

THE RELATIONSHIP BETWEEN THE SHADOW ECONOMY, CORRUPTION, AND TAXES: EMPIRICAL EVIDENCE FROM COUNTRIES WITH HIGH AND LOW FINANCIAL DEVELOPMENT

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Abstract: The paper explores the relationship between the shadow economy, corruption, and taxes in 25 high-financial developed countries (HFDCs) and 30 low-financial developed countries (LFDCs) using the PVAR method. The results of the impulse-response function show that the corruption perception index (CPI) has a positive correlation with tax revenue

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and the shadow economy in HFDCs, while tax revenue and the shadow economy are negatively correlated. In contrast, in LFDCs, the shadow economy has a positive correlation with tax revenue and a negative correlation with the CPI. In addition, the study also suggests that there is no relationship between tax revenue and the CPI. From the above findings, we propose several related policies for each group of countries.

Keywords: shadow economy; tax revenue; corruption; financial development; PVAR.

JEL Codes: E26, H2, H26, D73.

1. Introduction

According to International Monetary Fund data from 1991 to the present, the shadow economy has directly impacted the economic sector, including positive and negative aspects (Onnis & Tirelli, 2011). The underground economy is understood as informal, tax-free activities that lead to difficulty in controlling the government's tax revenue, causing little or no impact on the official economy (Canh & Thanh, 2020). Amoh & Adafula (2019) and Achim et al. (2023) argued that the higher the tax evasion rate, the larger the shadow economy, and different tax burdens will have different effects that can be negative or positive on the level of the shadow economy. Thus, providing evidence that there exists a relationship between taxes and the shadow economy. Recent studies such as Bayar et al. (2018), Huynh & Nguyen (2020), Němec et al. (2021), and Nguyen & Luong (2020) showed that corruption has direct effects and is a "bridge" to the development scale of the underground economy. Not only economic corruption but also political corruption brings certain effects. In addition, the results of Němec et al. (2021) also implied that the tax burden is a "lubricant" for corrupt behavior; the higher the taxes on the economy, the greater the tax burden. This leads to corruption, and the corruption index shows signs of increasing, making the shadow economy operate more strongly than the official economy.

To further highlight the relationship between corruption and taxes in increasing the size of the shadow economy, we reviewed several recent studies on the relationship between corruption and taxes on financial development. As for the relationship between corruption and financial development, Ali et al. (2019) measured corruption using the CPI, concluding that low corruption will attract resources to the financial system, while Ekşi & Doğan (2020) argued that there is no relationship between these two factors. As for the link between taxes and financial development, Safuan et al. (2022) and Habibullah et al. (2017) pointed out a long-term non-linear relationship represented by an inverted U shape, implying that with a high level of financial development, tax evasion behaviors will be lower and vice versa. At the same time, they believe that it is necessary to increase economic entities' access to

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financial resources, thereby minimizing their ability to avoid tax. From this, it can be seen that financial development is a factor that needs to be considered when studying the relationship between the shadow economy, taxes, and corruption, while some previous studies have overlooked this issue (Yamen et al., 2023; see more Achim et al., 2023; Al-Hadi et al., 2022; Němec et al., 2021; Esaku, 2021; Nguyen & Luong, 2020; Huynh & Nguyen, 2020; Amoh & Adafula, 2019). Therefore, this study will fill the gap in previous studies.

In addition, to the best of our knowledge, previous studies, most recently by Yamen et al., 2023; Achim et al., 2023; Al-Hadi et al., 2022; Němec et al., 2021; and Esaku, 2021, have only considered relationships in individual pairs. Besides, instead of only considering the scale of the underground economy in one country or region such as Indonesia (Safuan et al., 2022), Malaysia (Din et al., 2019), the EU (Stankevičius & Asta, 2014), we based on Oanh et al. (2023) to conduct research on the relationship between the shadow economy, taxes and corruption on two groups of countries with high and low financial development. The study utilizes the PVAR research model, which has the advantage of controlling variables according to time trends and spatial fluctuations with estimated results that are more reliable than other models. At the same time, this method does not distinguish between exogenous and endogenous variables but considers them as common variables.

Based on the research gap, we have expanded the scope of research on the relationship of all three factors: tax, corruption, and the shadow economy, instead of pairwise or individual relationships, to provide economists with a more comprehensive view of the presence of the shadow economy in the formal economy. The purpose is to highlight the differences in this relationship between two groups with high and low financial development, thereby proposing appropriate policy implications for each group.

The rest of the study is structured as follows: Section 2 describes literature reviews. Section 3 summarizes the data and the research methodology. Section 4 explains the results and discussion. Finally, the conclusion and some policy recommendations are presented in Section 5.

2. Literature review

2.1. Theory of the relationship between the shadow economy, taxes, and corruption

The shadow economy is also known as the shadow economy, the underground economy, or the black economy. Canh & Thanh (2020) believed that the underground economy comprises informal activities that deliberately evade taxes, making it difficult for the government to control tax revenue and causing the country's tax revenue deficit. Medina & Schneider (2018) argued that the

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underground economy is all economic activity deliberately hidden from state management agencies for monetary, legal, and institutional reasons, where monetary reasons are understood as acts of tax evasion and contributions to social security for self-interest. The legal reason comes from the fact that businesses want to escape government management, and the main institutional reason is that businesses take advantage of legal "loopholes" to commit corrupt acts. In short, the underground economy is understood as part of the economy that is not recognized by the government and is, therefore, not taxed.

The relationship between the shadow economy, taxes, and corruption in the financial development context can be explained through the expected utility theory by Becker (1968), where individuals will try to maximize their benefits by taking advantage of all available resources. In addition, they are also willing to participate in illegal activities to avoid taxes and profit for themselves. This leads to an increase in the size of the shadow economy, causing a deficit in government tax revenue and directly negatively affecting the official economy. Besides, the theory also shows that financial development can help reduce the size of the shadow economy by providing individuals with more legal opportunities to generate income. At the same time, the asymmetric information theory by Akerlof (1970) also shows that when one transacting party has exclusive information or knowledge that the competing party does not have, asymmetric information will occur, thus leading to several problems such as adverse selection, moral hazard, and even market failure. In the context of taxes and corruption, asymmetric information can make it difficult for the government to enforce tax laws and prevent corruption, leading to reduced government tax revenue and negative impacts on the entire international economy. Financial development is an ideal environment that creates opportunities and conditions for individuals to legally generate income instead of participating in the underground economy. Financial development can also help reduce asymmetric information by increasing transparency and accountability in financial transactions. This contributes to increasing government revenue and positively impacts the overall economy.

