)|=\gamma_{0.25}+\eta_{1,0.25}TRADE_{it}+\eta_{2,0.25}TAX_{it}+\eta_{3,0.25}UNEMP_{it}+\eta_{4,0.25}GFCE_{it}+\eta_{5,0.25}GI_{it}+\eta_{6,0.25}EFI_{it}+\mu_{0.25,it}$$

(33)

At τ=0.50:

$$Q_{0.50}(SHADOW3)|=\gamma_{0.50}+\eta_{1,0.50}TRADE_{it}+\eta_{2,0.50}TAX_{it}+\eta_{3,0.50}UNEMP_{it}+\eta_{4,0.50}GFCE_{it}+\eta_{5,0.50}GI_{it}+\eta_{6,0.50}EFI_{it}+\mu_{0.50,it}$$

(34)

At τ=0.75:

$$Q_{0.75}(SHADOW3)|=\gamma_{0.75}+\eta_{1,0.75}TRADE_{it}+\eta_{2,0.75}TAX_{it}+\eta_{3,0.75}UNEMP_{it}+\eta_{4,0.75}GFCE_{it}+\eta_{5,0.75}GI_{it}+\eta_{6,0.75}EFI_{it}+\mu_{0.75,it}$$

(35)

At τ=0.90:

$$Q_{0.90}(SHADOW3)|=\gamma_{0.90}+\eta_{1,0.90}TRADE_{it}+\eta_{2,0.90}TAX_{it}+\eta_{3,0.90}UNEMP_{it}+\eta_{4,0.90}GFCE_{it}+\eta_{5,0.90}GI_{it}+\eta_{6,0.90}EFI_{it}+\mu_{0.90,it}$$

(36)

Where, τ shows the quantiles, i=1…, N shows cross sectional and t shows a time period starting from t=1…, T.

5. Determinants of Shadow Economy: A MMQR Analysis

We have explored the determinants of shadow economy. Although, it is difficult to measure the shadow economy due to the various proxies used to determine the size of shadow economy in the literature. We have used monetary aggregates-based proxies to calculate the size and development of the undocumented economy phenomenon.

5.1. Descriptive Statistics and Correlation of Key Variables

Now, we examine the descriptive statistics and correlations of the key variables. Table 2 presents the descriptive statistics of key variables (1995-2021) for selected SAARC countries. The ratio of reserve to narrow money (Shadow1) has a mean of 0.86, a median of 0.86, a maximum of 1.77, a minimum of 0, a standard deviation of 0.33, a negatively skewed skewness of -0.23, and a leptokurtic kurtosis of 3.62, indicating a non-normal distribution. The ratio of narrow to broad money (Shadow2) shows a mean of 0.39, a median of 0.33, a maximum of 0.94, a minimum of 0.13, a standard deviation of 0.05, an extremely skewed positive skewness of 1.22, and a leptokurtic kurtosis of 4.37, indicating a non-normal distribution. The ratio of currency in circulation to broad money (Shadow3) exhibits a mean of 0.16, a median of 0.14, a maximum of 0.29, a minimum of 0.07, a standard deviation of 0.05, a positively skewed skewness of 0.65, and a platykurtic kurtosis of 2.47, indicating a non-normal distribution. In terms of trade, the mean is 62.58, the median is 46.30, the maximum is 165.98, the minimum is 21.93, the standard deviation is 37.19, the skewness is 1.11 (extremely skewed positively), and the kurtosis is 3.21 (leptokurtic), suggesting a non-normal distribution. Regarding tax, the mean is 10.68, the median is 10.03, the maximum is 19.81, the minimum is 6.60, the standard deviation is 2.82, the skewness is 0.65 (positively skewed), and the kurtosis is 2.89 (platykurtic), indicating a non-normal distribution.

Table 2: Descriptive Statistics of Key Variables (1995-2021)

Statistic	Variables								
	Shadow1	**Shadow2**	**Shadow3**	**Trade**	**TAX**	**UNEMP**	**GFCE**	**GI**	**EFI**
Mean	0.86	0.39	0.16	62.58	10.68	5.67	12.21	-0.41	54.58
Median	0.86	0.33	0.14	46.30	10.03	4.97	10.75	-0.34	54.60
Maximum	1.77	0.94	0.29	165.98	19.81	13.08	22.78	0.64	66.00
Minimum	0.00	0.13	0.07	21.93	6.60	0.40	4.63	-1.18	40.90
Std. Dev.	0.33	0.19	0.05	37.19	2.82	3.40	5.10	0.45	4.21
Skewness	-0.23	1.22	0.65	1.11	0.65	0.20	0.47	0.22	0.17
Kurtosis	3.62	4.37	2.47	3.21	2.89	1.85	2.10	2.18	3.35
Jarque-Bera	**4.77**	61.82	15.44	39.13	13.47	11.66	13.40	6.82	1.83
Prob.	0.09	0.00	0.00	0.00	0.00	0.00	0.00	0.03	0.40
Obs.	189	189	189	189	189	189	189	189	189

Source: by the author

The unemployment rate exhibits a mean of 5.67, a median of 4.97, a maximum of 13.08, a minimum of 0.40, a standard deviation of 3.40, a positively skewed skewness of 0.20, and a platykurtic kurtosis of 1.85, indicating a non-normal distribution. Government final consumption expenditure (GFCE) shows a mean of 12.21, a median of 10.75, a maximum of 22.78, a minimum of 4.63, a standard deviation of 5.10, a positively skewed skewness of 0.47, and a platykurtic kurtosis of 2.10, suggesting a non-normal distribution. Governance Index (GI) has a mean of -0.41, a median of -0.34, a maximum of 0.64, a minimum of -1.18, a standard deviation of 0.45, a positively skewed skewness of 0.22, and a platykurtic kurtosis of 2.18, indicating a non-normal distribution. Economic Freedom Index (EFI) exhibits a mean of 54.58, a median of 54.60, a maximum of 66, a minimum of

40.90, a standard deviation of 4.21, a positively skewed skewness of 0.17, and a leptokurtic kurtosis of 3.35, suggesting a non-normal distribution.

Table 3 presents the correlations among the key variables. Shadow1 demonstrates a positive relationship with all variables except Shadow2 and Shadow3, which are negative. Shadow1 shows a weak relationship with all variables except Shadow2, which is moderately related to Shadow1.

