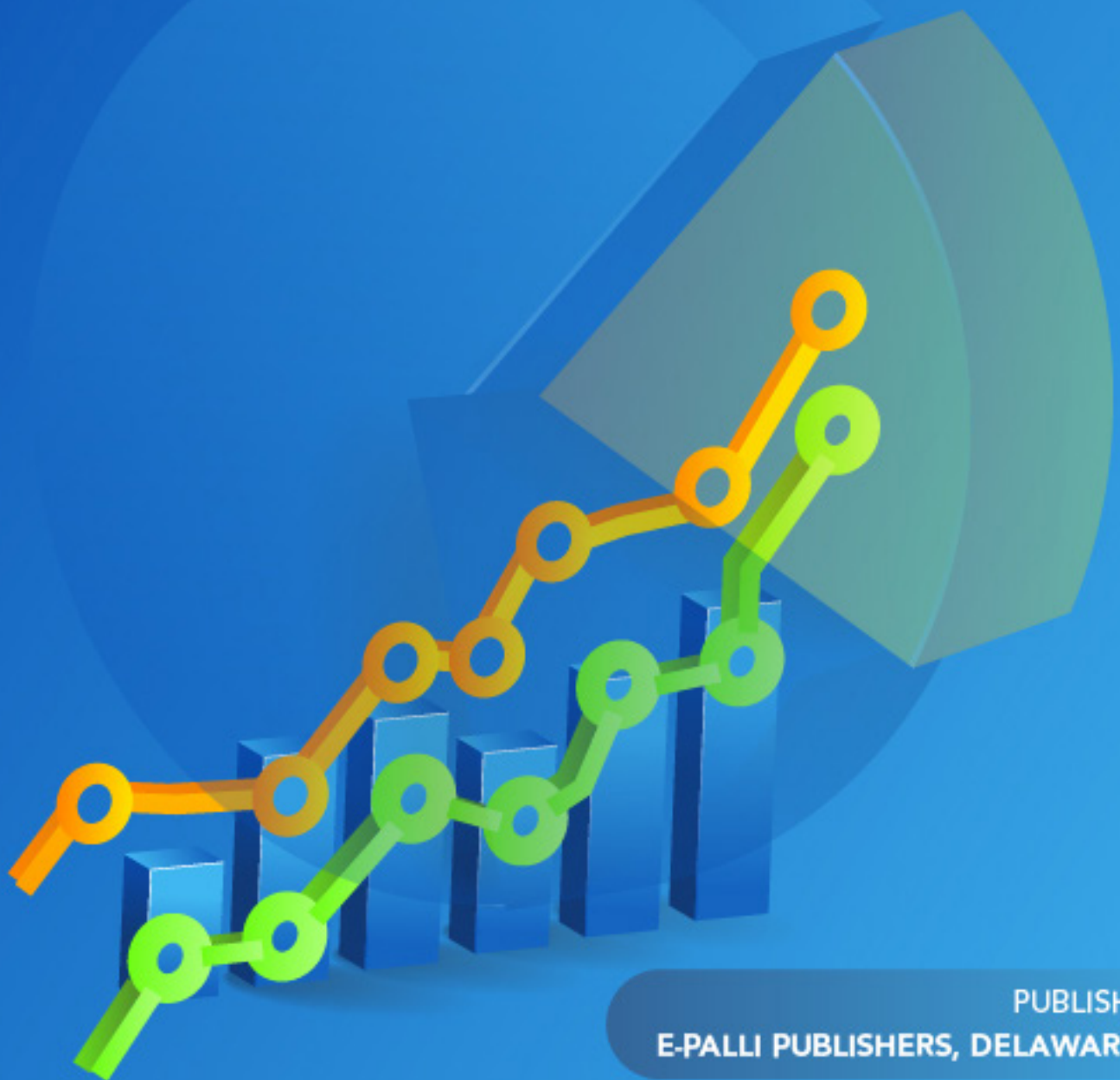




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Proxy (Indirect) Methods to Measure Informal Economy of Pakistan (2001–2025): A Comparative Study

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ABSTRACT

Measuring Pakistan's informal economy is intractable without direct data. This study is the first to systematically integrate, implement, and validate ten indirect proxy methods; non-monetary (electricity consumption, labor force), monetary (currency demand, cash-to-deposit ratio, large notes), income-expenditure (national accounts), and latent-variable (MIMIC and dynamic general equilibrium models) over the 2001–2025 period. Implementation follows rigorous protocols: electricity consumption is adjusted for non-residential usage and transmission losses via sectoral load factors; currency demand is estimated using a cointegrating ARDL framework that incorporates tax-to-GDP ratios and real interest rates; and the MIMIC model, validated through confirmatory factor analysis and Bayesian robustness checks, incorporates GDP per capita, corruption indices, and institutional quality as causal variables. Triangulation employs a range-bound convergence algorithm, weighting each estimate inversely to its forecast-error variance derived from pseudo-out-of-sample back-casting. Quantitative results reveal pronounced heterogeneity: the electricity-based proxy averages 26–30% (mean 28%); the currency-demand approach yields 38–44% (mean 41%); MIMIC and DGE estimates converge at 32–36% (mean 34%); and national accounts show the highest volatility, ranging 30–45%. The triangulated composite stabilizes at 34–38%, offering a robust baseline. Key limitations monetary proxies' sensitivity to velocity shifts, electricity estimates' dependence on stable elasticities amid energy crises, and latent-model endogeneity are bounded via sensitivity corridors. Policy-wise, differentiated estimates provide actionable intelligence: monetary measures inform anti-money laundering efforts, electricity metrics guide tax-gap adjustments, and the composite anchors fiscal consolidation under IMF programs. We conclude by proposing a concrete institutional roadmap to embed a validated, quarterly-updated hybrid weighting framework within Pakistan's national statistical system, replacing ad-hoc single-metric reliance.

