

How large is the size of Côte d'Ivoire's informal sector? A MIMIC approach

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Abstract. *The informal sector occupies an important place in developing economies. This paper attempts both to estimate the size of the informal sector in Côte d'Ivoire over the period 1987-2020 and to determine its trend. The results obtained using the MIMIC method reveal that the size of the informal sector is equal to 42.35% of GDP in 2020, and also reveal that there is a growth and a positive trend of the informal sector in Côte d'Ivoire. Moreover, tax pressure, inflation and corruption play a determining role in the development of informal activities in Côte d'Ivoire.*

Keywords: informal sector, MIMIC method, Côte d'Ivoire.

JEL Classification: C22, O17, Q41.

1. Introduction

The financing of the economy has been a controversial issue in the economic literature for several decades. However, the expansion of the informal sector in developing economies hinders the ability to mobilise the necessary resources. The second half of the 20th century saw the development of several theories that laid bare the causes and consequences of the informal sector on the economy. For Lewis (1954), the informal sector is characterised by the coexistence of two distinct and non-dichotomous sectors (dualisms). According to the author, the economy is composed of a “traditional” sector characterised by under-employment of labour and the “modern” sector characterised by an unlimited supply of labour. Furthermore, the traditional sector is seen as a labour pool for the modern sector. This is the reason for the rural exodus. According to Bacchetta et al. (2009), economic theory should be divided into three approaches to better understand the definition, origin and causes of the informal sector.

According to the first approach (the dualist approach), the informal sector is seen as a residual component of the labour market that has no relationship with the formal sector. The informal sector is then supposed to compensate for the inadequacy of the formal sector in a context of insufficient labour supply. This is what motivates Lewis (1954) to consider the informal sector as a subsistence sector, whose employment is intended to feed the formal sector. This approach is based on a dual market model. According to the structural approach, the informal sector is composed of small enterprises and undeclared workers, subordinate to large capitalist enterprises. Indeed, there would be an interdependence between the formal and informal sectors (Moser, 1978; Portes et al., 1989). This is a Marxist or structuralist inspired approach which asserts that the informal sector revolves around the formal sector and is subordinate to the latter (Treillet, 2013).

Finally, the legalist approach considers the informal sector to be the set of micro-entrepreneurs who act voluntarily in order to escape public regulation deemed harmful to the sustainability of their activity. This approach is based on the bad faith of entrepreneurs. These different theories show that the informal sector is a reality. Therefore, it is important to have statistics on its size in order to make effective and efficient decisions on the allocation of a country's resources.

Unfortunately, it is very difficult to obtain accurate statistical information on informal activities, as the actors naturally do not want to be identified. Nevertheless, the subject has given rise to a field of study devoted to estimating the size of the informal sector in an economy.

Thus, several empirical studies have attempted to measure the size of the informal sector using three different methods: the direct method based on microeconomic techniques, the indirect method based on macroeconomic techniques and finally, the modelling method, in this case the Multiple Causes Multiple Indicators (MIMIC) model. However, the most used of these three methods in the economic literature is the modelling method. For example, Aspilaire (2014) estimated the size of the informal economy in Haiti over the period 2000

to 2010, using a MIMIC model. These results show that fiscal pressure, public spending and inflation positively influence the expansion of the informal economy, but that GDP per capita has a negative influence. Indeed, the informal economy in Haiti represents 70.06% of GDP in 2010.

However, the emerging economic literature is undergoing a revival with regard to the method of estimating the informal sector. This method is based on a mixed method, i.e. the indirect method (money demand model) and the modelling method (MIMIC model) are used together, thus giving better estimates (Sharapenko, 2009; Pickhardt and Sarda, 2006).

Given these different methods, this paper is situated in the literature on the use of the modelling method to estimate the size of the informal sector. Thus, the objective of this study is, on the one hand, to estimate the size of the informal sector in Côte d'Ivoire from 1988 to 2020 and, on the other hand, to determine the major causes of this sector, which is beyond the control of the state.

This paper is organised as follows: the first part presents the MIMIC estimation technique; the second part is devoted to the presentation and analysis of the results obtained; and the third and final part is devoted to the conclusion and policy implications.