Table 3: Correlation Matrix of Key Variables (1995-2021)

Correlation	SHADOW 1	SHADOW 2	SHADOW 3	TRADE	TAX	UNEMP	GFCE	GI	EFI
SHADOW 1	1								
SHADOW 2	-0.42	1							
SHADOW 3	-0.21	0.36	1						
TRADE	0.22	0.24	-0.21	1					
TAX	0.13	0.08	0.07	0.13	1				
UNEMP	0.19	-0.49	-0.02	-0.05	0.20	1			
GFCE	0.14	0.38	-0.26	0.72	0.13	-0.18	1		
GI	0.11	0.02	-0.37	0.63	0.20	-0.04	0.71	1	
EFI	0.06	0.11	-0.14	0.13	0.38	-0.12	0.33	0.28	1

Source: by the author

Shadow2 shows a positive relationship with all variables except unemployment, which is negative. It has a weak relationship with all variables except Shadow3, unemployment, and government final consumption expenditure, which are moderately related to Shadow2. Shadow3 exhibits a negative relationship with all variables except tax, which is positive. It has a weak relationship with all variables except the governance index, which is moderately related to Shadow3. Trade demonstrates a positive relationship with all variables except unemployment, which is negative. It has a weak relationship with all variables except government final consumption expenditure, which is strongly related to trade. Tax displays a positive relationship with all variables but shows a weak relationship with all variables except the economic freedom index, which is moderately related to tax. Unemployment has a negative relationship with all variables and exhibits weak connections with them. Government final consumption expenditure has a positive relationship with all variables but weak connections, except with the economic freedom index, with which it has a strong relationship. Moreover, it has a weak relationship with the governance index. The governance index has a positive and weak relationship with the economic freedom index.

5.2. Cross-Sectional Dependence and Slope Homogeneity Tests

We have analyzed the results of cross-sectional dependence and slope homogeneity tests. Table 4 presents Pesaran's cross-sectional dependence tests. The variables shadow1, trade, tax, government final consumption expenditure, and economic freedom index are found to be insignificant, leading us to accept the null hypothesis. This indicates that there is no cross-sectional dependence among the selected SAARC countries.

Table 4: Pesaran's Cross-Sectional Dependence (CD)Test

Variable	CD-test	P-Value
SHADOW1	0.5960	0.5510
SHADOW2	3.4270	0.0010

Variable	CD-test	P-Value
SHADOW3	15.0520	0.0000
TRADE	-0.4700	0.6390
TAX	-1.0670	0.2860
UNEMP	4.3710	0.0000
GFCE	-0.5010	0.6160
GI	5.7880	0.0000
EFI	-0.0910	0.9280

Source: by the author

However, shadow2, shadow3, unemployment, and the Governance index are significant, leading us to reject the null hypothesis. This implies the presence of cross-sectional dependence among the selected SAARC countries. Table 5 presents the results of the slope homogeneity tests, which are based on the two-step Delta test and the HAC robust adjusted Delta test. Both tests provide unadjusted and adjusted statistics.

Table 5: Slope Homogeneity Test

Models	Delta Test				HAC Robust Adjusted Delta Test			
	Unadjusted	**P-Value**	**Adjusted**	**P-Value**	**Unadjusted**	**P-Value**	**Adjusted**	**P-Value**
Model – 1	**SHADOW1/ TRADE, TAX, UNEMP, GFCE, GI, EFI**							
	8.651	0.000	10.313	0.000	2.392	0.017	-2.852	0.004
Model – 2	**SHADOW2/ TRADE, TAX, UNEMP, GFCE, GI, EFI**							
	8.293	0.000	9.886	0.000	2.612	0.009	-3.114	0.002
Model – 3	**SHADOW3/ TRADE, TAX, UNEMP, GFCE, GI, EFI**							
	9.839	0.000	11.729	0.000	2.833	0.005	-3.377	0.001

Source: by the author

In all models, the p-values for both the unadjusted and adjusted statistics of the Delta test and the HAC robust test are significant. Thus, we reject the null hypothesis, indicating slope heterogeneity in the model.

5.3. Unit Root Tests

Given the evidence of cross-sectional dependence and slope heterogeneity reported above, conventional first-generation panel unit-root procedures may be inappropriate. Therefore, this study applies a second-generation test that accommodates cross-sectional dependence. Table 6 presents the cross-sectionally augmented IPS (CIPS) results under specifications with and without a deterministic trend. The interpretation of these tests depends on the reported statistics, significance levels, and chosen deterministic components (Westerlund et al., 2016).

In the no-trend case, the probability values for shadow2, shadow3, tax, unemployment, government final consumption expenditure, the governance index, and the economic freedom index are significant. Therefore, we reject the null hypothesis, indicating that these variables have no unit root and are stationary. On the other hand, the probability values of the variables shadow1 and trade are insignificant. Hence, we accept the null hypothesis, signifying that these variables have a unit root and are non-stationary.

Table 6: Unit Root Test Results

Second Generation Panel Unit Root Test						
Cross-Section-Dependence based Im-Pesaran-Shin (CSDIPS) Unit Root Test						
Variables	**Without Trend**			**With Trend**		
	Lags	**Zt Statistics**	**P-Value**	**Lags**	**Zt Statistics**	**P-Value**
SHADOW1	1	-0.379	0.152	1	-0.183	0.027
SHADOW2	0	-0.163	0.035	0	1.236	0.092
SHADOW3	0	0.270	0.060	1	1.374	0.015
TRADE	0	0.262	0.603	1	2.792	0.197
TAX	1	0.525	0.003	1	-0.052	0.000
UNEMP	1	1.680	0.054	1	1.455	0.027
GFCE	0	-1.419	0.078	0	-0.914	0.008
GI	0	-4.092	0.000	0	-3.301	0.000
EFI	0	-3.200	0.001	1	-1.297	0.097

Source: by the author

For the trend specification, the reported probability values for Shadow-1, Shadow-2, Shadow-3, tax, unemployment, GFCE, GI, and EFI are significant; therefore, we reject the null of a unit root for these variables at the reported significance levels. However, trade remains insignificant, so the test does not provide sufficient evidence to reject the unit-root null for trade. This interpretation concerns the individual test specifications and should not be taken as proof that all variables have the same order of integration.

5.4. Panel Cointegration Analysis

This subsection assesses whether the variables exhibit a long-run relationship. The study applies Kao, Pedroni, and Westerlund panel cointegration procedures and reports evidence of cointegration. However, the tests rely on different assumptions, and their interpretation should be considered in light of the cross-sectional dependence established earlier (Kao, 1999; Westerlund, 2007).

The Kao test comprises five modified Dickey-Fuller tests: Dickey-Fuller test, augmented Dickey-Fuller test, unadjusted modified Dickey-Fuller test, and unadjusted Dickey-Fuller test. The Pedroni test includes three tests: the modified Phillips-Perron test, the Phillips-Perron test, and the augmented Dickey-Fuller test. The Westerlund test involves four tests: two each for group dimension and panel dimension. The results of these cointegration tests are presented in Table 7.