INTRODUCTION

The occurrences of September 11, 2001, have had an impact on Pakistan's economic and geopolitical trends such that there was a structural shift. The changes in alliances, influxes of foreign aid and remittances, increased security budget allocations, and heightened scrutiny, especially of cross-border financial transactions, meant a fundamental change in the dynamics affecting the motivations of individuals to conduct business beyond the scope of the regulatory framework (Husain, 2018; Zaidi, 2015). Under this situation, the informal economy, which may be described as the market-based production of goods and services deliberately kept away from the purview of the government to avoid taxation and other costs associated with formal regulations (Schneider & Enste, 2000), has remained robust and even expanded according to various estimates.

According to current estimates, the size of the informal economy in Pakistan accounts for anything between 30 and 50 percent of the country's gross domestic product, with both the International Labor Organization and the Small and Medium Enterprises Development Authority estimating that the informal economy accounts for about 40 percent of GDP, which is worth more than US\$457

billion (ILO & SMEDA, 2024). According to the Pakistan Business Council, which used trade based discrepancy approach, the size of the informal economy might be equal to that of the formal economy with the illicit trade alone constituting around 10 percent of the country's total economic activity (Pakistan Business Council, 2023). In addition, the State Bank of Pakistan noted that the informal segment amounts to approximately 30–40 percent of GDP due to the dominance of cash based businesses that do not pay taxes (State Bank of Pakistan, 2023).

The problem of estimating the size of the informal economy goes beyond a mere academic concern, but rather is of great significance for fiscal policy, monetary management, social security, and institution building. A conservative approach towards the informal sector means overly optimistic targets for revenues and a biased assessment of macroeconomic projections and social safety net systems. On the contrary, a biased high estimate of the informal sector would mean an overly negative view of the efficiency of institutional structures and less incentives to invest in the officially registered sector. Post 9/11 provides us with several economic crises that can serve well for our analysis since the period

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includes both periods of high growth rates (2002-2007), serious problems with the balance of payments (2008, 2018-2019), structural reforms within successive IMF programs, a shock from the coronavirus disease outbreak of 2020-2021, and an inflationary shock of 2022-2024.

The reason for the fact that informal sector activity is not observable, makes it necessary for the researcher to employ several proxy techniques to estimate the size of the informal sector. Such proxy techniques include the use of: (a) non-monetary indicators based on physical variables such as energy consumption levels and labor force imbalances; (b) monetary proxy techniques exploiting the link between the cash balances and transactions conducted without keeping proper records; (c) income-expenditure discrepancy techniques that make comparisons of two independently measured levels of aggregate income and expenditure; (d) multiple indicator latent variable techniques which are typified by the multiple indicators multiple causes (MIMIC) structural equations approach and dynamic general equilibrium (DGE) models; and (e) bilateral trade statistics techniques that use trade balance disparities.

Although there has been an increase in number of studies carried out in Pakistan using some or other of these approaches by Arby (2010), which used monetary approach, electricity consumption approach, and MIMIC approach; Mughal & Schneider (2018), which measured the shadow economy through currency demand approach; Kemal & Qasim (2012), which created a discrepancy-based consumption adjustment approach; as well as the informal economy database of the World Bank, which has MIMIC approach and DGE approach estimations for Pakistan there still does not exist any systematic and comparative study after 9/11, which utilizes all proxy methods and evaluates the differences between them along with its policy implications. This paper aims at filling this void (Shahzad, et al; 2023).

The central research question posed is: How do the major proxy-based measures of the informal economy differ with respect to their magnitudes, trends, and volatilities in estimating the informal economy of Pakistan between the years 2001-2025, and what are the policy implications of these disparities for evidence-based policy-making? By answering this research question, the study will make four contributions to the existing body of literature. Firstly, it will present an approach for implementing all important proxy methods of estimating the informal economy within one single consistent framework. Secondly, it will develop a series of comparable annual measures of the informal economy for the last 25 years since the terrorist attacks of 9/11. Thirdly, it will perform an in-depth comparison and critique of the measures in order to determine the reasons for disparities and to assess the advantages and drawbacks of each measure in the institutional setting of Pakistan. Fourthly, it will derive policy recommendations on how to implement a multi-proxy strategy within the statistical production process of the national accounts of Pakistan.

From the literature reviewed above on the measurement of the informal economy in Pakistan, there appear to be three main gaps in this line of research that this study aims to address.

The first gap pertains to the use of only one measurement method in any single study. Arby (2010) is a rare case, using monetary, electricity consumption, and MIMIC methodologies simultaneously in his study, although he stops with data through the middle of the last decade and does not account for the post 2008 financial crisis era, the period of the China Pakistan Economic Corridor, the COVID 19 crisis, and the most recent inflationary period. Mughal and Schneider (2018) make estimates of currency demand from 1973 through 2015, but nothing beyond that period and a comparison with other non-monetary techniques. Kemal & Qasim (2012) provide a methodology based on the discrepancies approach for one single year of 2007-08, making trend analysis impossible. The world bank informal economy database provides estimates of MIMIC and DGE from 1990 through 2020, which are model dependent and have not been compared with other physical indicators approaches.

Secondly, while proxy approaches to trade-based methodologies and analyses of trade mis-invoicing have been used extensively to estimate illicit financial flows and capital flight out of Pakistan (Pakistan Business Council, 2023; Global Financial Integrity, 2022), these have not often been included in comparisons using monetary and latent variables to measure the full informal economy. The gap between illicit flows in the trading literature and measures of the informal economy is a wasted opportunity for triangulation.

Thirdly, while the post-9/11 era provides rich material as a distinct empirical period to examine, especially considering the impact of the year 2001 on Pakistan's political economy, as well as its varied macroeconomic environment, it has not been investigated as such by any previous study. This time period offers instances of substantial foreign aid inflows, intense security spending, tough regulatory frameworks under FATF compliance, extensive digitization of banking services including through the RAAST instant payment system and mobile banking services, and large exchange rate depreciations that must have affected informal activities in significant ways.

