Financial Inclusion and Economic Growth in WAEMU: A Multiscale Heterogeneity Panel Causality Approach

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2017

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January 18, 2018

Abstract

This paper examines the causal relationship between Financial Inclusion and economic growth in the West African Economic and Monetary Union (WAEMU) from 2006 to 2015. We combined the heterogeneity panel causality test proposed by Dimitrescu and Hurlin (2012) with the Maximal Overlap Discrete Wavelet Transform (MODWT) to analyze the bi-directional causality at different time scales. We used two Financial Inclusion indicators: the overall rate of demographic penetration of financial services (Financial Inclusion supply) and the overall rate of use of financial services (Financial Inclusion demand). Our results show that at scale 1 (2-4 years), there is no causality between economic growth and Financial Inclusion indicators. However, at scale 2 (4-8 years), we found a bi-directional causality between economic growth and Financial Inclusion. Policymakers should therefore promote reforms that are beneficial to financial inclusion, especially on the supply side, while making the levers for macroeconomic growth more efficient, which also seems to be a decisive factor in financial inclusion.

Keywords: Financial Inclusion, Economic Growth, Time Scales, Heterogeneity Panel Causality, MODWT.
JEL Classification: O1, G2, C00

1 Introduction

In recent years, the Central Bank of West African States (BCEAO[1]) have implemented several reforms to promote Financial Inclusion (FI) in WAEMU[2]. These reforms focus on the establishment of a legal framework and financial infrastructures more adapted to the banking activity, the support to the decentralized financial sector and the implementation of action promoting access to financial services[3] (BCEAO, 2017).

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[1]Banque Centrale des Etats de l'Afrique de l'Ouest
[2] West African Economic and Monetary Union
[3]Mobile money included

These reforms had a positive effect on the use of financial services. Indeed, Demirguc-Kunt et al. (2015) has shown a recent expansion of Financial Inclusion through mobile money accounts in WAEMU countries, particularly in Ivory Coast and Mali. BCEAO (2017) found that about 21.9 million individuals now have a mobile phone account against 11 million in 2013 in WAEMU. We noticed an increase from 2.6 to 7.8 million bank accounts from 2006 to 2014 and from 366,000 in 2010 to 16 millions in 2016 of electronic money coin. Last years, the demographic access and the supply of financial services has also increased to 18.4 points of services for 10,000 adults in 2014 against 0.9 points in 2006 and from 0 points of services of electronic currency issuer in 2009 to 24,300 in 2014 (see BCEAO, 2016). These studies show the positive repercussions of the measures taken by the BCEAO on Financial Inclusion within WAEMU. However, the Financial Inclusion despite this recent expansion in WAEMU is still weak relative to other regions (see Mlachila et al., 2016).

Financial Inclusion can be defined as "the pursuit of making financial services accessible at affordable costs to all individuals and businesses, irrespective of net worth and size respectively"[4]. World Bank (2014) defined Financial Inclusion as "the proportion of individuals and firms that use financial services".

According to the World Bank and the AfDB[5], the access to essential financial services would enable populations to have better-living conditions (health, investment in business, education . . .).

Several authors have highlighted the beneficial effects of Financial Inclusion on economic growth. However, macroeconomic studies remain low. Some works such as those of Hariharan and Marktanner (2012) have shown that Financial Inclusion had the potential to enhance economic growth and development. Sahay et al. (2015) have demonstrated that Financial Inclusion indicators had a positive impact on growth but had to be coupled with financial development. Sharma (2016) has found that various dimensions of Financial Inclusion promoted economic growth.

In subsaharian Africa countries, several studies related to Financial Inclusion have been taken. Kpodar and Andrianaivo (2011) argued that the joint impact of Financial Inclusion and mobile phone development on growth was stronger. Oruo (2013) found a strong positive correlation between Financial Inclusion and economic growth in Kenya. Onaolapo (2015) and Babajide et al. (2015) showed that effects of Financial Inclusion on the economic growth of Nigeria are positives. The Outlook Regional Economic (2015) argued that Financial Inclusion by lowering constraints to access credit generally boosted growth in African emerging and developing countries.