For the Kao test, all three models (model-1, model-2, and model-3) are found to be significant. Therefore, we reject the null hypothesis, indicating the presence of a long-run relationship in all models. Similarly, the Pedroni test shows significance for model-1, model-2, and model-3, leading to the rejection of the null hypothesis, suggesting a long-run relationship in all models. The Westerlund test also demonstrates significance for model-1, model-2, and model-3, prompting the rejection of the null hypothesis and confirming the existence of a long-run relationship in all models

Table 7: Cointegration Test Results

Cointegration Tests		Model - 1		Model – 2		Model - 3	
		Statistic	P-Value	Statistic	P-Value	Statistic	P-Value
Kao Test	Modified Dickey-Fuller test	-0.4299	0.0336	0.5417	0.0940	0.4180	0.0380
	Dickey-Fuller test	-1.1883	0.0174	0.5708	0.0841	0.7524	0.0259
	Augmented Dickey-Fuller test	-1.1449	0.1261	-0.5019	0.0079	1.0391	0.0494
	Unadjusted modified Dickey	-2.7964	0.0026	0.7222	0.0351	0.0048	0.0981
	Unadjusted Dickey-Fuller test	-2.4995	0.0062	0.7369	0.0306	0.4136	0.0396
Pedroni Test	Modified Phillips-Perron test	2.0260	0.0214	2.9737	0.0015	2.0322	0.0211
	Phillips-Perron test	-1.4399	0.0750	0.5532	0.0901	-1.3451	0.0893
	Augmented Dickey-Fuller test	-2.2087	0.0136	-1.0049	0.0575	-1.8074	0.0353
Westerlund Test	Gt	-1.7570	0.0590	-1.8000	0.0480	-1.4820	0.0930
	Ga	-2.6190	0.0000	-2.5490	0.0000	-2.4100	0.0000
	Pt	-5.6740	0.0830	-4.2830	0.0690	-3.9780	0.0160
	Pa	-3.2410	0.0000	-3.2800	0.0790	-3.0820	0.0820

Source: by the author

5.5. Method of Moments-Quantile Regression Results for the Monetary Indicators of the Shadow Economy

This subsection reports the Method of Moments Quantile Regression (MMQR) estimates for the three monetary indicators. MMQR permits associations between the explanatory variables and the dependent monetary ratio to vary across quantiles (Machado & Silva, 2019). The preceding tests indicate cross-sectional dependence, slope heterogeneity, and evidence of long-run association; however, these diagnostics do not by themselves establish causal identification. Table 8 and Figure A.1 present the estimates for Shadow-1, the reserve-money-to-narrow-money ratio.

Table 8: MM-QR Estimates for the Monetary Indicators of Shadow Economy Based on Ratio of Reserve to Narrow Money

DV: Ratio of Reserve to Narrow Money (Shadow-1)							
Variables	**Location**	**Scale**	**Q 0.10**	**Q 0.25**	**Q 0.50**	**Q 0.75**	**Q 0.90**
TRADE	0.0202***	0.0134***	0.00402	0.0122	0.0219***	0.0317***	0.0410***
	(0.00730)	(0.00473)	(0.0126)	(0.00875)	(0.00717)	(0.00750)	(0.00943)
TAX	3.954***	0.736**	2.830***	3.327***	3.837***	4.466***	5.308***
	(0.554)	(0.374)	(0.590)	(0.500)	(0.530)	(0.720)	(1.076)
UNEMP	19.55***	11.00***	2.749	10.18**	17.80***	27.20***	39.78***
	(5.470)	(3.688)	(5.894)	(4.973)	(5.244)	(7.159)	(10.72)

GFCE	11.96**	2.403	8.289	9.912**	11.58**	13.63**	16.38*
	(5.153)	(3.474)	(5.422)	(4.605)	(4.921)	(6.638)	(9.909)
GI	0.0961***	0.0145	-0.0726**	-0.0815***	-0.0945***	-0.106***	-0.119***
	(0.0143)	(0.0109)	(0.0283)	(0.0223)	(0.0149)	(0.0113)	(0.0139)
EFI	6.289***	4.697***	-1.308	-1.574	-5.789***	-9.607***	-13.75***
	(1.706)	(1.300)	(3.236)	(2.494)	(1.720)	(1.413)	(1.665)
Constant	-0.236**	-0.166*	0.0328	-0.0691	-0.218*	-0.353***	-0.499***
	(0.118)	(0.0896)	(0.231)	(0.181)	(0.121)	(0.0936)	(0.114)

*Source: by the author. Note. Standard errors are reported in parentheses. *** p < .01, ** p < .05, * p < .10.*

The dependent variable in Table 8 is the ratio of reserve money to narrow money (Shadow-1). Explanatory variables include trade, tax revenue, unemployment, government final consumption expenditure (GFCE), governance index (GI), and economic freedom index (EFI). The MMQR specification distinguishes location and scale components, allowing explanatory variables to be associated with both the central tendency and dispersion of the conditional outcome (Machado & Silva, 2019). Consequently, interpret the quantile coefficients with respect to the monetary ratio rather than as direct percentage-point changes in unrecorded GDP.

Trade is positively associated with Shadow-1 across all quantiles. The effect of trade on Shadow-1 is significant in all quantiles, except the 0.10 and 0.25 quantiles. This phenomenon can be attributed to trade's role in expanding the total money in circulation and promoting economic growth. Trade positively influences the ratio of reserves to narrow money because, as countries engage in cross-border transactions, foreign currency is introduced. Typically, this foreign currency is converted into local currency, increasing the general money supply. The influx of funds allows financial institutions to maintain larger reserves, thereby enhancing the ratio of reserves to narrow money. Additionally, trade stimulates economic activity, leading to increased output, job creation, and higher incomes. This, in turn, encourages higher rates of saving and deposit formation, further strengthening banks' reserves. general, trade plays a crucial role in improving the ratio of reserves to narrow money (Schneider, 2005; Khan et al., 2021). Our findings align with previous studies, including Schneider (2005) and Khan et al. (2021).

Taxation has a positive and statistically significant association with Shadow-1 across all quantiles. This effect is attributed to taxes stimulating the growth of reserves held by central banks, thereby favorably influencing the ratio of reserves to narrow money. Governments can choose to allocate a portion of their tax revenue to augment their reserves. By bolstering reserves, central banks enhance their capacity to manage economic fluctuations and stabilize the money supply. The increased reserves act as a cushion for the banking system, enabling it to meet liquidity requirements and maintain investor confidence in the financial system. Consequently, this strengthens the stability of the money supply, reducing the likelihood of financial crises and positively impacting the ratio of reserves to narrow money. Moreover, a higher reserve ratio fosters confidence in the economy, enhancing trust in the national currency. This, in turn, attracts both domestic and foreign investments. Through the augmentation of central bank reserves, the promotion of economic stability, and the encouragement of economic growth, taxes play a pivotal role in enhancing the ratio of reserves to narrow money (Schneider et al., 2010; Angour and Nmili, 2019). Our findings are consistent with previous studies, including Schneider et al. (2010), Gaspareniene et al. (2016), Angour and Nmili (2019), Khan et al. (2021), and Khan and Rehman (2022).