The main tax and corruption factors are part of the shadow economy that have an influence and are directly related to the level of growth or decline of the underground economy (Blackburn et al., 2012). Taxes are mandatory amounts that individuals and organizations are obliged to make to the State. Cobham (2005) and Sung et al. (2017) argued that the most sustainable and long-term financial resources that governments collect, especially for developing countries, should sustainably generate revenue from tax revenue by the level of expenditure necessary to create confidence in the hearts of the people that their tax payment is effective in providing services public and investing in infrastructure. Besides, some studies that look at the

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legal capacity of the state indicate that countries that develop well financially will often report the majority of their tax revenue to tax authorities (Guo & Hung, 2020). At the same time, based on the theory of capital supply, the economic institutional theory by Acemoglu et al. (2005), and the theory of exclusion and exit by Perry (2007), the team found that one thing in common between these theories is the reference to the institution. So, it can be understood that countries with good institutional quality will create a comprehensive financial environment, promote publicity and transparency, and help the government repel tax evasion, contributing to the recession of the informal economy.

The shadow economy has been "leading the way" for corruption to develop, when individuals and businesses must bribe officials to avoid control and enjoy benefits "poured into their own pockets" (Amara & Khlif, 2018). Playing as a "bridge" to the shadow economy, corruption is considered one of the factors that the research team is particularly interested in. Jain (2001) and Rose-Ackerman & Palifka (2016) argued that corruption is the use of public power for personal gain. Corruption is often expressed through acts such as accepting bribes, embezzlement, taking advantage of positions to profit or cover up, and obstructing illegal intervention in the supervision and investigation of judgment enforcement for the sake of interest. Another aspect that has to be covered is corruption and the banking system stability. Research by Tran et al. (2017) showed that corruption can cause deviations in the allocation of loans, increasing the likelihood of corporate default due to increased capital costs and loans that are not used effectively. Weill (2011) argued that corruption reduces trust in the legal institution and serves as a kind of 'tax' that levies loans to borrowers. It can be seen that corruption is quietly loosening financial channels, reducing reputations, and increasing financial risks to banks.

The impact of the underground economy in the context of financial development is an extremely attractive topic and is of interest to many researchers worldwide (Affandi & Malik, 2020; Blackburn et al., 2012). Currently, many studies define financial development as meeting the needs of individuals and organizations to manage financial risk and achieve optimal profitability through creating or improving products and services (Merton, 1992). Svirydenka (2016) expanded the definition of financial development by referring to the depth of scale, liquidity, accessibility, and efficiency. Rajan & Zingales (2003) referred to opening the door to financial development that will create competition that makes interest groups, namely those holding positions in the financial and industrial industries, reduce their privileges and interests. Besides, this hypothesis holds that trade openness and capital flows are the keys to successful financial development.

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In general, the relationship between the shadow economy, taxation, and corruption in the context of financial development is closely linked, and through the PVAR model, we will clarify more on this topic.

2.2. Empirical studies on the linkage of the shadow economy, taxes, and corruption in the financial development context

Many previous studies found a negative relationship between the shadow economy and financial development (Berdiev & Saunoris, 2016; Mar'i & Cavusoglu, 2021; Bayar & Ozturk, 2016; Jimoh, 2017; Njangang et al., 2020; Rahman et al., 2023). In addition, this relationship is also nonlinearly represented by an inverted U through the studies of Din et al. (2019) conducted in Malaysia, Canh & Thanh (2020) in 114 economies, Safuan et al. (2021) conducted in Indonesia, and Abu-Lila et al. (2021) conducted in Jordan. Gharleghi & Jahanshahi (2020) pointed out a negative relationship between financial development and the shadow economy only in countries with per capita income over 33,600 USD; on the contrary, in developing countries, there is a positive relationship.

Dreher & Schneider (2010) suggested that corruption and the shadow economy are complementary factors only in low-income countries. Other studies show a positive correlation between corruption and the shadow economy such as Buehn & Schneider's (2012) approach according to the structural equation model empirically in 51 countries, Bayar et al. (2018) conducted in 11 transition economies in Central and Eastern Europe, Ouédraogo (2017) studied in 23 sub-Saharan countries, Nguyen & Luong (2020) considered in 17 Asian countries, and Esaku (2021) studied in Uganda. In addition, Ouédraogo (2017) argued that poor governance and weak institutions also increase the size of the shadow economy. Huynh & Nguyen (2020) studied in 24 Asian countries and indicated that corruption and the shadow economy are complementary components. Němec et al. (2021) conducted in the Czech Republic using the DSGE model, concluding that corruption and increasing awareness of corruption tend to shift economic activities to the shadow economy.

Kodila-Tedika & Mutascu (2013) concluded that the shadow economy negatively impacts tax revenue in African countries. Stankevičius & Asta (2014) studied EU countries and found that as tax burdens increase, the increase in social security will become a driving force for the development of the shadow economy. Furthermore, Schneider et al. (2015) pointed out that tax evasion positively affects the size of the shadow economy in Europe. Iqbal & Rahman (2017) used the monetary method and found that increased taxes, management intensity, and inflation are the driving forces for the development of the shadow economy and tax evasion. In addition, Rocha et al. (2018) considered a formalization program in Brazil and concluded that reducing tax burdens reduces the informality of businesses. Amoh & Adafula (2019)

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concluded that tax burdens and high unemployment rates increase the motivation to work in the shadow economy, thereby creating a risk of tax evasion. Recently, Achim et al. (2023) using the Pooled OLS regression model showed a U-shaped relationship between tax burdens and the shadow economy only for direct taxes, while indirect taxes and social contributions are represented by an inverted U.