The purpose of this paper is to determine whether the measures taken in recent years to promote financial inclusion have indeed caused economic growth in WAEMU and vice versa. According to Triki and Faye (2013), Financial Inclusion can be defined in 3 dimensions: access, use, and quality of financial services. Here we use two indicators as proxies for financial inclusion: the overall rate of demographic penetration of financial services and the overall rate of use of financial services[6]. We use these proxies to analyze the impact of financial inclusion from the point of view of supply and demand for financial products. The first indicator is used as proxy for access and quality to financial services and also represents the financial inclusion supply. The second indicator is used as proxy for the use of financial services and also represents the demand for financial inclusion. We want to see which of the policies favoring the supply or demand of financial services is conducive to sustained economic growth and vice versa.

In our present paper, we propose a dynamic approach of analysis of the causality between Financial Inclusion

[4] http://www.investopedia.com
[5] African Development Bank
[6] Mobile Money Included

and growth. The approach used here allow analyzing the evolution and the direction of causality over different time scales. We favor this approach for certain reasons. First, Sahay et al. (2015) supported the possibility of a reverse causation in this relationship between the variables in time.

Then, these data at different time scales make it possible to analyze economic relations more precisely (economic relations are far from being static) than to a single time scale using raw data. Several authors have confirmed the importance of taking into account different time scales in the analysis of the links between economic variables. Solow (2000) argued the importance of taking into account the time scale for a more realistic analysis of the relationships between economic variables [7]. Gallegati et al. (2014) asserted that the true economic relationships between variables are those found at the disaggregated level (data at different timescales) rather than at the usual aggregate level (raw data). According to the authors, aggregate data estimate an average of relationships across time scales that can mitigate the effect of each regressor on all timescales. We can also cite several authors such as Gallegati et al. (2011); Aguiar-Conraria and Soares (2011); Crowley and Hallett (2014); Gallegati et al. (2014) that showed the empirical advantages of the analysis at different time scales[8] on classical methods in the analysis of macroeconomic relations.

To study this relationship at different times scales, we have combined the wavelet methods and the panel causality test proposed by Dimitrescu and Hurlin (2012). Firstly, we have implemented the MODWT[9] to get the data at different time scales and then, we have applied the panel causality test at each time scale. The wavelet analysis allows to accurately choose and to analyze the time scale where we want to study the causality between variables. In addition, this methodology allows: First, the analysis of non-stationary series dynamics (see Percival and Walden, 2000) which avoids the loss of information subject to the stationarisation of data and second this approach releases the hypothesis of co-integration of data of ECM[10].

The contribution of this work is threefold. Firstly, this study seeks to fill the gap in the literature on the relationship between Financial Inclusion and economic growth in the WAEMU. Secondly, this study allow at different time scales, to investigate the dynamic causality between Financial Inclusion and growth. Finally, this study analyzes financial inclusion in terms of supply and demand for financial services simultaneously.

The rest of the study is structured as follows. Section 2 presents a brief review of the literature on Financial Inclusion and growth relationship. Section 3 provides the econometric methodology used to analyze the Financial Inclusion and growth causality. Section 4 examines the data and empirical results and Section 5 concludes.

2 Literature review

The literature on the nexus between Financial Inclusion and economic growth from a macroeconomic point of view is recent and not very extensive. Hariharan and Marktanner (2012) have shown that Financial Inclusion could stimulate economic growth. They also argued that Financial Inclusion could create capital because of this strong positive correlation with the total factor productivity. They concluded that Financial Inclusion could increase the savings portfolio, the efficiency of intermediation of financial sector, foster entrepreneurship and thus economic

[7] Solow (2000, p 156) says " I can easily imagine that there is a true macrodynamics, valid at every time scale. . . . At short scales, I think something sort of Keynesian is a good approximation, and surely better than anything straight neoclassical. At very long scales, the interesting questions are best studied in a neoclassical framework . . . At the five to ten years time scale, we have to piece things together as best as we can, and look for an hybrid model that will do the job."