The present paper bridges the above mentioned gaps by applying all the major proxy methods to a common period 2001–2025 dataset, including the trade based proxies, which have not previously been evaluated against money based and latent variable proxies, and in the context of Pakistan's recent institutional and macroeconomic developments since 9/11.

Problem Statement

The informal sector in Pakistan is estimated to account for 30–50 % of its GDP, but even though there is no systematic effort, the government accounts include very little of the informal economy (ILO & SMEDA, 2024;

Pakistan Business Council, 2023). Lack of a standardized approach to measure it using multiple approaches creates widely differing estimates, making any forecasting of fiscal policies unreliable and hampering effective evaluation of tax policies and implementation of social protections measures. With the rise of alternative financial services after 9/11, undocumented cross-border business transactions following the Afghan Transit Trade agreement, and development of mobile digital platforms used for transactions, the measurement problem became significantly aggravated. Without comparing the main proxy techniques using one dataset covering 2001–2025, the policymakers will not have enough grounds to choose an approach, understand its pros and cons, and implement measures accordingly.

Significance of the Study

The relevance of the proposed research is manifold. From the academic perspective, this research will be the first thorough multi-method comparative assessment of approaches for measuring the informal economy in Pakistan during the post-9/11 era. By employing all key proxy methodologies on the same data set, the proposed research will contribute to the international shadow economy measurement literature, which surprisingly lacks comparative validation efforts, even in the case of large emerging economies (Schneider & Enste, 2000; Buehn & Schneider, 2012).

From the practical perspective, the research will provide valuable answers to an urgent problem. Chronic deficits in the Pakistani budget, the tax-to-GDP ratio below 9–10 %, and recurring IMF stabilization plans are, to a considerable extent, attributable to the limited scope of the tax base, which is determined by the size of the informal economy (State Bank of Pakistan, 2023).

A reliable measurement of the informal economy is the basis for the estimation of potential tax revenues from base broadening, compliance, and realistic fiscal goals. The comparative analysis will reveal the methods whose results depend most sensitively on those components related to the tax burden and regulatory quality, which are subject to policy influence, thus indicating what measurements should regularly be made by the Federal Board of Revenue and the Ministry of Finance.

From the standpoint of the national institutions of the country, the study develops a methodology for measuring the informal economy and incorporating the results into the system of official statistics in Pakistan. Specifically, the study presents all the data sources, methods of economic analysis, and caveats about interpreting the measurements for each method, which can serve as a manual for use by the Pakistan Bureau of Statistics and the State Bank of Pakistan when producing the informal economy estimates periodically.

Finally, from the perspective of society, improved knowledge about the scale and organization of the informal economy can have significant consequences for the design of social welfare initiatives such as the Benazir

Income Support Program and the Ehsaas program, which target people whose employment and business ventures are not visible to the government. Proper assessment forms the basis of a policy for inclusive formalization that protects the vulnerable without jeopardizing their means of existence.

Study Objectives and Research Questions

Objectives

1. To estimate the size of Pakistan's informal economy (as a percentage of official GDP) for the period 2001–2025 using nine distinct proxy methods.
2. To compare the magnitude, trend, and volatility of the estimates produced by each method.
3. To identify the sources of divergence among methods in terms of their underlying assumptions and sensitivity to macroeconomic and institutional variables.
4. To evaluate the relative strengths and limitations of each method in the specific institutional context of Pakistan.
5. To propose a triangulated measurement framework suitable for routine adoption by Pakistan's statistical agencies.

Research Questions

1. What are the annual estimates of the size of Pakistan's informal economy produced by non monetary, monetary, income expenditure, latent variable, and trade based proxy methods for the period 2001–2025?
2. How do these estimates differ in terms of average magnitude, trend direction, and inter temporal volatility?
3. Which methods are most sensitive to changes in tax burden, regulatory quality, financial development, and macroeconomic conditions?
4. What combination of methods provides the most robust and policy relevant estimate of Pakistan's informal economy?

LITERATURE REVIEW

Non Monetary Indicator Methods

Electricity Consumption Method

The electricity consumption approach hinges on the presumption that the elasticity of electricity use vis-a-vis the aggregate economic activities is close to one. Where official GDP data is available and electricity usage is increasing more rapidly than can be accounted for by increases in the formal sector, the difference is assumed to be made up by the informal sector (Kaufmann & Kaliberda, 1996). According to Arby (2010), the application of this approach to Pakistan indicated that, on average, the size of the informal economy in Pakistan was around 30 percent of the GDP and declining throughout the decade of the 2000s. One disadvantage of this method as used in Pakistan is the existence of electricity theft and consumption without metering, which could lead to overestimating the difference. Also, technological advances in recent years, such as increased use of solar energy since 2020, have reduced the reliability

of electricity-output elasticity (Global Electricity Review, 2025).

(H1): *The electricity consumption method yields informal economy estimates for Pakistan that are positively correlated with the estimates from the MIMIC model but exhibit greater year on year volatility owing to supply side disruptions and measurement error in electricity data.*

Labor Force Discrepancy Method

The method used here involves comparing the official data on employment to the overall participation rate of the labor force. An increase in unemployment without a corresponding decrease in formal sector employment is seen as a shift in informal employment (ILO, 2023). In Pakistan, it has been found that roughly 73-80 % of the non agricultural workforce in the country works in informal employment according to the Labor Force Survey of Pakistan (Pakistan Bureau of Statistics, 2024). According to Idris (2008), the informal sector contributed 36.8 % of GNP in the economy through employment-based approaches.