Huňady & Orviská (2015) showed that corruption has a negative impact on tax revenue, and this impact becomes significant for goods and services taxes rather than income taxes. Liu & Feng (2015) found that countries relying on direct taxation tend to be less corrupt than countries dependent on indirect taxes. Moreover, Albulescuet al. (2016), Alm et al. (2016), Khlif and Amara (2019) and Al-Hadi et al. (2022) found that the relationship between corruption and tax evasion is intertwined and mutually reinforcing. Mohammadi Khyareh (2019) conducted a study in 31 OECD countries and affirmed that in a highly corrupt environment, businesses do not trust the government's tax management capabilities, leading to high tax evasion. Using the MIMIC model, Yamen et al. (2023) concluded that the application of digitization hurts tax evasion, thereby indirectly reducing corruption.

Tran et al. (2017), Toader et al. (2018), and Ali et al. (2019) found that corruption has a negative impact on the stability of the banking system. Nurhidayat & Rokhim (2018) conducted an empirical study in Asia, the results showed that higher levels of corruption and government intervention in crises will increase the risk-taking behavior of banks. Ozili (2019) argued that corruption has a positive meaning in moderating income among African banks. Bolarinwa & Soetan (2019) used the GMM model to prove that corruption positively affects bank profits in developing countries and this is more pronounced in developed countries. However, a study by Ekşi & Doğan (2020) in 19 Eastern European and Central Asian countries found no relationship between the level of corruption and financial development.

Bittencourt et al. (2014) studied the relationship between tax evasion, the size of the shadow economy, financial development, and inflation. The results showed that low financial development and high inflation lead to a large shadow economy and vice versa. At the same time, in countries with low financial development, businesses often misreport to evade taxes for benefits, and vice versa. Ahamed (2016) and Guo & Hung (2020) pointed out that there is an inverse correlation between corporate tax evasion and the level of financial development. Ahamed (2016) emphasized that this relationship is clear in countries with strong legal systems and fewer informal labor rates. Habibullah et al. (2017) studied five founding members of ASEAN, Safuan et al. (2022) studied in Indonesia, both of whom confirmed the long-term nonlinear relationship between tax evasion and financial development through an inverted U. The literature review shows that previous studies have only considered individual relationships. To our best knowledge, no study has simultaneously examined the

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three relationships of the shadow economy, taxes, and corruption. Previous studies have considered a wide range of single countries and international scopes such as Indonesia (Safuanet al., 2022), Malaysia (Din et al., 2019), the banking system in Pakistan (Ali et al., 2019), or research at an organization, international scope, economic alliance: OCED (Mohammadi Khyareh 2019), EU (Stankevičius & Asta 2014). The author found that corruption, taxes, and the shadow economy are closely related to the level of financial development, which is further affirmed in the empirical study of Oanh et al. (2023) in the context of financial development. In addition, the methods used in previous research are not uniform, and research results also vary. In this study, we use the PVAR model with the advantage of not distinguishing between exogenous and endogenous variables but considering all variables as common endogenous. Moreover, each variable in PVAR depends on its past data and all other variables, showing simultaneity and equality with each other. Starting from these gaps, we decided to synthesize and simultaneously study the relationship between the shadow economy, taxes, and corruption in the context of financial development in HFDCs and LFDCs by applying the PVAR model.

2.3. Hypotheses

Countries are striving to promote financial development and perfect the legal framework related to financial activities to create transparency and clarity in the market. This helps economic entities access capital more easily, encouraging them to join the formal sector rather than the informal sector. The government can easily monitor and manage abnormal activities in the economy, reducing tax evasion and corruption. The development of finance also promotes transparency, not only in the financial market but also in the economy. Based on this and previous studies, we construct the hypotheses set in the following financial development context:

H1: The shadow economy has a negative (-) relationship with tax revenue.

To further substantiate this hypothesis, in addition to the above assumption, we also refer to some recent related studies such as Achim et al. (2023); Amoh and Adafula (2019); Rocha et al. (2018); Iqbal and Rahman (2017);

H2: The shadow economy has a negative (-) relationship with the CPI.

Similarly, for the second hypothesis, we also refer to some related studies such as Esaku (2021); Němec et al. (2021); Huynh and Nguyen (2020); Bayar et al. (2018);

H3: Corruption has a negative (-) relationship with tax revenue.

Some recent studies by Yamen et al. (2023); Al-Hadid et al. (2022); Kliff and Amara (2019); Mohammadi Khyareh (2019); on this relationship also show the covariance between tax and corruption.

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3. Methodology and empirical data

3.1. Model

Based on the theory given in Section 2 and the empirical studies of Berdiev & Saunoris (2016) and Mar'i & Cavusoglu (2021), the model to study the correlation between the shadow economy, taxes, and corruption is established as follows:

$$Y_{i,t} = A_1 Y_{i,t-1} + A_2 Y_{i,t-2} + \dots + A_k Y_{i,t-k} + \sum_x X_{i,t} + u_i + \mu_{i,t} \quad (1)$$

Where:

$Y_{i,t} = [SE, CPI, TAX]$ is a (1×3) vector of endogenous variables with SE: Shadow economy, CPI: Corruption perception index; TAX: Tax revenue;

$Y_{i,t-k}$ is a 1×3 lagged endogenous variables vector;

A_1, A_2, \dots, A_k are the $(k \times k)$ estimated coefficients vectors;

$X_{i,t}$ are the $(1 \times h)$ the exogenous vectors, where h is the number of exogenous variables, including 16 variables in the model;

\sum_x are the $(h \times k)$ estimated coefficients matrices;

u_i is the fixed effect vector of the dependent variable;

$\mu_{i,t}$ is a vector of white noise errors.

This study includes 16 exogenous variables in the model to increase the level of explanation for the model. Table 1 presents the measurement methods and data sources of variables.