[8] Dynamic Analysis

[9] Maximal Overlap Discrete Wavelet Transform

[10] Error Correction Models

growth. Sahay et al. (2015) have used macroeconometrics and microeconometrics methodologies to study the link between Financial Inclusion and GDP growth. The results showed that Financial Inclusion have a positive impact on GDP growth but must be combined with financial development. However, as more inclusion and financial development increases, the positive effect of inclusion on growth decreases. Sharma (2016) using the Vector autoregression (VAR) and the Granger causality, have shown that various dimensions of Financial Inclusion (banking penetration, availability, and usage of banking services) have positively impacted the economic growth. Author found a bi-directional causality between the geographical penetration of banking services and the economic development and a unidirectional causality between the number of deposits and the GDP.

In sub-Saharan African countries, Kpodar and Andrianaivo (2011) have addressed the question of whether Financial Inclusion was one of the channels through which the development of mobile telephony improved the economic growth. They have shown that mobile penetration had a positive impact on the economic growth by facilitating Financial Inclusion, but it has also consolidated the impact of Financial Inclusion on the economic growth. Greater penetration of mobile telephony increases access to deposits and loans. She have concluded that the joint impact of Financial Inclusion and mobile phone development on the growth was stronger. Oruo (2013) has investigated the relationship between Financial Inclusion and economic growth in Kenya. She has found that the economic growth had a strong positive correlation with Financial Inclusion, especially the branch networks of the banking sector, mobile money accounts and the users. Onaolapo (2015) studied the effects of Financial Inclusion on the economic growth of Nigeria. He found a significant positive relationship between financial inclusion and economic growth. The author also showed that Financial Inclusion greatly influenced poverty reduction and financial intermediation through positively impacted Bank Branch Networks, Loans to Rural Areas and small enterprises. Babajide et al. (2015), were interested in the impact of Financial Inclusion on growth. They found that Financial Inclusion positively impacted the total factor of production and the capital per worker, which impact positively the final output of the economy. The Outlook Regional Economic (2015) by using a micro-founded general equilibrium model, analyzed the impact of Financial Inclusion on growth in Africa. They showed that lowering credit access constraints and lowering participation costs to market for firms and companies could stimulate growth and productivity and reduce inequality.

3 Methodology

In this section, we present the econometric methodology used to study the causality between Financial Inclusion and economic growth. First, we provide an overview of Maximum Overlap Discrete Wavelet Transform and then, we present the panel causality test proposed by Dimitrescu and Hurlin (2012).

3.1 Maximum Overlap Discrete Wavelet Transform (MODWT)

We use the MODWT to implement the data at different time scales (see Percival and Walden, 2000). The MODWT localizes variations in the signal or time series in time and frequency simultaneously. The variability and the evolution over time can be captured by decomposing the time series at many timescales.

Let X_t, the data. The time series can be decomposed by a sequence of projections onto wavelet basis:

$$s_{J,k} = \int X_t \Phi_{J,k}(t)dt \tag{1}$$

$$d_{j,k} = \int X_t \psi_{j,k}(t)dt \tag{2}$$

where $j = 1, 2 \ldots J$, the level of multiresolution and $J = log2(T)$; Φ,the father wavelet and Ψ, the mother wavelet. $s_{J,k}$, the smooth wavelet coefficient (long run movements) provides a smooth or overall pattern of the original signal and $d_{j,k}$, the wavelet detail coefficient (short run movements) capture local fluctuations in each scale over the entire period of a time series. $\Phi_{J,k}$ and $\psi_{j,k}$ are scaling and translation obtained from Φ and Ψ and are defined as follow

$$\Phi_{J,k}(t) = 2^{-j/2}\Phi(2^{-j}t - k) = 2^{-j/2}\Phi(\frac{t - 2^j k}{2^j}) \tag{3}$$

$$\Psi_{J,k}(t) = 2^{-j/2}\Psi(2^{-j}t - k) = 2^{-j/2}\Psi(\frac{t - 2^j k}{2^j}) \tag{4}$$