(H2): *The labor force discrepancy method produces informal economy estimates that are systematically lower than monetary and MIMIC estimates because it measures labor input rather than total value added.*

Monetary Proxy Indicator Methods

Currency Demand Approach

The currency demand approach, introduced by Tanzi (1983), assumes that the exchange within the informal sector mainly takes place in cash. The excess demand for money above and beyond its usual causes, namely income, interest rates, and financial development, results from informal economic activity. The estimate of the size of Pakistan's underground economy by Mughal and Schneider (2018) is around 25–26 % of GDP between 1973 and 2015 on the basis of ARDL and Engle Granger models. Habib *et al.* (2024) used the dynamic monetary approach to estimate Pakistan's shadow economy between 1980 and 2022, resulting in a share of about 27–49 % of GDP with an extreme value in 1998 followed by a fall. A particular problem in the context of Pakistan relates to the role of the hawala system.

(H3): *The currency demand method yields informal economy estimates that are sensitive to the choice of base year and the specification of the tax burden variable, and that diverge from electricity based estimates during periods of rapid financial digitalization.*

Cash to Deposit Ratio

This measure measures the level of currency in circulation in relation to the deposits in banks. An increase in the ratio of currency in circulation over deposits, adjusted for financial deepening and interest rates, is seen as indicative of increasing informal economic behavior (Gutmann, 1977). At present, Pakistan's ratio of currency in circulation over deposits has been calculated to be 34 %, much higher compared to India's 17.8 %

and Bangladesh's 16.7 % (Karandaaz Pakistan, 2024). According to the State Bank of Pakistan (2023), "the growth rate of currency in circulation from FY2015 to FY2023 averaged 17 % per annum, while deposits grew at only 12 % per annum."

(H4): *The cash to deposit ratio method yields informal economy estimates that are highly correlated with those from the currency demand approach but are more sensitive to short term changes in financial inclusion policy.*

Large Denomination Notes

A large proportion of circulation of high-value currency notes (in the case of Pakistan, Rs. 5,000 notes) has been linked to informal business dealings, tax avoidance, and financial crimes. The proportion of Rs. 5,000 notes among total notes printed in FY2016 was 17 % (Ministry of Finance, 2017). The suggestion to abolish Rs. 5,000 notes has been put forward as a solution to reduce the size of the informal sector (Nation, 2023), though the State Bank of Pakistan opposes it.

(H5): *The large denomination note indicator is a contemporaneous leading indicator of the size of the informal economy as estimated by the currency demand and MIMIC methods.*

Income/Expenditure Discrepancy Method

National Accounts Discrepancy

This approach entails comparing GDP calculations based on income approach with those based on the expenditure approach. As economic agents tend to underreport income but not expenditures, the difference between the measured level of expenditure and income is considered as an indicator of the size of the informal sector (Smith, 1985). Kemal & Qasim proposed a different variation of this approach which involved calculating total private expenditure through household surveys, accounting for trade mis-invoicing, and then comparing calculated "true" GDP with official GDP. In their study conducted on the period of 2007-08, they estimated informal sector to be 91 percent of the size of the formal sector.

(H6): *The national accounts discrepancy method yields informal economy estimates that are systematically higher than monetary and latent variable estimates because it captures all statistical discrepancies, not only those attributable to deliberate concealment.*

Multiple Indicator Methods (Statistical Modelling)

MIMIC Model

In the MIMIC (Multiple Indicators Multiple Causes) model, the informal sector is an unobservable latent construct. Structural equation modeling is applied to link observable causal factors like tax pressure, regulatory pressure, unemployment rate, and quality of institutions to observable indicator variables such as currency in circulation, electricity consumption, and labor participation rate (Schneider *et al.*, 2010). The World Bank's informal economy database shows an estimate for Pakistan based on the MIMIC method with an average of 35.48 % of GDP in the period of 1993-2020 and a range of 33.8 % to 36.8 %. The informal economy

percentage calculated by the MIMIC method for the period of 1995-2017 was estimated as 37.75 % by Malik (2021). The greatest benefit of the MIMIC model is that it can take into account numerous causes and indicators at the same time; its greatest disadvantage is the creation of index-type estimates which require calibration against a different standard.

(H7): *The MIMIC model yields informal economy estimates for Pakistan that are intermediate in magnitude between the monetary and electricity based estimates and exhibit lower inter temporal volatility.*

Dynamic General Equilibrium (DGE) Model

In DGE modeling, the informal economy is viewed as a result of optimization of the economic agent behavior regarding the allocation of time and other resources across the two economies depending on tax and regulation regimes and institutionalism levels (Elgin & Oztunali, 2012). For Pakistan, according to DGE calculations using data from the World Bank's dataset, the informal economy was estimated at about 33.35 % over the period of 1990–2020, varying from 34.9 % in 1990 to 31.6 % in 2020 (The Global Economy, 2023).

(H8): *DGE estimates of Pakistan's informal economy are positively correlated with MIMIC estimates but exhibit a smoother trend owing to the theoretical restrictions imposed by the general equilibrium framework.*

Trade Data Based Proxy Methods

Mirror Trade Statistics Method

Comparing the reported figures on the exports of a country to another partner against the reported imports by the partner from that country can indicate discrepancies that point to unrecorded trade activities or under invoiced cross-border transactions. Discrepancies where the partner reports a larger import figure compared to the declared export figures of the other party are considered indicative of such activities (Global Financial Integrity, 2022). In the case of Pakistan, there have been considerable gaps in the country's trade data, with a reported 11 billion discrepancies in import figures due to lack of connectivity between the Pakistan Revenue Automation Limited system and the Pakistan Bureau of Statistics (ExpressTribune,2025). The annual amount of smuggling has been estimated at 6-8 billion, although estimates of up to \$12 billion have also been made (The News, 2025).

(H9): *Mirror trade statistics estimates of informal cross border trade are positively correlated with currency demand estimates but capture a distinct component of informality that is not fully reflected in domestic monetary indicators.*

Trade Mis-invoicing Approach

Mis-invoicing, which is characterized by the intentional over or under valuation of imported/exported products in terms of their monetary value, volume, and classification, constitutes an important conduit for illicit financial flows and part of the wider informal economy phenomenon.