Table 1 Description of variables used in the model

	<i>Variable</i>	<i>Sign</i>	<i>Studies</i>	<i>Source</i>
<i>Exogenous variables</i>	Shadow economy (%GDP)	SE	Canh & Thanh (2020)	Elgin et al. (2021)
	Tax (%GDP)	TAX	Njangang et al. (2020); Nguyen & Luong (2020)	World Bank, UNU-WIDER
	Corruption Perceptions Index	CPI	Nguyen & Luong (2020))	Transparency International
	Institutional Quality	IQ	Canh & Thanh (2020), Hassan & Schneider (2016)	World Bank

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Per capita income (%GDP)	INC	Bittencourt et al. (2014), Schneider & Torgler (2007), Canh & Thanh (2020)	World Bank
Foreign Direct Investment (%GDP)	FDI	Canh & Thanh (2020)	World Bank
Population growth (%)	PG	Njangang et al. (2020)	World Bank
Government expenditure (%GDP)	GOV	Njangang et al. (2020)	World Bank
Human Development Index	HDI	Medina & Schneider (2018)	UNDP (Chương trình Phát triển Liên Hiệp Quốc)
Trade openness (%GDP)	TOP	Canh & Thanh (2020), Njangang et al. (2020)	World Bank
Inflation (%)	INF	Canh & Thanh (2020), Njangang et al. (2020)	World Bank (World Development Indicator)
Exchange rate (USD)	LN_EXC	Suggested by the author	World Bank
Remittances (%GDP)	REM	Nguyen & Luong (2020)	World Bank
Unemployment rate (%)	UNEM	Schneider & Torgler (2007), Canh & Thanh (2020)	World Bank (World Development Indicator)
Money supply (%GDP)	M2	Safuan et al. (2021)	World Bank (World Development Indicator)
Private investment (%GDP)	INV	Suggested by the author	World Bank
Gross national expenditure (%GDP)	GNE	Suggested by the author	World Bank
Illegal financial flows (USD)	LN_IFF1, LN_IFF2	Collin (2020), Kar & Freitas (2013)	Global Financial Integrity

Source: Self-processing

3.2. Data

Shadow economic data is taken from Elgin et al (2021), corruption data is collected from Transparency International, and tax data are taken from the World Bank, UNU-WIDER. In addition, the HDI index is taken from UNDP, and illegal financial flows are taken from Global Financial Integrity. The remaining variable data is taken from the World Bank.

Based on the idea of Oanh et al. (2023) using the average value of the overall financial development index ($\text{OE} \pm$) of 55 countries around the world during the period 2009 - 2021, we divide the data into a high financial development group consisting of 25 countries with a financial development index greater than $\text{OE} \pm$ and a low financial development group consisting of 30 countries with the financial development index less than $\text{OE} \pm$. Data on financial development indicators are collected from the IMF.

4. Empirical results

4.1. Descriptive statistics

Table 2 shows the average value, standard deviation, maximum, and minimum values of 19 variables. Here are a few notable points about the endogenous variables when comparing the two descriptive statistical tables.

First, the average value of the shadow economy of the HFDCs group is 1.4448 times larger than the LFDCs group, with a standard deviation in the two groups not too large. Second, the average tax revenue value of the HFDCs group is about 1.3794 times larger than the LFDCs group, with a standard deviation of 27.1368% for the HFDCs group, higher than the LFDCs at only 5.6797%. Third, the author notes that the average CPI of both financial development groups is below 5, implying that there is not yet full awareness of corruption in countries. For exogenous variables, there are still differences in data between two groups of financially developed countries. However, there are no prominent needs in terms of representing statistical data values.

Table 2 Descriptive statistics of variables in the model

<i>High-financial developed countries (HFDCs)</i>				
<i>Variable</i>	Mean	Std. Dev	Max	Min
<i>SE</i>	28.8098	10.3105	57.4	11.0218
<i>TAX</i>	21.6005	27.1368	159.6	2.3134
<i>CPI</i>	4.2575	1.0156	7.3	2.4
<i>LN_EXC</i>	3.4657	2.7741	10.0523	-0.3425
<i>GNE</i>	4.6262	0.0881	4.8895	4.2966
<i>LN_IFF1</i>	8.8566	1.8283	12.6282	3.6346

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LN_ IFF2	9.6469	1.6162	13.2413	3.9943
INC	8.8497	0.6311	10.0931	7
INV	3.5046	0.727	5.2088	1.6742
M2	4.4335	0.6188	6.4757	3.3961
REM	0.1421	1.8962	3.2304	-5.4042
TOP	4.2924	0.4664	5.2283	3.0958
UNEM	1.8715	0.7946	3.5133	-1.3863
PG	0.9825	1.4392	11.794	-3.7424
IQ	0.1467	0.6551	1.5778	-0.9156
FDI	3.6877	8.2280	109.0253	-40.0866
GOV	16.17	5.0240	36.2169	2.3601
HDI	0.754	0.0672	0.881	0.565
INF	4.3807	9.9613	154.7561	-3.7491

Low-financial developed countries (LFDCs)

Variable	Mean	Std. Dev	Max	Min
SE	41.6237	9.0986	68.9	24.9327
TAX	15.6599	5.6797	39.59931	5.5370
CPI	3.3411	0.9032	5.9	1.5
LN_EXC	3.9357	2.7208	8.8209	-1.2755
GNE	4.6968	0.1019	5.0164	4.2756
LN_ IFF1	6.5528	1.2136	8.8342	3.4335
LN_ IFF2	7.5250	0.9968	9.7884	4.6921
INC	7.7542	0.8287	9.4469	6.1212
INV	3.1962	0.5675	4.4794	2.2406
M2	3.6324	0.4674	4.7930	2.5662
REM	1.5994	1.0522	3.4869	-1.9882
TOP	4.1448	0.4007	5.0624	2.7944
UNEM	1.5890	0.8552	3.3325	-1.1394
PG	1,4487	1,4009	3,8671	-1,8543
IQ	-0.1592	0.7168	1.8591	-1.1253
FDI	3.9242	10.1507	138.215	-41.651
GOV	13.6169	3.8345	23.7639	4.4033
HDI	0.6418	0.1188	0.819	0.327
INF	5.6959	6.4571	59.2197	-2.4898

Source: self-processing

4.2. Unit root test

Estimating the PVAR model requires the data series to ensure stationarity. From the existing data set, the author performs the ADF (Augmented Dickey-Fuller) method on panel data used to test the stationarity of the data. The results in Table 3 show that, in the model of HFDCs, CPI, LN_ IFF1, LN_ IFF2, FDI, GOV, HDI, INF, GNE, INC, INV, and TOP stop at level I(0), while SE, TAX and the remaining exogenous

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variables stop at first difference I(1). In the LFDCs model, TAX, CPI, LN_ IFF1, LN_ IFF2, FDI, GOV, HDI, INF, INC, REM, TOP all stop at the level I(0), and the variables else stops at the first difference I(1). The variables in the model in HFDCs and LFDCs do not stay at the same level. Therefore, the author can proceed to estimate the PVAR model.