For the decomposition, we use Daubechies least asymmetric (LA) wavelet filter of length 8 because it is one of the best and most used in wavelets theory.

The decomposition of the series by the MODWT is usually implemented by the Pyramidal Algorithm (see Mallat, 1999). The multiresolution analysis of the X_t using the MODWT can be written as follows

$$X_t = \sum_{j=1}^{J} d_{j,k} + s_{J,k}, \tag{5}$$

3.2 Panel Heterogeneity Causality Test

We apply to the data at different time scales, the heterogeneity panel causality test introduced by Dimitrescu and Hurlin (2012)[11]. This test is a extension to panel data version of the Granger (1969) causality test for time series. The underlying regression writes as follows

$$y_{i,t} = \alpha i + \sum_{k=1}^{K} \beta ik y_{i,t-k} + \sum_{k=1}^{K} \gamma ik x_{i,t-k} + \epsilon_{i,t} \tag{6}$$

where $x_{i,t}$ and $y_{i,t}$ are the observations of two stationary variables for individual i in period $t$and α_i are the fixed effects. Coefficients are allowed to differ across individuals but are assumed time- invariant. The maximal lag order K is assumed to be identical for all individuals and the panel must be balanced.

As in Granger (1969), the procedure to determine the existence of causality is to test for significant effects of past values of x on the present value of y. The null hypothesis is therefore defined as

$$H0 : \gamma i1 = \gamma i2 = \ldots = \gamma ik = 0, \forall i = 1, \ldots, N \tag{7}$$

which corresponds to the absence of causality for all individuals in the panel. The test assumes there can be causality for some individuals but not necessarily for all. The alternative hypothesis thus writes

$$\begin{gathered} H1 : \gamma i1 = \gamma i2 = \ldots = \gamma ik = 0, \forall i = 1, \ldots, N_1 \\ \gamma i1 \neq 0 \quad \text{or} \quad \gamma i2 \neq 0 \quad \text{or} \ldots \text{or} \quad \gamma ik \neq 0, \forall i = 1, \ldots, N_1 + 1, \ldots, N \end{gathered} \tag{8}$$

[11] DH

where $N_1 \in [0; N-1]$ is unknown. If $N_1 = 0$, there is causality for all individuals in the panel. N_1 is strictly smaller than N, otherwise there is no causality for all individuals and $H1$ reduces to $H0$. Against this backdrop, DH propose the following procedure: run the N individual regressions implicitly enclosed in (6), perform F-tests of the K linear hypotheses $\gamma i1 = \gamma i2 = \ldots = \gamma ik = 0$ to retrieve W_i, and finally we compute $\overline{W}$ as the average of the N individual Wald statistics

$$\overline{W} = \frac{1}{N}\sum_{k=1}^{K} W_i \tag{9}$$

where W_i is the standard adjusted Wald statistic for individual i observed during T periods. We emphasize that the test is designed to detect causality at the panel-level, and rejecting $H0$ does not exclude that there is no causality for some individuals. Using Monte Carlo simulations, DH show that $\overline{W}$ is asymptotically well-behaved and can genuinely be used to investigate panel causality. Under the assumption that Wald statistics W_i are independently and identically distributed across individuals, it can be showed that the standardized statistic $\bar{Z}$ when $T \to \infty$ and then $N \to \infty$ (sometimes interpreted as T should be large relative to N) follows a standard normal distribution

$$\bar{Z} = \sqrt{\frac{N}{2K}} \times (\overline{W} - K) \to \mathcal{N}(0,1) \tag{10}$$