2. Modeling the size of the informal sector in Côte d'Ivoire

In the previous section, we have clearly shown that apart from the mixed method, there are three methods to measure the size of the informal sector. The method, the indirect approach and finally, the modelling method in this case the Multiple Causes Multiple Indicators (MIMIC) model. For Othmane and Mama (2016), the MIMIC approach remains the best method for estimating the size of the informal sector. Thus, for the specific case of the Ivorian economy, we opt for this approach because of the availability of data to be analysed.

2.1. Structural equation (MIMIC) model

The MIMIC model is a facet of structural equation modelling (SEM), namely, a multiple indicator, multiple cause model. The pioneers considered the size of the informal sector as a hidden variable, an “unobserved or latent variable” (Frey and Weck-Hanneman, 1984). Subsequently, these authors introduced the MIMIC model constructed by Zellner (1970), Goldberger (1972) and others in the field of informal sector size determination. Indeed, this model puts in structural relation several explanatory variables and several explained variables to determine the variable to be studied which is the latent variable. It is essential to know the causes and consequences of the informal sector in an economy in general to better circumscribe it in economic theory. Thus, the variables that must be used to model and estimate the weight of informality must be cause and effect variables (indicators) taken from the needs of the analysis envisaged and from the field of existing theory.

Since the MIMIC model is a form of structural equations, it contains at least two equations, here there is a first equation highlighting the structural relationship and a second highlighting the measurement relationship.

The structural equation is in the following form:

$$\mu_t = \alpha' X_t + \varepsilon_t \quad (1)$$

Where: $X_t' = (X_{1t}, X_{2t}, \dots, X_{p-1t}, X_{pt})$ is a vector ($1 \times q$) of variables that are each time series. Each time series $X_{it}; i = 1 \text{ to } q$ is a potential causal variable of the latent variable μ_t and the error term ε_t represents the unexplained component $\alpha_t = (\alpha_1, \alpha_2, \dots, \alpha_{q-1}, \alpha_q)$, vector ($1 \times q$) defining the causal relationships between the latent variable and its causal variables. The basic assumption of the MIMIC model for the causal variables is that the variables are measured as deviations from their mean and that the error term and the causal variables are uncorrelated with each other, i.e. $E(\mu_t) = E(X_t) = E(\varepsilon_t) = 0$ and $E(\varepsilon_t X_t') = E(X_t \varepsilon_t') = 0$. Let us denote by ψ the variance of ε_t and by Φ the variance-covariance matrix ($q \times q$) formed of the causal variable X_t .

The measurement model highlights the link between the latent variable and its indicators, in other words, it expresses the unobservable latent variable in terms of a group of the observable variables. It can be written as follows:

$$Y_t = \beta \mu_t + \omega_t \quad (2)$$

Where:

$Y_t' = (Y_{1t}, Y_{2t}, \dots, Y_{p-1t}, T_{pt})$ is a vector ($1 \times p$) of variables (indicators) that are each time series. Each time series Y_{jt} is a potential indicator, and the error term represents the unexplained component.

$\omega_t = (\omega_{1t}, \omega_{2t}, \dots, \omega_{p-1t}, \omega_{pt})$ is a vector ($p \times 1$) of shocks where each; $j = 1 \text{ to } p$, is white noise. Let θ_ω be the variance-covariance matrix of ω_{jt} ;

β is a vector ($p \times 1$) of regression coefficients $\beta_j, j = 1 \text{ to } p$ representing the magnitude of expected changes in the so-called indicator variables for a one unit change in the latent variable. The same assumption that prevails for the causal variables also applies to the indicators, i.e. the indicators are measured as deviations from their mean, thus $E(Y_t) = E(\omega_t) = 0$.

Furthermore, it assumes in the measurement model that there is no correlation between the error term and the causal variables or between the error term and the slow variable, which can be translated as follows: $E(\omega_t X_t') = E(X_t \omega_t') = 0$ and $E(\omega_t \mu_t') = E(\mu_t \omega_t') = 0$. A final assumption is that $E(\omega_t \varepsilon_t') = E(\varepsilon_t \omega_t') = 0$.