Unemployment shows a positive association with Shadow-1 across all quantiles. This effect remains significant in all quantiles except the 0.10 quantile. Unemployment's influence on the total money in an economy has a favorable effect on the ratio of reserves to narrow money. Rising unemployment leads to decreased consumer spending as people have less money and reduced purchasing power. Consequently, companies witness a decline in demand for their products and services, affecting their earnings and capital expenditures. To counter this economic slowdown,

central banks often implement expansionary monetary policies, such as lowering interest rates or engaging in quantitative easing, to inject liquidity into the financial system. These measures expand the money supply, ultimately resulting in a higher reserve-to-narrow money ratio. Increased bank reserves serve as a cushion, sustaining lending activities and fostering economic growth, which can ultimately reduce unemployment rates (Davidescu, 2017; Tran et al., 2022). Our findings are in line with prior studies, including Schneider et al. (2010), Davidescu (2017), Angour and Nmili (2019), Lahlou et al. (2020), and Tran et al. (2022).

Government final consumption expenditure (GFCE) is also positively associated with Shadow-1 across all quantiles. This effect is significant in all quantiles except the 0.10 quantile. Increased government spending on consumption injects money into the economy, leading to a surge in aggregate demand. This heightened spending stimulates economic activity, prompting businesses to increase the production of goods and services. Consequently, banks experience a rise in deposit inflows and greater demand for loans, expanding the narrow money supply. To meet the escalating demand for money, banks may need to augment their reserves. Thus, the ratio of reserves to narrow money tends to increase as government final consumption expenditure fosters economic growth and augments the money supply (Berdiev and Saunoris, 2018; Khan and Rehman, 2022). Our findings align with previous studies, including Schneider et al. (2010), Berdiev and Saunoris (2018), Medina and Schneider (2018), Khan et al. (2021), and Tran et al. (2022), as well as Khan and Rehman (2022).

The Governance Index (GI) has a negative and statistically significant association with Shadow-1 across all quantiles. The governance index can negatively influence the ratio of reserves to narrow money due to several factors. Countries with low governance indices often suffer from weak institutional structures, corruption, and a lack of transparency. This situation can erode public confidence in both the government and the financial system, leading to reduced demand for narrow forms of currency like cash and demand deposits. If individuals and businesses opt for alternative storage methods, such as foreign currencies or tangible assets, the ratio of reserves to narrow money could further decrease. Moreover, a low governance index may deter foreign investments and capital inflows, hindering the accumulation of reserves and reducing general liquidity in the financial system. Consequently, a decline in reserves relative to narrow money can impact monetary stability and investor confidence. A low governance index compromises the credibility and effectiveness of governance institutions, negatively affecting the ratio of reserves to narrow money (Ruge, 2010; Manolas et al., 2013; Khan and Rehman, 2022). Our findings align with previous studies, including Schneider et al. (2010), Ruge (2010), Manolas et al. (2013), Elmirzaev and Elmurodov (2021), and Khan and Rehman (2022).

The Economic Freedom Index (EFI) is negatively associated with Shadow-1 across all quantiles. This effect is significant in all quantiles except the 0.10 and 0.25 quantiles. The negative impact of the economic freedom index on Shadow-1 can be attributed to the index measuring a nation's level of economic liberty. Factors such as government regulations, protection of property rights, and ease of doing business are considered in this index. Lower economic freedom often leads to increased government regulations and intervention in the economy. This may result in inefficiencies, administrative hurdles, and barriers to entry for businesses. Consequently, limitations in the financial industry can arise, making it challenging for banks to operate freely and efficiently. In such a scenario, the ratio of reserves to narrow money, which indicates the percentage of reserves held by a central bank relative to the total issuance of narrow money, may suffer. Excessive regulations and governmental oversight can restrict the banking system's flexibility and independence, making it harder to maintain adequate reserve levels and effectively control the money supply. Ultimately, this could negatively impact the ratio of reserves to narrow money, potentially leading to financial system instability and diminished confidence in the currency (Schneider et al., 2010; Khan and Rehman, 2022). Our findings are consistent with previous studies, including Schneider et al. (2010), Khan et al. (2021), and Khan and Rehman (2022).

Table 9 and Figure A.2 present the MMQR estimates for Shadow-2, defined as the ratio of narrow to broad money. As in the first model, the regressors are trade, tax revenue, unemployment, GFCE, GI, and EFI. The estimates therefore permit comparison of the signs and significance of associations

across alternative monetary indicators. However, differences between Shadow-1 and Shadow-2 may also arise from variation in monetary composition, banking structures, and deposit behaviour.

Trade exhibits a positive and statistically significant association with Shadow-2 across all quantiles, with values being higher compared to those in Table 8. Tax also is positively associated with Shadow-2 in all quantiles. However, the effect of tax on Shadow-2 is significant except for the 0.10, 0.75, and 0.90 quantiles, and the values are smaller in comparison to those presented in Table 8.

Table 9: MM-QR Estimates for the Monetary Indicators of Shadow Economy based on Ratio of Narrow to Broad Money

DV: Ratio of Narrow to Broad Money (Shadow-2)							
Variables	**Location**	**Scale**	**Q 0.10**	**Q 0.25**	**Q 0.50**	**Q 0.75**	**Q 0.90**
TRADE	0.0257***	0.00733	0.0141***	0.0196***	0.0245***	0.0303***	0.0432***
	(0.00541)	(0.00500)	(0.00430)	(0.00282)	(0.00458)	(0.00817)	(0.0161)
TAX	0.0100*	0.00359	0.00433	0.00704***	0.00944**	0.0123	0.0186
	(0.00522)	(0.00483)	(0.00415)	(0.00272)	(0.00454)	(0.00798)	(0.0161)
UNEMP	-0.0251***	0.00521	0.0174***	0.0208***	-0.0239***	0.0287***	0.0346***
	(0.00435)	(0.00365)	(0.00340)	(0.00281)	(0.00371)	(0.00640)	(0.0103)
GFCE	0.0210***	0.00793**	0.00925**	0.0144***	0.0191***	0.0264***	0.0355***
	(0.00481)	(0.00403)	(0.00376)	(0.00313)	(0.00410)	(0.00703)	(0.0114)
GI	-0.200***	0.0723*	-0.0929**	-0.140***	-0.183***	-0.250***	-0.332***
	(0.0484)	(0.0406)	(0.0378)	(0.0314)	(0.0413)	(0.0708)	(0.115)
EFI	0.311***	0.166**	-0.0483	-0.174***	-0.284***	-0.416***	-0.707***
	(0.0821)	(0.0760)	(0.0668)	(0.0431)	(0.0690)	(0.125)	(0.241)
Constant	0.185***	0.105***	0.0449	0.0868*	0.156***	0.283***	0.346***
	(0.0554)	(0.0331)	(0.0554)	(0.0503)	(0.0543)	(0.0740)	(0.0910)