Also, for a fixed T dimension with $T > 5+3K$, the approximated standardized statistic $\tilde{Z}$ follows a standard normal distribution

$$\tilde{Z} = \sqrt{\frac{N}{2K} \times \frac{T-3K-5}{T-2K-5}} \times [\frac{T-3K-3}{T-3K-1} \times \overline{W} - K] \to \mathcal{N}(0,1) \tag{11}$$

The testing procedure of the null hypothesis in (7) is finally based on $\bar{Z}$ and $\tilde{Z}$. If these are larger than the corresponding normal critical values, then one should reject $H0$ and conclude that there is Granger causality. For large N and T panel datasets, $\bar{Z}$ can be reasonably considered. For large N but relatively small T dataset, $\tilde{Z}$ should be favored. Using Monte Carlo simulations, DH have shown that the test exhibits very good finite sample properties, even with both T and N small.

4 Data and Empirical Results

The dataset consists of a cross-country observations from for 8 countries from WAEMU countries over the 2006-2015 period. We use annual data. The dataset has been obtained from the World Bank and Central Bank of West African States (BCEAO) databases. We use two proxies of Financial Inclusion: the overall rate of demographic penetration of financial services (DemoF) that represents the access and the available supply of financial services and the overall rate of use of financial services (UseF) that represents the demand and use of financial services. As economic growth proxy, we use GDP per capita growth (GDPg). The choice of this period of study is the consequence of a constraint on the data. Some descriptive statistics are reported in Table 1.

[TABLE 1 HERE]

Firstly, we compute the wavelet coefficients using the MODWT to obtain the data at different time scales. For the decomposition, we use Daubechies Least Asymmetric (LA) wavelet filter of length 8[12] (see Daubechies, 1992). The maximum number of scales or decompositions allowed is $log2(T)$[13] where T is the number of observations. However,

[12] One of the best wavelets filters used in the theory (Percival and Walden, 2000)

[13] $\log2(10) = 3.3219$

the wavelet coefficients become too small at large scales, then we have decided to stop to 2 decompositions or scales with 2 wavelet details and 1 smooth wavelet coefficient (long run dynamic or trend). Secondly, we apply three panel unit root tests at each scales. In case where the three tests contradict, the decision rule is a simple majority rule. The analysis of Table 2 (MW[14], IPS[15], CIPS[16] panel stationarity tests) shows that for the $D1$ and $D2$ scales, the panel unit root hypothesis is rejected while for the $S2$ scale it is not rejected. We cannot, therefore, use the $S2$ scale in the analysis in view of the stationarity hypothesis of the VAR models.

[TABLE 2 HERE]

Finally, we apply the DH panel causality test at $D1$ and $D2$ scales. Given the number of data, the optimal number of lags allowed by the DH panel causality test is 1[17]. Given the small size of our sample, the Ztilde test statistic is the most suitable (see Methodology Section) for the analysis of the results.

[TABLE 3 HERE]