Expressing the general model in variance-covariance form is equivalent to writing:

$$\Sigma \begin{pmatrix} \text{Var}(Y_t) & \text{Cov}(Y_t, X_t) \\ \text{Cov}(X_t, Y_t) & \text{Var}(X_t) \end{pmatrix} = \begin{pmatrix} \left[\frac{Y_t}{X_t} \right] \\ \left[\frac{X_t}{Y_t} \right] \end{pmatrix} \quad (3)$$

Using the starting hypotheses of the model, which we recall: first, the variables are directly measurable and are expressed as deviations from their mean:

$$E(\mu_t) = E(X_t) = E(Y_t) = E(\omega_t) = 0.$$

There is no correlation between the error term and the causal variables or between the error term and the latent variable, which can be translated as follows:

$$E(\omega_t X_t') = E(X_t \omega_t') = 0 \text{ and } E(\varepsilon_t X_t') = E(X_t \varepsilon_t') = 0.$$

The error terms and the latent variable are uncorrelated in the measurement equation:

$$E(\omega_t \mu_t') = E(\mu_t \omega_t') = 0.$$

There is no correlation between the error terms in the different equations:

$$E(\omega_t \varepsilon_t') = E(\varepsilon_t \omega_t') = 0.$$

We can find the variances and covariances using simple calculations:

$$E(Y_t Y_t') = \beta(\alpha' \phi \alpha + f) \beta' + \theta_\omega, E(X_t Y_t') = \phi \alpha \beta', E(Y_t X_t') = \beta \alpha' \phi, E(X_t X_t') = \phi.$$

So we conclude that θ_ω is the variance-covariance matrix of the error terms in the measurement model, the variance of the error terms in the structural equation, ϕ the variance-covariance matrix of the causal variables and on the last place the variance-covariance matrix of the general MIMIC model which shows the structure between the observed variables and the unobservable variable, the latent variable which is in our case the informal economy, as follows:

$$\Sigma \begin{pmatrix} \beta(\alpha' \phi \alpha + f) & \beta \alpha' \phi \\ \theta \alpha \beta' & \phi \end{pmatrix} \quad (4)$$

If the assumed model is correct and the parameters are known we will obtain $\Sigma(\theta) = \Sigma$.

2.2. Data and data source

This paper aims to estimate the size of the informal sector in Côte d'Ivoire using the MIMIC method. As mentioned above, the use of the MIMIC model requires both two groups of variables: causal variables (which determine the size of the informal sector) and indicator variables (which are indicators of an expansion of the informal sector). Faced with the problem of data availability, which is a common problem in developing countries, we use annual data from 1987 to 2020. Indeed, the data to be analysed comes from the World

Bank's World Development Indicator (WDI 2022) website. The problem of data availability is a common one for developing countries.

a) Causal variables

Tax burden (TAX)

According to the literature review, the tax burden is the main cause of the development of informal activity (Loayza, 1996; Schneider, 2005).

Indeed, the increase in the tax burden represents an additional cost of production of goods and services for the firm, which increases their price on the formal market. Firms operating in Côte d'Ivoire have a greater incentive to engage in informal activities in order to avoid taxes and reduce production costs in order to sell their products at lower prices given the competition in the informal and formal economy. In the econometric analysis, the tax burden is measured by the share of tax revenue in GDP. We expect a positive sign associated with this variable.

Hypothesis 1: An increase in the tax burden leads to an increase in the size of the informal sector, *ceteris paribus*.

Corruption perception index (CORR)

The quality of institutions determines the size of the informal sector (Schneider, 2010). In our paper, we approximate the quality of institutions by the corruption perception index. We expect a positive sign associated with this variable.

Hypothesis 2: An increase in corruption leads to an increase the size of the size of the informal sector, *ceteris paribus*.

Inflation (INFL)

In our study, this variable is approximated by the consumer price index. Indeed, inflation reflects the ability of households to purchase baskets of goods, or to lack the ability to purchase them and turn to the informal sector to constitute the lower end of the informal labour market. In other words, the absence of price controls leads to a preference of economic agents to operate in the informal sector (Bounoua et al., 2012). Aspilaire (2014) in his work shows through a DYMIMIC model that inflation is an explanatory factor of the growth of the informal sector in Haiti.