*Source: by the author. Note. Standard errors are reported in parentheses. *** p < .01, ** p < .05, * p < .10.*

Unemployment shows a positive association with Shadow-2 across all quantiles, except the 0.50 quantile. The effect of unemployment on Shadow-2 is significant in the reported estimates, with coefficients that should be compared across specifications rather than within Table 9 alone. Similarly, GFCE shows a positive and statistically significant association with Shadow-2 across all quantiles, with values smaller than those in Table 9. GI shows a negative and statistically significant association with Shadow-2 across all quantiles, with values smaller than those in Table 9. In contrast, EFI is negatively associated with Shadow-2 across all quantiles. The effect of EFI on Shadow-2 is significant except for the 0.10 quantile, and the values are greater than those in Table 9.

Table 10 and Figure A.3 present the MMQR estimates for Shadow-3, measured as currency in circulation relative to broad money. The explanatory variables remain trade, tax revenue, unemployment, GFCE, GI, and EFI. The reported results show that trade is positively and significantly associated with Shadow-3 across the examined quantiles. Nevertheless, an association with currency holdings should not automatically be interpreted as a proportional change in

unrecorded production, because currency demand is influenced by both formal and informal transactions.

Table 10: MM-QR Estimates for the Monetary Indicators of Shadow Economy based on Ratio of Currency in Circulation to Broad Money

DV: Ratio of Currency in Circulation to Broad Money (Shadow-3)							
Variables	**Location**	**Scale**	**Q 0.10**	**Q 0.25**	**Q 0.50**	**Q 0.75**	**Q 0.90**
TRADE	4.359***	0.765*	3.151***	3.731***	4.279***	4.881***	5.969***
	(0.601)	(0.450)	(0.618)	(0.499)	(0.571)	(0.818)	(1.418)
TAX	0.0630***	0.00347	0.0576***	0.0599***	0.0627***	0.0660***	0.0682***
	(0.00784)	(0.00425)	(0.00957)	(0.00826)	(0.00782)	(0.00911)	(0.0107)
UNEMP	0.164***	0.0543	0.0803	0.116*	0.160**	0.212***	0.246***
	(0.0625)	(0.0338)	(0.0763)	(0.0660)	(0.0627)	(0.0726)	(0.0856)
GFCE	4.274***	0.0626	4.177***	4.218***	4.270***	4.330***	4.368***
	(0.642)	(0.348)	(0.783)	(0.676)	(0.639)	(0.746)	(0.878)
GI	0.211***	0.0687**	-0.105	-0.150**	-0.206***	-0.272***	-0.314***
	(0.0572)	(0.0310)	(0.0699)	(0.0605)	(0.0578)	(0.0664)	(0.0786)
EFI	2.346	-7.322***	-6.065***	-0.254***	-4.502*	-0.220**	-0.302***
	(1.812)	(2.378)	(2.134)	(0.0372)	(2.418)	(0.0954)	(0.114)
Constant	0.209***	-0.0239	0.243***	0.230***	0.214***	0.191***	0.164
	(0.0533)	(0.0367)	(0.0481)	(0.0432)	(0.0489)	(0.0724)	(0.108)

*Source: by the author.Note. Standard errors are reported in parentheses. *** $p < .01$, ** $p < .05$, * $p < .10$.*

Unemployment is positively associated with Shadow-3 across all quantiles. The effect of unemployment on Shadow-3 is significant except at the 0.10 quantile, with values lower than those in Table 8 but higher than those in Table 9. Government final consumption expenditure (GFCE) shows a positive and statistically significant association with Shadow-3 across all quantiles, with values being lower than those in Table 8 but higher than those in Table 9. The governance index (GI) exhibits a negative impact on Shadow-3 in all quantiles. The effect of GI on Shadow-3 is significant, except for the at0 quantile, with values being lower than those in Tables 8 and 9. The economic freedom index (EFI) has a negative and statistically significant association with Shadow-3 across all quantiles, with values being lower than those in Tables 8 and 9.

Cross-model interpretation and limitations. Across the three specifications, the broad signs reported for trade, tax revenue, unemployment, GFCE, governance, and economic freedom provide a useful basis for comparing the sensitivity of different monetary indicators. Nevertheless, differences in statistical significance and magnitude across quantiles should be treated as substantively important rather than red,unotngle claim of uniform effects. In addition, these estimates may be influenced by common regional shocks, differences in monetary aggregates, reverse causality, or omitted financial-sector variables. The present models do not supply separate country-specific estimates or an independent benchmark of informal output. Therefore, the evidence supports conclusions about associations with the three proxies; it does not establish the causal effects of the regressors on the measured size of the shadow economy (Schneider & Buehn, 2018; Machado & Silva, 2019).

6. Conclusions and Policy Recommendations

This study investigates the determinants of the shadow economy in seven SAARC countries during 1995–2021, with particular attention to monetary indicators associated with informal economic

activity. The analysis considers structural and institutional factors relevant to policy formulation, tax revenue, employment, government consumption, governance, and economic freedom. By applying MMQR to three monetary ratios, the study examines whether these relationships vary across the distribution of each indicator. This contributes regional evidence while retaining an important distinction between the indicators analysed and the unobserved size of the shadow economy.

The reported results suggest that trade, tax revenue, unemployment, and GFCE are positively associated with the reserve-money-to-narrow-money ratio (Shadow-1), whereas GI and EFI are negatively associated with this indicator, subject to differences in significance across quantiles. Similarly, the estimates for narrow money relative to broad money (Shadow-2) generally show positive associations for trade, tax revenue, unemployment, and GFCE and negative associations for GI and EFI. In addition, the third specification reports comparable broad patterns for currency in circulation relative to broad money (Shadow-3). However, the strength and statistical significance of individual coefficients differ across models and quantiles, and these findings are associations with monetary measures rather than direct estimates of changes in informal GDP.

The study contributes to the empirical literature by examining three monetary indicators within a common SAARC framework and applying MMQR to assess distributional differences. Although monetary ratios have been used in research on informal economic activity, they capture several aspects of financial and monetary behaviour. Therefore, the contribution lies primarily in comparing their associations with institutional and macroeconomic variables across quantiles, rather than in providing a direct measurement of the size of the shadow economy (Schneider & Buehn, 2018; Machado & Silva, 2019).