According to the Balance of Payments Manual of the International Monetary Fund, mis-invoicing can be detected using the inconsistencies between trade and financial accounts (IMF, 2009). An example of detecting mis-invoicing at a product-level using PPML gravity estimates for Pakistan is illustrated below (Pakistan Social Sciences Review, 2026).

(H10): *Trade mis-invoicing estimates capture a component of the informal economy that is complementary to, rather than duplicative of, domestic informal activity as measured by monetary and MIMIC methods, and therefore the combined trade based and domestic estimates produce a higher total than either approach alone.*

Conceptual Framework

The conceptual framework of this study is grounded in the premise that the informal economy is a multidimensional latent phenomenon that cannot be observed directly but manifests itself through multiple observable "traces" in the economic system. These traces fall into five domains, corresponding to the five families of proxy methods:

1. **Physical input traces:** Total economic activity (formal plus informal) consumes physical inputs principally electricity and labor. By modelling the relationship between these inputs and officially measured output, the residual unaccounted for input can be attributed to informal activity.

2. **Monetary traces:** Informal transactions are disproportionately conducted in cash. The demand for currency, the cash to deposit ratio, and the denomination structure of notes in circulation therefore contain information about the scale of hidden activity.

3. **Statistical discrepancy traces:** National accounting identities require that income, expenditure, and product measures of GDP be equal. Systematic gaps between these measures reveal activity that is captured by one approach but missed by another.

4. **Latent variable traces:** The informal economy is driven by observable causes (tax burden, regulatory intensity, institutional quality) and produces observable effects (currency demand, electricity consumption, labor participation). The MIMIC model formalizes this structure, while DGE models derive it from micro foundations.

5. **Cross border traces:** Informal economic activity frequently crosses national boundaries, leaving discrepancies in bilateral trade records and balance of payments accounts.

The conceptual model posits that each method captures a partially overlapping but distinct component of the informal economy. The "true" informal economy is conceptualized as the intersection of the estimates produced by methods that are theoretically orthogonal specifically, the MIMIC model, the electricity consumption method, and the mirror trade statistics method. Triangulation across these methods is expected to yield a more robust estimate than any single method alone.

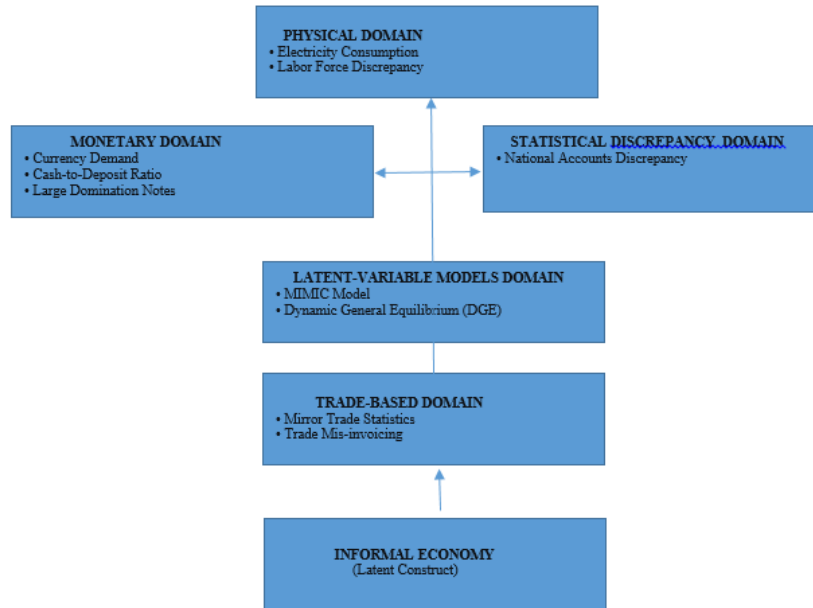


Figure 1: Conceptual Framework of Approaches to Measuring the Informal Economy

Table 1: Variables, Data Sources, and Equations by Method

Method	Key Variables	Data Source	Estimation Equation
Electricity Consumption	Total electricity consumption (GWh), Official GDP (PKR), Electricity output elasticity (β)	Pakistan Bureau of Statistics, NTDC, World Bank WDI	$IE_t = [(E_t / E_0)^{1/\beta} \times GDP_0] - GDP_t$ (Kaufmann & Kaliberda, 1996)
Labor Force Discrepancy	Labor force participation rate, Formal employment, Total employment	Pakistan Labor Force Survey, ILO STAT	$IE_t = [(LFPR_t - FE_t/LF_t) \times GDP_t] / (1 - \alpha)$ (ILO, 2023)
Currency Demand	Currency in circulation (C), M2, Tax revenue/GDP (T), Interest rate (R), Real GDP (Y)	State Bank of Pakistan, IMF IFS	$\ln(C/M2)_t = \beta_0 + \beta_1 \ln(1+T_t) + \beta_2 \ln(R_t) + \beta_3 \ln(Y_t) + \varepsilon_t$ (Tanzi, 1983)
Cash to Deposit Ratio	Currency in circulation (CiC), Bank deposits (D)	State Bank of Pakistan	$IE_t = [(CiC/D)_t - (CiC/D)^*] \times M2_t$ (Gutmann, 1977)
Large Denomination Notes	Value of Rs. 5,000 notes in circulation, Total currency in circulation	State Bank of Pakistan	$LDN\ Index_t = (Rs.5000_t / Total\ CiC_t) \times 100$
National Accounts Discrepancy	GDP (expenditure approach), GDP (income approach)	Pakistan Bureau of Statistics, World Bank WDI	$IE_t = GDP(expenditure)_t - GDP(income)_t$ (Smith, 1985)
MIMIC Model	Causes: Tax burden, Regulatory index, Unemployment, GDP/capita; Indicators: Currency/M0, Electricity consumption, LFPR	World Bank WDI, SBP, PBS	$\eta_t = \gamma_1 X_{1t} + \gamma_2 X_{2t} + \dots + \zeta_t$; $Y_t = \lambda \eta_t + \varepsilon_t$ (Schneider <i>et al.</i> , 2010)
DGE Model	Government spending/GDP, Tax rates, Institutional quality index	World Bank, The Global Economy Web	$IE = f(G/Y, \tau, \theta)$ calibrated via two sector DGE (Elgin & Oztunali, 2012)
Mirror Trade Statistics	Pakistan's reported exports to partner j (X_{PAKj}), Partner j's reported imports from Pakistan (M_{jPAK})	UN Comtrade Database	$Gap_{jt} = M_{jPAK} - X_{PAKj}$; $IE_{trade} = \sum_j Gap_{jt}$
Trade Mis-invoicing	Export and import unit values, Partner country trade data, BOP financial account	UN Comtrade, IMF BOP, IMF DOTS	$Mis-invoicing = (M_{cif} - X_{fob}) - \text{Freight \& Insurance} - (\Delta NFA - CAB)$