The test results in Table 3 indicates that at scale 1 (2-4 years), there is no causality between the economic growth and the two indicators of Financial Inclusion. However, it should be noted that the Zbar statistic indicates that the economic growth causes the overall rate of growth of demographic services. In view of its contradictory results, the conclusions obtained from the Ztilde statistic, which is the most adapted to our study, must for reasons of robustness be taken with precautions at this scale. At scale 2 (4-8 years), the causality is present and is even bi-directional. The overall rate of demographic penetration of financial services (supply) and the overall rate of use of financial services (demand) cause GDP growth and vice versa. The analysis of the statistic tests Ztilde at scale 2 (4-8 years) provides further information. Firstly we have found that economic growth causes more Financial Inclusion than this one causes economic growth. Indeed, a strong growth implies a greater income and therefore can lead to investments in financial infrastructures more efficient in order to sustain this growth. These investments therefore lead to an increase in the supply and quality of available financial services and thus make them more accessible to the population (geographical penetration). In addition, an increase in income implies an increase in the demand for financial services and therefore increases their use. Secondly, the use of financial services (demand) causes more economic growth than their demographic penetration. That can be explained by the fact that an increase in the use of financial services drives GDP per capita growth. Indeed, the use of financial services by the population gives them access to savings and credit that have a positive impact on investment. Beyond this, there is also the facilitation and securisation of financial transactions that can lead to an increase in the dynamics of the economy. Finally, we have found that economic growth causes more geographic penetration of financial services than their use. Indeed, the populations, despite an increase in their income due to the economic growth, may decide personally not to use available financial services. This may be the consequence of this lower impact of economic growth on the use of financial services.

5 Conclusion

This study has examined the causal relationship between Financial Inclusion and economic growth using WAEMU panel data from 2006 to 2015. We used the GDP per capita growth as the proxy of economic growth and two indicators as proxies of the Financial Inclusion: the overall rate of demographic penetration of financial services

[14] Maddala and Wu
[15] Im, Pesaran and Shin
[16] Cross-sectionally augmented IPS
[17] $T > 5 + 3K$, where K is the lag number

and the overall rate of use of financial services. We combined MODWT and panel causality test from Dimitrescu and Hurlin (2012) to analyze this relationship.

The findings reveal that the causal relationship between the economic growth and the Financial Inclusion depends on the time scale. At scale 1 (2-4 years), there is no causality but at scale 2 (4-8 years), there is a bidirectional causality between the economic growth and the Financial Inclusion. We have also found that the use of financial services (demand) causes more the economic growth than the demographic penetration of financial services (supply). But in the other sense, the economic growth causes more the demographic penetration of financial services (supply) than the use of financial services (demand). The results are almost similar to those of Sharma (2016). There is no causality between the Financial Inclusion and the economic growth at short run but at medium or long run, there is a bi-directional causality. We can conclude that Financial Inclusion measures that have been implemented have actually simulated growth in WAEMU in long run and vice versa. These results show that, for stronger inclusive growth, economic policies favoring the use or demand for services (lower borrowing rates, higher interest rates creditors, specialization of banks in the mobile money sector.) in the first instance must be taken. This will then lead to sustained growth, which will then promote the development or supply of financial products and so on.

The results from this study are relevant for policymakers. They could improve the Financial Inclusion and macroeconomic growth simultaneously to reach an inclusive and sustainable growth. Firstly, the policymakers should continue to encourage and even intensify policies and reforms promoting the demand for financial services. This would stimulate the economic growth by increasing savings and therefore investments. At the same time, they should strengthen and liberalize the investment regulatory framework and create an environment conducive to exports by facilitating administrative procedures and fighting against corruption. All these measures will promote the economic growth which in turn will increase the supply of available financial services.

In short, policymakers and financial authorities should, while promoting financial inclusion, simultaneously put in place policies that simulate macroeconomic growth in order to have a stronger positive impact on both sides.