The findings have policy relevance when interpreted alongside the limitations of the indirect monetary indicators. Accordingly, policy implications should emphasise institutional effectiveness, the conditions supporting formal employment, and the quality of public expenditure rather than assume that changes in a monetary ratio necessarily represent corresponding changes in unrecorded output.

- First, SAARC governments could prioritise improved governance and the institutional conditions associated with greater economic freedom. The negative associations of GI and EFI with the monetary indicators are consistent with the literature highlighting the roles of corruption control, regulatory quality, and institutional credibility (Dreher & Schneider, 2010; Medina & Schneider, 2018). However, the present estimates do not establish that a specific increase in either index will cause an equivalent reduction in the shadow economy. Policy design should therefore consider the institutional circumstances of each economy.
- Second, addressing unemployment and improving the efficiency and targeting of public spending may support transitions into formal employment. The positive associations of unemployment and GFCE with the monetary indicators warrant further investigation; however, they do not justify an across-the-board reduction in essential public services. Instead, governments should assess the composition and effectiveness of expenditure while strengthening labour-market opportunities, social protection, and administrative capacity (Medina & Schneider, 2018; Tran et al., 2022).
- Third, the positive association between tax revenue as a percentage of GDP and the monetary ratios should not be equated with evidence that higher statutory tax rates increase the shadow economy. Tax revenue and tax rates measure different concepts; indeed, revenue also responds to economic activity, collection efficiency, and compliance. Therefore, decisions about tax rates require additional analysis of tax design, administrative burdens, and enforcement. Simplifying compliance and improving trust in public institutions may be useful approaches to consider alongside tax policy (Kirchler, 2007; Medina & Schneider, 2018).

For comparative policy use, the results can be organised around three areas. Institutional policies concern governance, corruption control, and regulatory quality; labour-market policies concern

employment opportunities and incentives to register activity; and fiscal policies concern the efficiency of expenditure and the design and administration of taxes. Each area may be relevant across SAARC economies, but implementation should account for country-specific administrative capacity and economic conditions. Moreover, the quantile results suggest that a single regional policy prescription may overlook heterogeneity across monetary conditions, although this study does not identify separate national treatment effects.

7. Recommendations for Future Research

Future research should assess alternative indicators of the shadow economy and validate the monetary proxies against independently constructed estimates, including MIMIC-based measures (Medina & Schneider, 2018; Schneider & Buehn, 2018). In addition, researchers could investigate unemployment, agricultural employment, labour-force participation, and GDP per capita growth, together with structural changes in banking systems, financial inclusion, and digital payments. Country-specific models, alternative panel specifications, and tests for potential endogeneity would help determine whether the reported relationships are robust across SAARC economies. Replication using harmonised monetary definitions and transparent source metadata would further strengthen comparability and the interpretation of quantile-based evidence. Furthermore, future analyses could compare the sensitivity of the three monetary ratios to changes in banking-sector reserve requirements, financial deepening, and currency-substitution patterns. Such comparisons would help distinguish changes in monetary composition from changes in unrecorded productive activity. Researchers could also examine whether the estimated associations remain stable before and after major regional economic disruptions, while documenting the country coverage, variable definitions, missing observations, and model assumptions used in each specification. These extensions would strengthen the interpretation and transferability of the present SAARC evidence without treating monetary ratios as direct estimates of the shadow economy or claiming a causal effect from the existing regressions.

Ethical statement: Not Applicable

Conflicts of interest: The authors declare that there are no conflicts of interest.

Funding statements: No external funding was received for this research.

AI Declaration Statement: AI tools (ChatGPT) were used for proofreading. After using this tool/service, the author(s) reviewed and edited the content as needed and take(s) full responsibility for the content of the publication.

References

Abdih, M. Y., & Medina, L. (2013). Measuring the informal economy in the Caucasus and Central Asia. International Monetary Fund.

Abu Alfoul, M. N., Khatatbeh, I. N., & Jamaani, F. (2022). What determines the shadow economy? An extreme bounds analysis. *Sustainability*, *14*(10), 5761.

Acosta-González, E., Fernández-Rodríguez, F., & Sosvilla-Rivero, S. (2014). An empirical examination of the determinants of the shadow economy. *Applied Economics Letters*, *21*(5), 304-307.

Angour, N., & Nmili, M. (2019). Estimating shadow economy and tax evasion: Evidence from Morocco. *International Journal of Economics and Finance*, *11*(5), 1-7.

Berdiev, A. N., & Saunoris, J. W. (2018). Does globalisation affect the shadow economy? *The World Economy*, *41*(1), 222-241.

Binder, M., & Coad, A. (2011). From average Joe's happiness to miserable Jane and cheerful John: using quantile regressions to analyze the full subjective well-being distribution. *Journal of Economic Behavior & Organization*, *79*(3), 275-290.

Blomquist, J., & Westerlund, J. (2013). Testing slope homogeneity in large panels with serial correlation. *Economics Letters*, *121*(3), 374-378.

Breusch, T. S., & Pagan, A. R. (1980). The Lagrange multiplier test and its applications to model specification in econometrics. *The Review of Economic Studies*, *47*(1), 239-253.