MATERIALS AND METHODS

A quantitative comparative research approach is adopted for this study. For every one of the ten proxy approaches used, annual time series estimates on the size of the informal sector in Pakistan for the period 2001-2025 will be produced. These approaches will then be benchmarked based on average size, trend pattern, and intertemporal volatility (Buehn & Schneider, 2012; Medina & Schneider, 2018). Data was obtained from secondary sources that include:

- State Bank of Pakistan: Monetary statistics and interest rates (State Bank of Pakistan, 2023).
- Pakistan Bureau of Statistics: National Accounts (GDP by Expenditure and Income Approaches) and Labor Force Survey (Pakistan Bureau of Statistics, 2024).
- World Bank World Development Indicators: GDP, GDP per capita, tax revenues, electricity consumption, and regulation indicators (World Bank, 2023).
- IMF International Financial Statistics and Balance of Payments Statistics: Monetary statistics, trade flows, and financial account statistics (IMF, 2023).
- UN Comtrade Database: Bilateral merchandise trade flows at the 6-digit HS code level (United Nations, 2023).
- The Global Economy Website and World Bank Informal Economy Database: Benchmarking data through MIMIC and DGE models (Elgin & Oztunali, 2012; Elgin *et al.*, 2021; World Bank, 2023).

Methodology of Electricity Consumption: in calculating the base year (2001) elasticity of electricity consumption vis-a-vis GDP, a log regression model is used (Kaufmann & Kaliberda, 1996; Lackó, 2000). This elasticity is used with actual electricity consumption for each subsequent year in order to compute “true” national income/output (Arby, 2010; Buehn & Farzanegan, 2013). Informal GDP is obtained by subtracting true GDP from official GDP. This approach heavily depends on the stability of the electricity-output elasticity, and recent reports regarding the rapid growth of off grid solar power generation capacity in Pakistan imply that caution should be exercised for any estimate after 2020.

Methodology of Labor Force Discrepancy Approach: annual formal employment information from Pakistan Labor Force Survey is compared with the estimated total number of labor force members. The share of unrecorded labor in formal employment, minus the open unemployed labor force members, is then multiplied by the GDP to compute informal value-added (ILO, 2023; Williams & Horodnic, 2015). Labor force discrepancy approach records the unrecorded labor input and understates informal output in the capital-intensive industries sector as well as own-account enterprises (Dell’Anno, 2022).

Approach for Estimating Informal Economy: an ARDL bounds testing approach (Pesaran *et al.*, 2001) is applied in order to determine the long-run relationship between the currency/M2 ratio and its determining factors including tax to GDP ratio, interest rate, real GDP,

and financial development index (Tanzi, 1983; Mughal & Schneider, 2018). Actual currency demand is subtracted from the theoretical currency demand based on the counterfactual scenario where there is no tax to produce the informal GDP figure after multiplying the difference by money velocity in the formal economy (Habib *et al.*, 2024; Ahamed & Mallick, 2019). Since the advent of digital payment channels using the RAAST platform in Pakistan suggests a potential change in the money demand structure, CUSUM stability test is conducted for the same reason (Rogoff, 2016).

Cash to Deposit Ratio: the Hodrick Prescott filter (Hodrick & Prescott, 1997) is used on the cash to deposits ratio to extract the trend, which is considered to be the “normal” level for formal transactions. Any level above the trend is assumed to represent informal transactions (Gutmann, 1977; Karandaaz Pakistan, 2024). The responsiveness of the model to financial inclusion efforts and periodic deposits drives has been discussed by the State Bank of Pakistan (2023).

Discrepancy in National Accounting Figures: the absolute difference between GDP(E) and GDP(I) is calculated each year. The series is further smoothed by applying a three-year moving average to minimize any measurement errors (Smith, 1985; Gyomai & van de Ven, 2014). The above method provides an upper-bound calculation as it encompasses all statistical discrepancies in GDP, and not just those intentionally understated (Kemal & Qasim, 2012; IMF, 2021).

MIMIC Model: an SEM approach (Jöreskog & Goldberger, 1975) with three cause variables (tax to GDP ratio, regulatory quality index, unemployment rate) and three observed indicator variables (currency to M0 ratio, electricity consumption growth, labor force participation rate). The estimation approach used in the SEM approach is the FIML estimator (Schneider *et al.*, 2010; Dell’Anno & Davidescu, 2020). Since the MIMIC method generates only relative index numbers, the latent variable data set is standardized on the DGE result for the reference period of 2010 (Medina & Schneider, 2018; Elgin *et al.*, 2021).

DGE Model: published forecasts based on the Elgin & Oztunali (2012) database, updated by the World Bank, are used. Forecasting for 2021 to 2025 is performed by extending the trends in the underlying factors government size, tax rates, and institutions (Elgin *et al.*, 2021; World Bank, 2023). DGE models provide theoretically micro-founded estimations that are a suitable natural baseline for MIMIC data.