Table 3 Unit root test results by ADF method

Variable	Value	HFDCs		LFDCs	
		I(0)	I(1)	I(0)	I(1)
SE	P_value	0.8639	0	0.9822	0
	Statistic t	39.2277	219.012	39.2966	235.597
TAX	P_value	0.2659	0	0.0376	-
	Statistic t	55.8017	189.263	80.8678	-
CPI	P_value	0.0781	-	0.0493	-
	Statistic t	64.7773	-	79.1656	-
IFF1	P_value	0	-	0.0002	-
	Statistic t	127.219	-	106.169	-
IFF2	Statistic t	0	-	0.0004	-
	Statistic t	119.303	-	104.180	-
FDI	P_value	0	-	0	-
	Statistic t	143.644	-	140.693	-
GOV	P_value	0.0003	-	0	-
	Statistic t	92.0420	-	119.799	-
HDI	P_value	0.0008	-	0	-
	Statistic t	87.4645	-	118.347	-
INF	P_value	0.0021	-	0	-
	Statistic t	83.5004	-	127.243	-
LN_EXC	P_value	0.4417	0	0.7484	0
	Statistic t	44.7122	113.251	46.7237	155.551
GNE	P_value	0.0376	-	0.1068	0
	Statistic t	69.1588	-	73.9178	228.807
INC	P_value	0	-	0.0001	-
	Statistic t	115.600	-	108.425	-
INV	P_value	0.0392	-	0.1998	0
	Statistic t	68.9252	-	68.9814	201.722
M2	P_value	0.9795	0	0.6709	0
	Statistic t	31.7331	192.172	54.6502	242.312
REM	P_value	0.2216	0	0.0023	-
	Statistic t	57.3386	142.690	0.2675	-
TOP	P_value	0.0612	-	0.0016	-
	Statistic t	66.2923	-	97.5078	-
UNEM	P_value	0.6962	0	0.2137	0

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PG	Statistic t	44.4127	150.816	68.3978	211.627
	P_value	0.6638	0	0.4513	0.0010
IQ	Statistic t	45.2583	111.076	60.6768	99.4226
	P_value	0.5745	0	0.6742	0
	Statistic t	47.4955	182.23	54.5548	206.918

Source: Self-processing

4.3. Optimal lag selection

Based on Tables 4 and 5, the optimal lag in HFDCs is 1, while in LFDCs it is 4, due to the priority of AIC testing.

Table 4 Results of optimal lag selection for HFDCs

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-631.3899	NA	0.2216	7.0039	8.1418	7.4644
1	-336.7150	512.7343*	0.0128*	4.1472*	5.4335*	4.6677*
2	-328.8905	13.3799	0.01293	4.1589	5.5937	4.7395
3	-325.3606	5.9302	0.0137	4.2136	5.7968	4.8543
4	-320.8532	7.4373	0.0143	4.2585	5.9901	4.9593

Source: Self-processing

Table 5 Results of optimal lag selection for LFDCs

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-1035.220	NA	1.9937	9.2018	10.2025	9.605
1	-454.8007	1035.080	0.01706	4.44	5.5712*	4.8958*
2	-446.4207	14.7348	0.0172	4.4452	5.7069	4.9536
3	-435.7929	18.4214*	0.017	4.4316	5.8239	4.9926
4	-426.1041	16.5518	0.0169*	4.4259*	5.9486	5.0394

Source: Self-processing

4.4. Results of autocorrelation and stability condition test

Figure 1 shows that all eigenvalues of the characteristic polynomial in the models are within the unit circle, indicating that the PVAR models at different stages ensure stability and sustainability.

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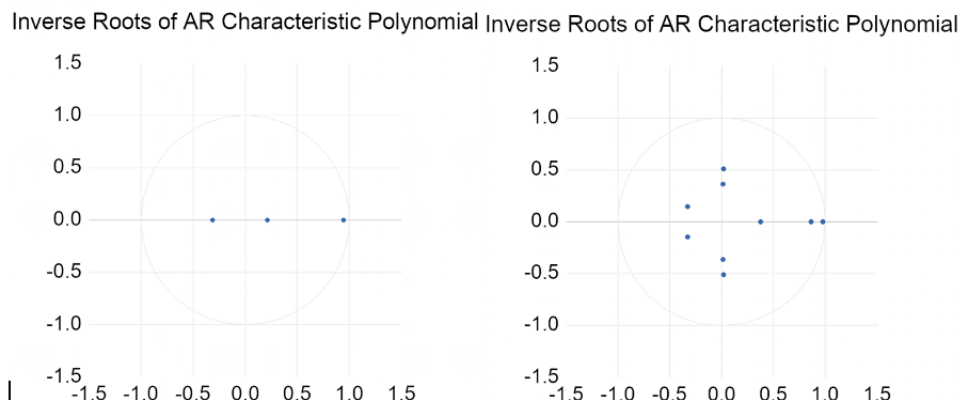


Figure 1 Inverse roots of AR characteristic polynomial

Source: Self-processing

Table 6 shows the autocorrelation test with hypothesis H0: There is no autocorrelation in the model. Specifically, Table 6 shows that at lag 4, the p-values at each level are >10%, meaning that H0 is rejected, and the model does not have autocorrelation. Likewise, for LFDCs, at lag 5, the model has no autocorrelation. Next, we proceeded with impulse-response functions and variance decomposition.