Cagan, P. (1958). The demand for currency relative to the total money supply. *Journal of Political Economy*, *66*(4), 303-328.
Cerasa, A. (2008). CIPS test for unit root in panel data: further Monte Carlo results. *Economics Bulletin*, *3*(16), 1-13.
Çinar, S., & Nur, H. B. (2018). Determinants and stability demand for money: A sample of BRIC-T countries. *The Empirical Economics Letters*, *17*(7), 852-862.
Davidescu, A. A. (2017). What are the main determinants of the Romanian shadow economy? An empirical analysis based on structural equation models. In *Development, growth and finance of organizations from an Eastern European context* (pp. 159-170). Springer, Cham.
Din, B. H. (2016). Estimating the determinants of shadow economy in Malaysia. *Malaysian Journal of Society and Space, 12*(5), 191-201.
Dreher, A., & Schneider, F. (2010). Corruption and the shadow economy: an empirical analysis. *Public Choice*, *144*(1), 215-238.
Elmirzaev, S., & Elmurodov, S. (2021). Determinants of shadow economy in Asian countries. *Financial and Economic Sustainability*, *1*(1), 1-9.
Feige, E. L. (1994). The underground economy and the currency enigma. *Macroeconomics*, *49*(Supplement), 119-136.
Frey, B. S., & Pommerehne, W. W. (1984). The hidden economy: state and prospects for Measurement 1. *Review of Income and Wealth*, *30*(1), 1-23.
Garcia, M. T. M., & de Freitas Sanches, D. M. A. (2021). The shadow economy determinants-The case of Portugal. *Journal of Tax Administration*, *6*(2), 76–94.
Gasparėnienė, L., Remeikienė, R., & Heikkila, M. (2016). Evaluation of the impact of shadow economy determinants: Ukrainian case. *Intellectual Economics*, *10*(2), 108-113.
Goel, R. K., & Nelson, M. A. (2016). Robust determinants of the shadow economy: An international comparison (CESIFO Working Paper No. 5873). Center of Economic Studies, IFO.
Gyomai, G., & Van de Ven, P. (2014). The non-observed economy in the system of national accounts. *Statistics Brief*, *18*(1), 1-12.
Hassan, M., & Schneider, F. (2016). Size and development of the shadow economies of 157 countries worldwide: Updated and new measures from 1999 to 2013 (Discussion Paper No. 10281). Institute of Labor Economics
Ike, G. N., Usman, O., & Sarkodie, S. A. (2020). Testing the role of oil production in the environmental Kuznets curve of oil producing countries: New insights from Method of Moments Quantile Regression. *Science of the Total Environment*, *711*(2020), 1-10.
International Labor Organization (1972). Employment, incomes and equality: A strategy for increasing productive employment in Kenya. ILO, Geneva.
Kao, C. (1999). Spurious regression and residual-based tests for cointegration in panel data. *Journal of Econometrics*, *90*(1), 1-44.
Khan, S., & Rehman, M. Z. (2022). Macroeconomic fundamentals, institutional quality and shadow economy in OIC and non-OIC countries. *Journal of Economic Studies*, 49(8), 1566-1584.
Khan, S., Hamid, B. A., & Rehman, M. Z. (2021). Determinants of shadow economy in OIC and non-OIC countries: the role of financial development. *International Journal of Emerging Markets*, *18*(10), 3373-3393.
Kirchler, E. (2007). *The economic psychology of tax behaviour*. Cambridge University Press.
Koenker, R., & Bassett Jr, G. (1978). Regression quantiles. *Econometrica: Journal of the Econometric Society*, *46*(1), 33-50.
Lahlou, K., Doghmi, H., & Schneider, F. (2020). The size and development of the shadow economy in Morocco. *Document de travail*, Bank Al-Maghrib, Morocco.
MacAfee, K. (1980). A glimpse of the hidden economy in the national accounts. *Economic Trends*, *136*(1), 81-87.
Machado, J. A., & Silva, J. S. (2019). Quantiles via moments. *Journal of Econometrics*, *213*(1), 145-173.
Manolas, G., Rontos, K., Sfakianakis, G., & Vavouras, I. (2013). The determinants of the shadow economy: The case of Greece. *International Journal of Criminology and Sociological Theory*, *6*(1), 1036-1047.
Medina, L., & Schneider, M. F. (2018). Shadow economies around the world: what did we learn over the last 20 years? International Monetary Fund.

Mughal, K., & Schneider, F. (2018). Shadow economy in Pakistan: Its size and interaction with official economy. Retrieved from: https://mpra.ub.uni-muenchen.de/87087/

Navickas, M., Juščius, V., & Navickas, V. (2019). Determinants of shadow economy in Eastern European countries. *Scientific Annals of Economics and Business*, *66*(1), 1-14.

Neal, T. (2014). Panel cointegration analysis with xt pedroni. *The Stata Journal*, *14*(3), 684-692.

O'Connell, P. G. (1998). The overvaluation of purchasing power parity. *Journal of International Economics*, *44*(1), 1-19.

O'Neill, D. M. (1983). Growth of the underground economy, 1950-81: Some evidence from the current population survey: a study (Vol. 98). US Government Printing Office.

Pesaran, M. H., & Yamagata, T. (2008). Testing slope homogeneity in large panels. *Journal of Econometrics*, *142*(1), 50-93.

Portes, A. (1996). The informal economy. In exploring the underground economy, edited by S. Pozo. WE Upjohn Institute for Employment Research: Kalamazoo, MI.

Portes, A., Castells, M., & Benton, L. A. (Eds.). (1989). The informal economy: Studies in advanced and less developed countries. JHU Press.

Putniņš, T. J., & Sauka, A. (2015). Measuring the shadow economy using company managers. *Journal of Comparative Economics*, *43*(2), 471-490.

Reilly, B., & Krstic, G. (2018). Shadow Economy: Is an Enterprise Survey a Preferable Approach? *Panoeconomicus*, 66 (5), 589-610.

Remeikienė, R., Gasparėnienė, L., & Kartašova, J. (2014). Country-level determinants of the shadow economy during 2005-2013: the case of Greece. *Mediterranean Journal of Social Sciences*, *5*(13), 454-460.

Ruge, M. (2010). Determinants and size of the shadow economy–a structural equation model. *International Economic Journal*, *24*(4), 511-523.

Schneider, F. (1994). Measuring the size and development of the shadow economy. Can the causes be found and the obstacles be overcome? In: Brandstätter, H., Güth, W. (eds) Essays on Economic Psychology. Springer, Berlin, Heidelberg. Retrieved from: https://doi.org/10.1007/978-3-642-48621-0_10

Schneider, F. (2010). The influence of public institutions on the shadow economy: An empirical investigation for OECD countries. *Review of Law & Economics*, *6*(3), 441-468.

Schneider, F. (2015). Shadow economy and shadow labor market: Developments over the past 20 years. *Economic Policy Perspectives*, *16* (1), 3-25.

Schneider, F., & Buehn, A. (2018). Shadow economy: Estimation methods, problems, results and open questions. *Open Economics*, *1*(1), 1-29.

Schneider, F., & Williams, C. C. (2013). The shadow economy (IEA Ed.). Institute of Economic Affairs, London.

Schneider, F., Buehn, A., & Montenegro, C. E. (2010). New estimates for the shadow economies all over the world. *International Economic Journal*, *24*(4), 443-461.

Smith, P. M. (1997). Assessing the size of the underground economy: The statistics Canada perspective. *The underground economy: Global evidence of its size and impact*, 11-37. The Fraser Institute, British Columbia, Vancouver, Canada.

Swamy, P. A. (1970). Efficient inference in a random coefficient regression model. *Econometrica: Journal of the Econometric Society*, 311-323.

Tran, T. P. K., Tran, N. P., Van Nguyen, P., & Vo, D. H. (2022). Government expenditure–shadow economy nexus: the role of fiscal deficit. *International Journal of Emerging Markets*, *19*(2), 322-338.

Westerlund, J. (2007). Testing for error correction in panel data. *Oxford Bulletin of Economics and statistics*, *69*(6), 709-748.

Westerlund, J., Hosseinkouchack, M., & Solberger, M. (2016). The local power of the CADF and CIPS panel unit root tests. *Econometric Reviews*, *35*(5), 845-870.

Williams, C. C., & Schneider, F. (2016). Measuring the Global Shadow Economy: the prevalence of informal work and labour. Edward Elgar Publishing.