Hypothesis 3: The higher the inflation, the larger the size of informal sector, *ceteris paribus*.

b) Indicators

After considering various causes influencing the size of Côte d'Ivoire informal sector, the MIMIC model requires to select different indicators that reflect the existence of informal sector. In this research, two indicators are introduced simultaneously instead of a single indicator as in the case of the indirect approach models, in accordance with the literature review.

The logarithm of GDP per capita (index, base year 2015 = 100) (LGDPC)

Many studies use this variable as a benchmark indicator of the expansion of the informal sector in an economy. In this study, it provides information on the expansion of the informal sector. Thus, a high per capita income reflects a high level of informal activity.

Hypothesis 4: The larger the size of the informal sector, the lower the GDP is, *ceteris paribus*.

The money supply (MS)

Informal activities being activities not recognised by the state are carried out in cash rather than through banking transactions (credit cards, cheques etc.) in order to avoid audit controls. The money supply is supposed to indicate the development of the informal sector (Dell'anno, 2007; Schneider et al., 2010). According to the DSEPP (2021), the quantity of money in circulation (M2) recorded a net increase of CFAF 2,732.7 billion (+24.6%) to CFAF 13,820.1 billion at the end of April 2021, compared to CFAF 11,087.4 billion at the end of April 2020. Indeed, agents operating in the informal sector do not leave traces of their transactions. They always need liquidity in case a deal comes up.

Hypothesis 5: The larger the size of the informal sector, the larger the currency held by the public is, *ceteris paribus*.

The table below summarises the different groups of variables used in this model.

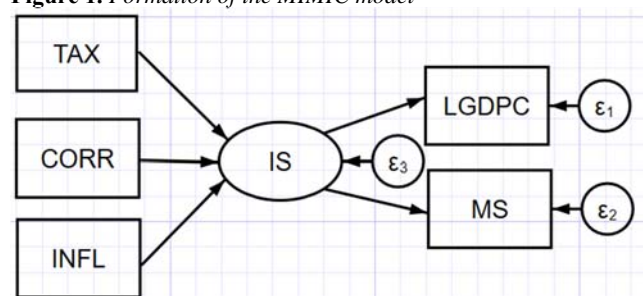
Table 1. MIMIC description of the variables in the MIMIC model

Variables	Description	Source
Indicator variables		
LGDPC	The logarithm of gross domestic product per capita	WDI, 2021
MS	Money supply	WDI, 2021
Causal variables		
TAX	Tax burden as a percentage of GDP	WDI, 2021
INFL	Consumer price index (inflation)	WDI, 2021
CORR	Corruption perception index	WDI, 2021

Source: Author.

A general representation of the MIMIC model where the two parts of the model are easily recognizable in the following diagram highlighting the causal variables on the left and the indicators on the right:

Figure 1. Formation of the MIMIC model



Source: Author.

3. Empirical results

In this section, the results of the estimation of the MIMIC model are interpreted: the effect of the causal variables on the latent variable in the first instance and the effect of the latent variable on the indicators. These results allow us to make a prediction of the size of the informal sector. Before estimating the MIMIC model, we performed two stationarity tests on our time series. Thus, the Augmented Dickey Fuller (ADF) and Phillips-Perron (PP) tests reveal that all our series are stationary of unit order, i.e. stationary in first difference (I (1)).

Moreover, these results led us to apply the Johansen cointegration test to verify the existence of one or more long term relationships. Thus, we apply the cointegration test of Johansen (1988). The results of the Johansen cointegration test show that there is a cointegrating relationship because the probability is greater than 5% that there is more than 1 cointegrating relationship. However, we use the level time series in order not to lose the long term association between the variables and to be able to estimate a long term MIMIC model. The tests on the residuals of the long-run model show that the residuals are not homoscedastic, self-correlated and follow a normal distribution. In addition, because our sample size is small, we used the Swain scaling factor in STATA 17 to correct the chi-square statistic.