Table 6 The result of the autocorrelation test of the model

<i>HFDCs</i>					
Lag	1	2	3	4	
Prob	0.1949	0.9812	0.7750	0.2737	
<i>LFDCs</i>					
Lag	1	2	3	4	5
Prob	0.5414	0.4702	0.2964	0.1731	0.1225

Source: Self-processing

4.5. Results of impulse-response function

The results in Figure 2 show that in HFDCs:

When the implicit economic shock increases by one standard deviation, the CPI increases by 0.01% and tax revenue decreases by 0.02%. The results show a positive correlation between tax revenue and the CPI, and no correlation between tax revenue and the shadow economy.

When the tax revenue shock increases by one standard deviation, the CPI increases by 0.019%, while the shadow economy does not react to the shock in the first year. Still, there is fluctuation in the second year, decreasing to 0.043%. The results show

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a positive correlation between the shadow economy and the CPI, and no correlation between tax revenue and the shadow economy.

When the CPI shock increases by one standard deviation, the shadow economy and tax revenue do not react in the first year, but there are still fluctuations in subsequent years. The result given between the CPI for the shadow economy and tax revenue is that there is no correlation.

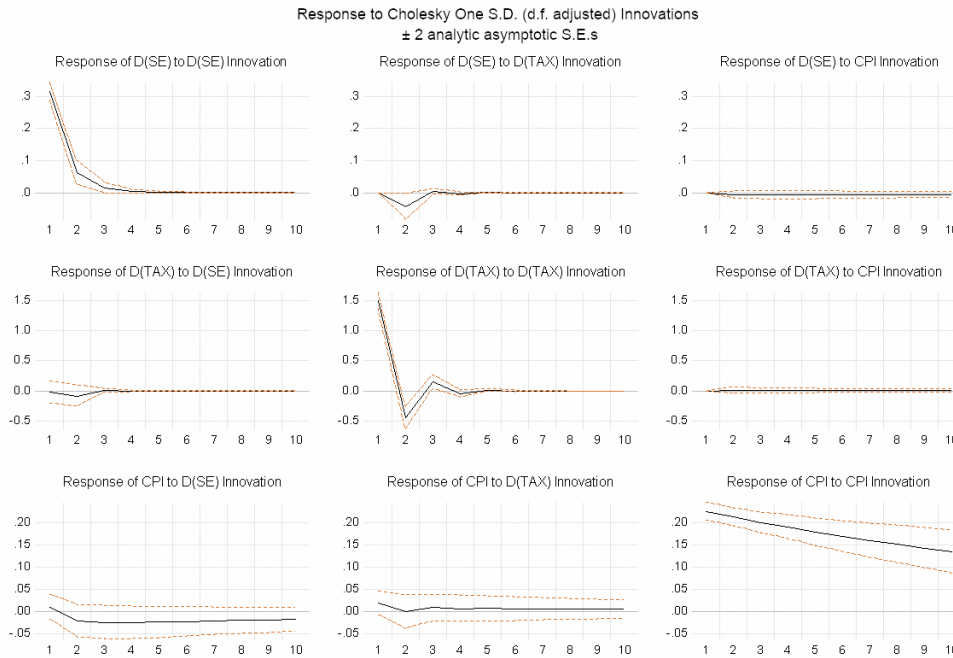


Figure 2 Impulse-response function results for HFDCs

Source: Self-processing

The results in Figure 3 show that in LFDCS:

When the shock from the shadow economy increases by one standard deviation, the CPI and tax revenue decrease by 0.002% and increase by 0.04%, respectively. The results show that the shadow economy positively correlates with tax revenue, while there is a negative relationship with the CPI.

When receiving a tax revenue shock that increases by one standard deviation, the results show that the shadow economy and the CPI do not react in the first year. Therefore, the conclusion is that there is no relationship between tax revenue for the shadow economy and the CPI in this case.

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Similarly, the shadow economy and tax revenue do not respond to shocks from a one standard deviation increase in the CPI. Therefore, the conclusion is that there is no relationship between the CPI for the shadow economy and tax revenue in this case.

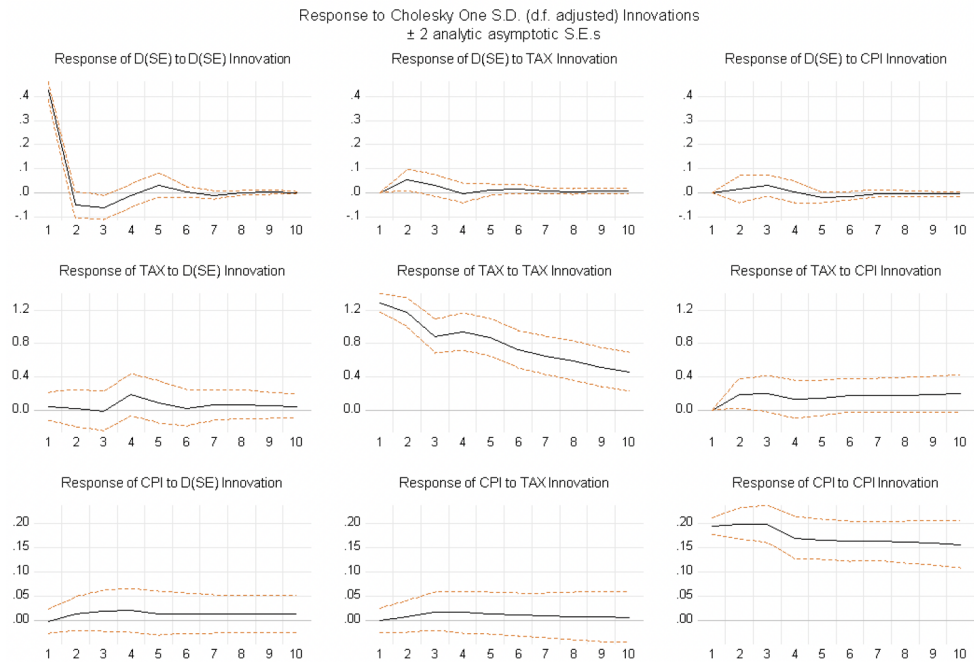


Figure 3 Impulse-response function results for LFDCs

Source: Self-processing

Table 7 shows the correlation results when considering shocks in HFDCS and LFDCs.