Appendix

Table A.2: Data: Description and Sources

Variables	Description	Measurement Units	Sources
SHADOW1	Ratio of reserve to narrow money	US$ Billion	Central Banks of SAARC countries
SHADOW2	Ratio of narrow to broad money	US$ Billion	Central Banks of SAARC countries
SHADOW3	Ratio of the currency in circulation to broad money	US$ Billion	Central Banks of SAARC countries
TRADE	Trade	% of GDP	WDI
TAX	Tax revenue	% of GDP	WDI
UNEMP	Unemployment Rate	% of total labor force (modeled ILO estimate)	WDI
GFCE	Government Final Consumption Expenditure	% of GDP	WDI
GI	Governance Index	Index	WGI
EFI	Economic freedom Index	Index	The Heritage Foundation

Source: by the author

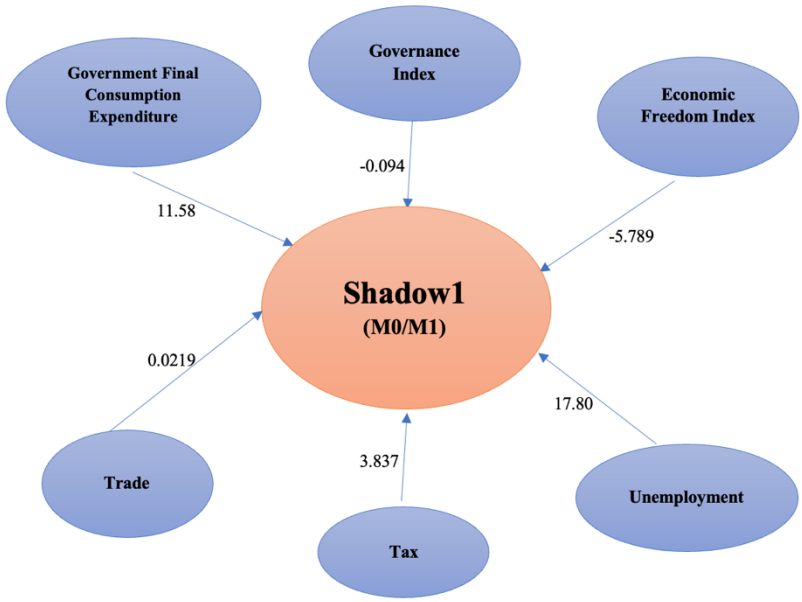


Figure A.1: MMQR Estimates for the Monetary Indicators of Shadow Economy based on Shadow 1 (at $Q_{0.50}$)

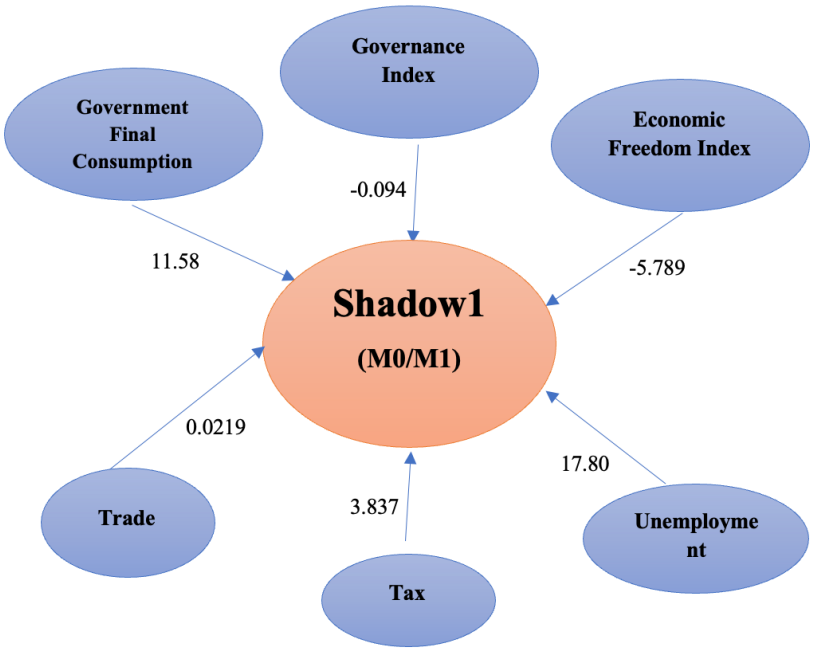


Figure A.2: MMQR Estimates for the Monetary Indicators of the Shadow Economy based on Shadow 2 (at $Q_{0.50}$)

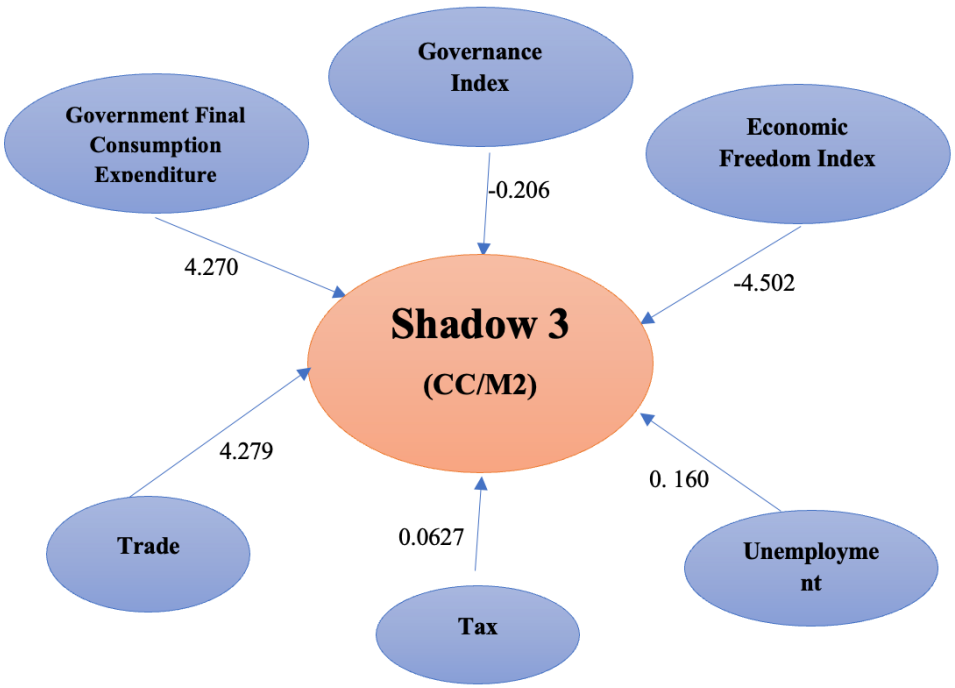


Figure A.3: MMQR Estimates for Monetary Indicators of Shadow Economy based on Shadow 3 (at $Q_{0.50}$)