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Country	Variable	Observations	Mean	Standard Deviation	Minimum	Maximum
Benin	DemoF	10	4.335	5.9941	1.23	20.51
	UseF	10	53.022	14.6982	34.63	80.79
	GDPg	10	1.3752	1.8181	-0.7088	4.2434
Burkina-Faso	DemoF	10	4.716	6.3589	0.86	18.47
	UseF	10	28.517	13.17174	10.54	53.19
	GDPg	10	2.3454	1.8183	-0.2054	5.2210
Ivory Coast	DemoF	10	5.578	7.8365	0.38	23.03
	UseF	10	37.635	24.2202	12.96	74.02
	GDPg	10	2.0329	4.5305	-6.6476	8.0017
Guinea-Bissau	DemoF	10	0.737	0.4878	0.21	1.58
	UseF	10	5.834	3.8490	1.2	13.94
	GDPg	10	0.6820	2.7963	-4.3148	6.5754
Mali	DemoF	10	7.88	12.0920	1.25	37.49
	UseF	10	33.652	18.9608	19.32	73.4
	GDPg	10	0.8861	2.1193	-3.7211	3.9826
Niger	DemoF	10	8.997	13.4988	0.31	37.34
	UseF	10	9.902	7.8389	0.86	23.1
	GDPg	10	1.6940	3.5819	-4.3880	7.6076
Senegal	DemoF	10	11.217	14.3276	1.22	40.45
	UseF	10	41.734	19.4756	21.85	76.3
	GDPg	10	0.8863	1.3295	-1.1819	3.4216
Togo	DemoF	10	2.94	2.1022	1.43	8.44
	UseF	10	50.361	19.6618	28.09	92.32
	GDPg	10	1.36401	1.20776	-.5021	3.1481

Table 1: Descriptive statistics of variables from 2006 to 2015.

Variables	MW	IPS	CIPS
Scale 1(D_1)			
DemoF	54.994 (0.000*)	-3.4318 (0.0003*)	-3.276 (0.001*)
UseF	248.144 (0.000*)	-4.9176 (0.0000*)	-4.421 (0.000 *)
GDPg	268.071 (0.000*)	-4.2589 (0.0000)	-1.790 (0.037**)
Scale 2 (D_2)			
DemoF	186.625 (0.000*)	-3.4318 (0.0003*)	-3.266 (0.001*)
UseF	149.828 (0.000*)	-4.2589 (0.0000*)	-0.207 (0.418)
GDPg	394.928 (0.000*)	-4.9176 (0.0000*)	-7.092 (0.000*)
Scale 3 (S_2)			
DemoF	0.000 (1.000)	2.7776 (0.9973)	-0.677 (0.249)
UseF	0.000 (1.000)	2.5532 (0.9947)	-1.319 (0.094***)
GDPg	0.000 (1.000)	2.0916 (0.9818)	-1.599 (0.055***)

Note: Numbers in the parenthesis show the p-values.
*Significant at the 1% level.
**Significant at the 5% level.
***Significant at the 10% level.

Table 2: Panel unit roots test of variables at different time scales.

Scale 1 (D_1: 2-4 years)	Lag	Wbar	Zbar	Ztilde	HO
DemoF → GDPg	1	0.3413	-1.3174 (0.1877)	-0.9771 (0.3285)	DemoF does not homogeneously cause GDPg
GDPg → DemoF	1	2.0350	2.0701 (0.0384**)	0.4512 (0.6519)	GDPg does not homogeneously cause DemoF
UseF → GDPg	1	0.9061	-0.1879 (0.8510)	-0.5009 (0.6165)	UseF does not homogeneously cause GDPg
GDPg → UseF	1	1.4912	0.9825 (0.3259)	-0.0074 (0.9941)	GDPg does not homogeneously cause UseF
Scale 2 (D_2: 4-8 years)	Lag	Wbar	Zbar	Ztilde	HO
DemoF → GDPg	1	9.8974	17.7948 (0.0000*)	7.0813 (0.0000*)	DemoF does not homogeneously cause GDPg
GDPg → DemoF	1	24.8333	47.6665 (0.0000*)	19.6763 (0.0000*)	GDPg does not homogeneously cause DemoF
UseF → GDPg	1	15.1078	28.2155 (0.0000*)	11.4751 (0.0000*)	UseF does not homogeneously cause GDPg
GDPg → UseF	1	21.5901	41.1803 (0.0000*)	16.9415 (0.0000*)	GDPg does not homogeneously cause UseF

Note: Numbers in the parenthesis show the p-values.
*Significant at the 1% level.
**Significant at the 5% level.

Table 3: DH panel causality at different times scales.