Table 7 Correlation results between variables

<i>Correlation</i>	<i>HFDCs</i>	<i>LFDCs</i>
<i>Correlation between the shadow economy and tax revenue</i>	-	+
<i>Correlation between tax revenue and the CPI</i>	+	No
<i>Correlation between shadow economy and the CPI</i>	+	-

Source: Self-processing

Firstly, the correlation between the shadow economy and tax revenue in the high financial development group shows an inverse relationship, while the low financial development group shows a direct relationship. The positive correlation implies that

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tax revenue and the shadow economy may play a complementary role in development in the low financial development region. Specifically, an increase in shadow economic activity to some acceptable level will increase the scale of both the formal and overall economy, from which the government collects more tax revenue. In addition, money laundering activities by businesses to use money legally will also contribute to the government's tax revenue, and tax evasion behaviors may be somewhat reduced as economic entities participating in shadow activities consider using "clean money" to cover up more profitable activities. For the HFDCs group, it is consistent with the empirical research of Achim, Mirza, and Văidean (2023), Amoh and Adafula (2019), and Iqbal and Rahman (2017). The explanation for this comes from the scale of the shadow economy in the high financial development region being subject to stricter supervision from the government in monitoring the cash flows of economic entities through transaction information quickly provided by banks. Therefore, tax evasion behaviors may be reduced because they have to consider the cost-benefit of successful tax evasion and the higher likelihood of being detected by the government than in low financial development regions, and thereby, tax revenue will increase.

For the correlation between tax revenue and the CPI, the HFDCs group shows a positive correlation, while the LFDCs group shows no correlation between these two variables. The explanation for this comes from the fact that countries in the low financial development group have different tax-related policies and corruption that has affected unclear correlation results. In addition, there may be many unusual fluctuations during the financial development process in each country, leading to policies that are not suitable and still have many shortcomings. For the HFDCs region, the positive correlation between tax revenue and CPI, or, in other words, tax evasion and corruption, has a positive relationship. This is consistent with recent research by Yamen et al. (2023), Mohammadi Khyareh (2019), Khelif & Amara (2019), and Albulescu et al. (2016). Ali et al. (2019) affirmed that a low level of corruption will attract investments and create a developed financial system. High financial development will also come with improvements from the law in many aspects; institutional quality is increasingly improving, thereby helping the government manage tax revenue from entities in the economy. According to Albulescu et al. (2016), to reduce tax evasion, it is also necessary to fight corruption; these two tasks must be carried out simultaneously.

Finally, in HFDCs, a positive correlation exists between the shadow economy and the CPI, a result similar to the research of Němec et al. (2021), which argues that increasing corruption awareness shifts activities to the shadow economy. On the other hand, LFDCs show a negative correlation between these two factors, a result similar to recent research by Esaku (2021), Nguyen & Luong (2020), and Huynh &

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Nguyen (2020). The relationship between the HFDCs and LFDCs groups is different, similar to the conclusion of Dreher & Schneider (2010) when arguing that corruption and the shadow economy are complementary factors and only occur in low-income countries.

In previous studies considering the individual relationship and only approaching in developed and developing countries like Dreher & Schneider (2010) or research in a specific region such as Asia (Nguyen & Luong, 2020; Huynh & Nguyen, 2020; Nurhidayat & Rokhim, 2018), Europe (Albulescu et al. 2016; Achimet al., 2023; Schneider et al., 2015), Africa (Kodila-Tedika & Mutascu, 2013; Ozili, 2019), and OECD organization (Mohammadi Khyareh 2019) or EU bloc (Stankevičius & Asta, 2014). The studies show similar results. However, in this study, the author approaches from a more comprehensive perspective when placing these relationships in the context of financial development, which is considered an important factor in the economy that needs to be considered to be able to give a more appropriate answer. Moreover, IMF experts argue that financial development should only reach an optimal level. If it exceeds this level, it will hinder the economic growth of a country (Cecchetti & Kharroubi, 2012). Dividing into two groups of countries based on the financial development index has highlighted the relationship between the shadow economy, corruption, and tax. Specifically, the results show that the connections differ for low and high financial development countries, helping policymakers make correct decisions suitable for the financial development level of countries when dealing with difficulties before shocks from the shadow economy, the CPI, and tax revenue.

4.6. Variance decomposition results

After analyzing IRF, the author performed variance decomposition to see how the shocks of the variables SE, TAX, and CPI are explained by the remaining variables. The results are described in Table 8.

Table 8 Variance decomposition results

<i>HFDCs</i>			
<i>Variance decomposition of SE</i>			
<i>Period</i>	SE	TAX	CPI
<i>1</i>	100.0000	0.0000	0.0000
<i>2</i>	98.1943	1.7718	0.0339
<i>3</i>	98.1356	1.7831	0.0981
<i>4</i>	98.0792	1.7940	0.1268
<i>Variance decomposition of TAX</i>			
<i>Period</i>	SE	TAX	CPI
<i>1</i>	0.0108	99.9891	0.0000

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2	0.3174	99.6790	0,0037
3	0.3165	99.6773	0.0061
4	0.3185	99.6727	0.0088
Variance decomposition of CPI			
Period	SE	TAX	CPI
1	0.2114	0.6982	99.0904
2	0.5472	0.3703	99.0825
3	0.8154	0.3215	98.8631
4	0.9895	0.2779	98.7326
LFDCs			
Variance decomposition of SE			
Period	SE	TAX	CPI
1	100.0000	0.0000	0.0000
2	98.3373	1.5536	0.1091
3	97.4628	1.9561	0.5811
4	97.4602	1.9567	0.5831
Variance decomposition of TAX			
Period	SE	TAX	CPI
1	0.0941	99.9059	0.0000
2	0.0622	98.7687	1.1691
3	0.0563	98.0545	1.8892
4	0.7417	97.3985	1.8596
Variance decomposition of CPI			
Period	SE	TAX	CPI
1	0.0126	3.71E-05	99.9874
2	0.2390	0.0832	99.6778
3	0.4805	0.3333	99.1862
4	0.6612	0.4534	98.8854

Source: Self-processing

For the shadow economy, in HFDCs, the shadow economy is explained by itself, tax revenue, and the corruption perception index (CPI), respectively, at 98.6%, 1.34%, and 0.06% (average of 4 years). In LFDCs, the shadow economy is explained by itself, tax revenue, and the CPI, respectively, at 99.29%, 0.49%, and 0.22% (average of 4 years). This implies that tax revenue explains the shadow economy in HFDCs more than in LFDCs. Conversely, in HFDCs, corruption contributes less to the explanation of the fluctuations of the shadow economy compared to LFDCs.