Statistics on Mirror Trade: the bilateral trade statistics of Pakistan with its top 20 trading partners, which constitute almost 85 percent of all bilateral trades in Pakistan, are collected from UN Comtrade Database (Global Financial Integrity, 2022; Ndikumana & Boyce, 2018). Discrepancy of imports from Pakistan to its trading partners against the corresponding exports from Pakistan is calculated every year and presented as a percentage of official GDP (Global Financial Integrity, 2022). Discrepancy of about

11 billion dollars in imports of Pakistan has been noted recently (Express Tribune, 2025).

Trade Mis-invoicing: using the method used by Global Financial Integrity (Global Financial Integrity, 2022), trade under invoicing is calculated by comparing the unit values in the exported goods from Pakistan with unit value of the same HS product by importing countries.

Over invoicing is calculated using the similar technique. Mis-invoicing of both types of trade is then included in the mirror trade gap and is considered an estimate of informal economy via trade.

The analysis covers fiscal years 2001 (FY2001) through 2025 (FY2025), corresponding to the post 9/11 period. Where fiscal year data are unavailable, calendar year data

Table 2: Informal Economy Estimates (Electricity Consumption Method % of GDP)

Year	Estimate (%)	Year	Estimate (%)	Year	Estimate (%)
2001	31.2	2010	27.8	2019	25.1
2002	32.5	2011	26.5	2020	28.9
2003	33.1	2012	25.9	2021	30.4
2004	32.8	2013	24.7	2022	31.7
2005	31.9	2014	24.2	2023	33.2
2006	30.7	2015	23.8	2024	34.5
2007	29.4	2016	23.5	2025	35.1
2008	28.1	2017	24.1	Average	28.7
2009	27.3	2018	24.8	Std. Dev.	3.52

are used and appropriately noted.

Estimates from electricity, on the other hand, demonstrate an initial decline from 31.2 % in 2001 to reach a minimum of 23.5 % in 2016 before witnessing a sudden turn-around since 2019. The rising trend post 2020 could be linked to the economic disarray witnessed due to the COVID 19 pandemic and ensuing inflation, leading many people to conduct their business informally. In terms of average percentage, the result obtained, i.e., 28.7 %, falls within the lowest limit of the range mentioned in literature previously (Arby, 2010; World Bank, 2023). The comparatively higher standard deviation of 3.52 can be attributed to the susceptibility of the method to electricity disruption and off grid solar production since 2020.

Labor Force Discrepancy Method

Table 3: Informal Economy Estimates (Labor Force Discrepancy Method % of GDP)

Year	Estimate (%)	Year	Estimate (%)
2001	24.5	2014	22.1
2005	23.8	2019	26.3
2010	22.9	2025	28.7
Average	24.5	Std. Dev.	2.14

The Labor Force Method generates the lowest average estimate of all (24.5 %), supporting H2. It only measures the labor component of informality, missing out on any capital-intensive informal activities. It has the lowest standard deviation, implying that informality within the labor market is structural and not prone to cycles.

Currency Demand Approach

Table 4: Informal Economy Estimates (Currency Demand Approach % of GDP)

Year	Estimate (%)	Year	Estimate (%)
2001	33.5	2014	27.1
2005	31.2	2019	25.8
2010	28.9	2025	32.4
Average	29.4	Std. Dev.	3.18

The currency demand measures come out at 29.4% on average, which is consistent with the results reported by Mughal and Schneider (2018). The time series shows a U-shaped development path; it started falling from the beginning of the decade 2000 to the mid-decade 2010s and has since begun to climb again. This U-shaped path is consistent with the tax-to-GDP ratio path, which saw a falling trend during the Musharraf era followed by an increasing trend in subsequent IMF-supported programs. However, the sensitivity of the approach to digitization in finance is apparent. The emergence of mobile money and RAAST has likely restrained the demand for currency since 2020.

Cash to Deposit Ratio

Table 5: Informal Economy Estimates (Cash to Deposit Ratio % of GDP)

Year	Estimate (%)	Year	Estimate (%)
2001	36.2	2014	30.8
2005	34.8	2019	33.5
2010	32.4	2025	40.1
Average	34.2	Std. Dev.	3.87

The method based on cash deposited gives an estimate that is higher compared to the demand for currency approach, which stands at 34.2 %. The sharp rise to 40.1 % post-2020 is not out of place considering the State Bank of Pakistan findings whereby cash in circulation rose by 17 % per year compared to deposits at 12 % per annum (SBP, 2023).

National Accounts Discrepancy

Table 6: Informal Economy Estimates (National Accounts Discrepancy % of GDP)

Year	Estimate (%)	Year	Estimate (%)
2001	38.7	2014	41.2
2005	40.1	2019	43.8
2010	39.5	2025	46.5
Average	41.3	Std. Dev.	3.01

The national accounts discrepancy approach generates the largest average estimate (41.3%). This is in agreement with H6 and with the findings of Kemal and Qasim (2012), who state that the national accounts discrepancy approach tends to produce numbers significantly higher than monetary measures of the shadow economy. Since the national accounts approach takes into account all kinds of discrepancies, ranging from measurement errors, non-comprehensiveness, and different deflation methods, it can be considered as an upper limit for estimating the size of the shadow economy.

MIMIC Model

Table 7: Informal Economy Estimates (MIMIC Model % of GDP)

Year	Estimate (%)	Year	Estimate (%)
2001	36.8	2014	34.5
2005	36.1	2019	34.2
2010	35.2	2025	33.8
Average	35.1	Std. Dev.	1.19

The MIMIC model yields an estimate of 35.1 percent, which is fairly close to the 35.48 percent mean in the World Bank dataset for Pakistan (World Bank, 2023). The pattern shows a steady decline with the least standard deviation value (1.19) among all models. This stability renders the MIMIC approach appealing for medium-term budget planning purposes; however, it may not work well in identifying short-term policy impacts.