3.1. Estimation results

The table below presents the results of the estimation of the MIMIC (3,1,2) model by the maximum likelihood method:

Table 2. Results of the estimation of the size of the informal sector in Côte d'Ivoire

	Coefficient	Std. err	z	P.value	[95% conf. interval]	
Structural						
IS						
Tax burden	0.0080*	0.0016	4.75	0.000	0.0047	0.0113
Corruption	0.0087*	0.0009	9.68	0.000	0.0069	0.0105
Inflation	-0.0004**	0.0002	-2.22	0.026	-0.0009	-0.0000
Measurement						
GDP per capita						
IS	1					
Constant	2.9809	0.0300	99.16	0.000	2.9220	3.0398
Money supply						
IS	86.5752*	19.8145	4.37	0.000	47.7395	125.411
Constant	-1.1723	6.0009	-0.20	0.845	-12.9339	10.5892
Var (e.GDPC)	0.0002	0.0002			0.0000	0.0017
Var (e.MS)	26.0133	6.5552			15.8743	42.6281
Var (e.SI)	0.0002	0.0002			0.0000	0.0019
Statistical tests						
Chi2	3.34					
Pvalue	0.1881					
Degress of freedom	14					

Note: Denotes significance at 1% significance level. Degrees of freedom = $0.5(p + q)(p + q + 1) - t$, where: p = number of causes, q = number of indicators, t = number of free parameters.

Source: Own calculations.

Les The estimation results reveal that the signs of the coefficients of the causal variables are as expected from the literature review, except for inflation. Indeed, the tax burden positively influences the informal sector at the 1% threshold. In other words, a 1% increase in the tax burden leads to a 71.50% increase in the informal sector, *ceteris paribus*. This can be explained by the fact that in the presence of severe taxation, economic agents become skeptical of the tax system. They then consider taxes as an additional cost to be avoided; consequently, they adopt tax avoidance behaviours such as tax evasion and avoidance. Moreover, the high elasticity of the tax burden (74.50) makes this variable the major cause of informality in Côte d'Ivoire. The quality of institutions, with corruption as a proxy variable, has a positive and significant impact on the size of the informal sector at the 1% level. Thus, *ceteris paribus*, a 1% increase in the corruption perception index causes a 34.57% increase in informal activities. This could be explained by the fact that corruption is an illegal activity and all unequal activities escape the tax system, hence the corruption that takes place in the informal sector. However, unexpectedly, inflation has no significant impact on the development of informal activities in Côte d'Ivoire.

3.2. Benchmarking analysis

It is important to note that the MIMIC model only produces the index of the trend in the size of the informal sector, while only telling us the changes in this sector from one year to the next. However, in order to calculate the size of the informal sector as a percentage of GDP, the benchmarking step is necessary to calibrate this index on the basis of exogenous information on its size. Only causal variables that are significant at the 5% level will be used to estimate the size of the informal sector (Nguyem, 2019; Hassan and Schneider, 2016). Based on the data in Table 1, the MIMIC index can be calculated using the structural equation below:

$$\mathbb{I}_t = \alpha_1 x_{1t} + \alpha_2 x_{2t} + \dots + \varepsilon_t \quad (5)$$

$$\mathbb{I}_t = 0.0080PF_t + 0.0087CORR_t - 0.0004INF_t + \varepsilon_t$$

The year 2016 is adopted as the base year because of a study conducted by Medina and Schneider (2018) which reveals that the size of the informal sector in Côte d'Ivoire was 43.4% of GDP in 2016. Thus, to calculate the size of the informal sector in 2020, we start by calculating the MIMIC index of the informal sector for the years 2020 and 2016 by replacing the values in the structural equation in the two years mentioned above:

$$\mathbb{I}_{2016} = 0.0080PF_t + 0.0087CORR_t - 0.0004INF_t = 0.0583$$

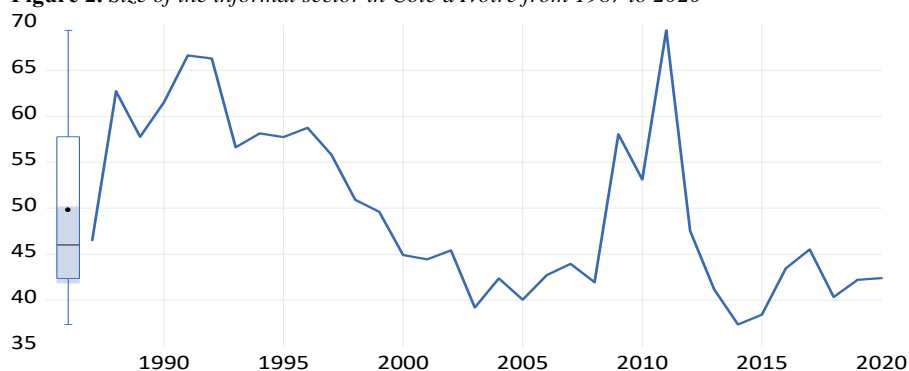
$$\mathbb{I}_{2016} = 0.0080PF_t + 0.0087CORR_t - 0.0004INF_t = 0.0569 \quad (6)$$

The above indices are the DY MIMIC indices for 2010 and 2019. To calculate the size of the informal sector in 2019, we apply the formula below – adapted from the work of Nguyem (2019), Hassan and Schneider (2016) and Tonuchi et al. (2020). We simply replace the above value in the model to estimate the size of the informal sector.

$$\mu_{2020} = \frac{\beta_{2020}}{\beta_{2016}} \mu_{2016}^* = \frac{0.0569}{0.0583} * 43,4 = 42,35\% \text{ of GDP} .$$

The process is repeated to obtain the size of the informal sector in Côte d'Ivoire from 1987 to 2020, and the detailed result is presented in the graph below:

Figure 2. Size of the informal sector in Côte d'Ivoire from 1987 to 2020



Source: Own calculations.

From 1987 to 1994, there was an increase in the size of the informal sector. This trend took a different turn after the devaluation of the local currency in 1994 and continued until 2003. This figure highlights the negative relationship between the informal sector and political stability. The peak of informal activities was reached in 2011 during the post-election crisis. Indeed, the decade of crisis favoured an expansion of the informal sector as the country was occupied in the north by an armed rebellion and in the south by a legitimate government. Thus, the development of informal activities in the north, which was without tax administration, led to a decrease in tax yields. According to our results, the informal sector occupies, on average, 50% of the national wealth from 1987 to 2020. In general, the results indicate a general downward trend marked by a succession of peaks and troughs in line with the macroeconomic performance of Côte d'Ivoire since the aftermath of the decade-long political and military crisis.

4. Conclusion

This study allowed us to estimate the size of the informal sector in Côte d'Ivoire from 1987 to 2020. To do so, we used the MIMIC approach. The results of our estimations reveal that the size of the informal sector in Côte d'Ivoire is equal to 42.35% of GDP in 2020. The main cause of the development of this sector is taxation. In addition, the quality of institutions, notably corruption, has also played a key role in the growth of the informal sector. A 1% increase in the corruption perception index leads to an increase in informality of 34.57%. However, inflation has no significant effect on the evolution of the size of the informal sector.

To provide a brief economic explanation of our results, we can say, first, that corruption and the informal sector are complementary in Côte d'Ivoire. Indeed, corruption through bribes is perceived as a tax to silence the tax administration official. This illegal tax is often and most of the time lower than the legal amount of the tax in force. Entrepreneurs manage to bribe in order to ensure the sustainability of their businesses while avoiding the heavy tax burden. These results are in line with the work of Dreher and Schneider (2009), who show that corruption and the informal sector are complementary in developing countries and substitutable in developed countries. Therefore, the relationship between corruption and informal sector development depends on the level of development of the economy.

The tax burden is the most popular determinant of the growth of the informal sector in Côte d'Ivoire. This is simply because individuals perceive taxation as an additional and unnecessary cost to be avoided. Thus, operating in the informal sector becomes the only way out of the tax burden. All our hypotheses were confirmed by MIMIC except for the impact of inflation on the informal sector in Côte d'Ivoire. It can be concluded that a high level of inflation in Côte d'Ivoire leads to a decrease in the informal sector.

These results are very important because having a real vision of the size of the informal sector allows the establishment of good economic policies. Taking this sector into account is important because its place in the economy is not negligible.

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