In HFDCs, tax revenue is explained by itself, the shadow economy, and the CPI, respectively, at 99.75%, 0.24%, and 0.01%. In LFDCs, tax revenue is explained by itself, the shadow economy, and the CPI, respectively, at 99.52%, 0.29%, and 0.19%. This implies the shadow economy mainly contributes to tax revenue in HFDCs and

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LFDCs. In addition, in LFDCs, corruption contributes more to explaining tax revenue fluctuations than in HFDCs.

Similarly, in HFDCs, the variation of the CPI is explained by itself, the shadow economy, and tax revenue, respectively, at 98.94%, 0.64%, and 0.42%. In LFDCs, the variation of the CPI is explained by itself, the shadow economy, tax revenue is 98.47%, 0.46%, and 1.07%. This shows that the shadow economy explains the CPI in HFDCs more than in LFDCs. Conversely, in HFDCs, tax revenue contributes less to explaining the fluctuations of the CPI.

5. Conclusions and policy implications

5.1. Conclusions

The PVAR model has provided some empirical results; specifically, there is an inverse relationship between the shadow economy and tax revenue (or, in other words, a positive relationship between the shadow economy and tax evasion) in the HFDCs. However, the case of the LFDCs group shows the opposite when the relationship between the shadow economy and tax revenue is positive. The author believes that the positive relationship in the context of low financial development is not difficult to understand; perhaps, at some level, shadow economic development will contribute to promoting the increase in tax revenue; however, tax evasion should not be considered as the downside of revenue because tax evasion is a part of the shadow economy, and therefore it is difficult to determine whether tax revenue increases and then tax evasion decreases in low financial development areas or not. Findings also suggest a positive relationship between tax revenue and the CPI in HFDCs, while there is no correlation between these two variables in LFDCs. Empirically, the results in HFDCs have shown a similar relationship to the previous empirical studies. As for LFDCs, further research may be needed in the future. In addition, the research results on the relationship between the shadow economy and the corruption perception index show a positive correlation in the HFDCs and vice versa in LFDCs. The notable thing is the positive relationship in HFDCs, while corruption is considered a part that increases the size of the shadow economy. Therefore, the relationship between these two variables must be further considered in HFDCs.

5.2. Policy implications

Countries, whether they are low or high in financial development, always have a contrast in the overall economy, including the formal and informal economies. The shadow economy is not entirely a bad form of operation; if managed and controlled, it is considered a supportive part of the development of the formal economy.

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Therefore, This paper aims to provide policymakers and governments with in-depth insights, helping them build a strong rule of law, thereby limiting corruption, and tax evasion, and controlling underground economic activities that affect the economy.

For HFDCs: Firstly, improve the tax system to enhance transparency in economic transactions through measures such as electronic tax notifications, online tax systems, and online monitoring to increase transparency and efficiency. *Secondly*, strengthen monitoring and effective enforcement of existing regulations and enhance international cooperation and coordination. The government should set specific monitoring limits and declare and report when conducting large transactions through banks to better control the flow of money in the economy and prevent activities such as money laundering and tax evasion. *Thirdly*, enhances the quality of governance in the public sector, which plays a crucial role in reducing tax evasion, increasing incentives for public officials, imposing heavy fines, and strictly dealing with violations. *Fourthly*, improve education organizations and enhance the quality of the workforce. The government needs to improve public services, create a favorable environment for economic development, and ensure a social support system to contribute to increasing the satisfaction of people's lives, helping to limit tax evasion and corruption activities.

For LFDCs: Firstly, promote transparency in the process of paying construction taxes by simplifying the tax registration, declaration, and online payment procedures to reduce the risk of errors and fraud during the tax submission process. *Secondly*, enhance supervision in tax management, implement information sharing between financial institutions and tax authorities, and coordinate with cybersecurity agencies and the police to build a secure database. Declare and report large transactions at banks to enhance transparency and prevent money laundering. *Thirdly*, improve the quality of institutional reforms in the state apparatus and strengthen inspections and monitoring to detect and address corrupt behaviors. Liberalize regulations, such as in the labor market, to create a competitive business environment and reduce corruption incentives. *Fourthly*, enhance education to raise awareness about taxes and anti-corruption efforts and create favorable conditions for the public to access tax information. Improve the quality of personnel in the tax sector to meet the requirements of the digital economy and cross-border transactions. Education goals are seen as the key to reducing the scale of the underground economy and developing the economy in the region.

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Author Contributions

Oanh and Quoc conceived the study and were responsible for the design and development of the data analysis. Nha, Chau, and Phat were responsible for data collection. In addition, Quoc and Oanh analysis, as well as data interpretation. Chau and Nha were responsible for the literature review section.

Disclosure statement

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Appendix - Table A.1 Countries covered by the study

<i>LFDCs</i>	<i>HFDCs</i>
Albania	Botswana
Angola	Brazil
Armenia	Bulgaria
Belarus	Chile
Benin	China
Bolivia	Colombia
Bosnia and Herzegovina	Croatia
Cameroon	Hungary
Costa Rica	India
Dominican Republic	Indonesia
Ecuador	Jamaica
El Salvador	Jordan
Georgia	Lebanon
Ghana	Malaysia
Guatemala	Mauritius
Kyrgyz Republic	Mexico
Madagascar	Morocco
Moldova	Peru
Nepal	Philippines
Nicaragua	Poland
Niger	Saudi Arabia
Nigeria	South Africa
Pakistan	Thailand
Paraguay	Turkey
Rwanda	Vietnam
Senegal	
Tanzania	
Tunisia	
Uganda	
Ukraine	