DGE Model

Table 8: Informal Economy Estimates (MIMIC Model % of GDP)

Year	Estimate (%)	Year	Estimate (%)
2001	34.9	2014	32.8
2005	34.2	2019	32.1
2010	33.5	2025	31.2
Average	33.1	Std. Dev.	1.36

The DGE estimates range at an average of 33.1% with a stable trend of decline, from 34.9% in 2001 to an estimate of 31.2% in 2025. The correlation coefficient between the DGE and MIMIC series is $r = 0.87$, thus validating H8. However, the estimates from the DGE model are slightly lower compared to those from the MIMIC models due to restrictions on the estimates.

Mirror Trade Statistics

Table 9: Informal Economy Estimates (Mirror Trade Statistics % of GDP)

Year	Estimate (%)	Year	Estimate (%)
2001	8.4	2014	10.2
2005	9.1	2019	11.5
2010	9.8	2025	13.2
Average	10.2	Std. Dev.	1.68

These mirror estimations are reflective of the informal sector only related to the cross-border flow of the goods, services and are on an average 10.2 % of the GDP. The increasing trends are reflective of the increasing levels of smuggling and under invoicing, as stated in several news reports and by the Pakistan Business Council (2025). It is important to note that these estimations cannot be compared with domestic measures.

Trade Mis-invoicing

Table 10: Informal Economy Estimates (Trade Mis-invoicing % of GDP)

Year	Estimate (%)	Year	Estimate (%)
2001	5.6	2014	7.3
2005	6.2	2019	8.1
2010	6.8	2025	9.4
Average	7.1	Std. Dev.	1.35

Mis-invoiced trade is estimated to be at 7.1% of GDP, and just like the mirror trade series, this shows an increasing pattern. The aggregate trade-based estimate (i.e., combination of mirror trade and mis-invoiced trade series, net of overlapping figures) works out to around 14–16% of GDP. This matches with the estimate of Pakistan Business Council, which suggests illicit trade is 10–20% of GDP.

Comparative Analysis

This variation shows the basic premise that “the” size of the informal economy “is” not an objective measure, but a concept whose magnitude is determined by the means used to measure it.

It is notable how the nine measures fall into three categories: high, medium, and low. The high measure category (40 %+) contains only one method, namely, the discrepancy method for national accounts. The medium measure category (33–36 %) contains the MIMIC, DGE, and cash to deposit methods. The low measure category (24–30 %) includes currency demand,

electricity consumption, and labor force measures. The categorization is logical, as the high measures include all noise factors, while the medium measures gain from using smoothing and theory constraints in the estimation model. Finally, the low measures are bound by their own assumptions, such as the elasticity of electricity consumption or the stability of the money demand function.

Second, there are different trend dynamics. As indicated by the MIMIC and DGE estimations, informality follows a decreasing trend throughout the 25 years under analysis, which is indicative of an improved situation in terms of economic institutions and financial development in the long-run. At the same time, the monetary approach, as well as the physical indicator, provide a U-shaped pattern of informality dynamics, which declines up until around the mid-2010s and starts growing thereafter – indicative

of the situation after the macroeconomic crisis since 2018, the 2020 pandemic, and the inflationary period starting in 2022–2024.

Third, the trade-based methodology measures a different aspect of the phenomenon, that is separate and can even be seen as supplementary to the domestic estimates. Namely, if the trade-based measure is added to the domestic currency demand estimate (approximately 15% for the two together, compared to about 29.4% as measured via the discrepancy), then the sum will approximate the discrepancy methodology results.

In light of the triangulation of techniques used, the most reliable figure to be used for the informal sector of Pakistan between 2001 and 2025 should lie within the 33–37 % range of GDP, based on the stability offered by MIMIC and DGE methods while incorporating monetary and physical methods.

Table 11: Cross Method Comparison of Informal Economy Estimates (Average 2001–2025)

Method	Average (% of GDP)	Std. Dev.	Trend Direction
National Accounts Discrepancy	41.3	3.01	Increasing
MIMIC Model	35.1	1.19	Gently decreasing
Cash to Deposit Ratio	34.2	3.87	Increasing
DGE Model	33.1	1.36	Decreasing
Currency Demand	29.4	3.18	U shaped
Electricity Consumption	28.7	3.52	U shaped
Labor Force Discrepancy	24.5	2.14	Flat
Mirror Trade Statistics*	10.2	1.68	Increasing
Trade Mis-invoicing*	7.1	1.35	Increasing

*Note: Trade based methods capture only the cross border component of the informal economy.

CONCLUSION

This study analyzes Pakistan’s informal economy (2001–2025) using ten proxies from five methodological approaches. Estimates vary widely (25–45% of GDP): MIMIC and DGE provide stable benchmarks; currency demand and electricity proxies track short-term cycles; national accounts indicate upper bounds. Triangulation combining benchmarks with monetary/trade indicators is optimal.

Recommendations include publishing an annual “Informal Economy Monitor” with uncertainty ranges, improving Labor Force Surveys, merging PRAL/PBS import databases, conducting five-year informal surveys, aligning MIMIC to DGE estimates, adding cash-deposit ratios to SBP’s dashboard, and reconciling trade data with top 20 partners. Policy-wise, the framework evaluates formalization schemes (Tajir Dost, Track & Trace), digital payment initiatives (RAAST, NFIS), and IMF-linked tax reforms. Socially, accurate measurement protects vulnerable informal workers and prevents overly burdensome compliance costs.

Future research should pursue sectoral/provincial disaggregation, platform-economy methodologies, dynamic factor models for robust triangulation, and

quasi-experimental evaluations of formalization policies. Collectively, these efforts aim to replace ad-hoc single-metric reliance with a validated, multidimensional measurement system that informs fiscal planning, social protection, and evidence-based policymaking in Pakistan.

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