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THE RELATIONSHIP BETWEEN ENERGY TRANSITION, INDUSTRIALIZATION AND EMPLOYMENT: A GMM PANEL VAR APPROACH

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ABSTRACT

Using quarterly data for the period 2013Q1-2017Q1, this study explores the relationship between energy transition, industrialization, and employment in the panel of developed and emerging countries. The GMM panel VAR proposed by Abrigo and Love (2016) and Granger causality test are used. After confirming the presence of unit root in our variables, the results of GMM panel VAR reveal that industrialization and employment negatively affect energy transition while energy transition does not have any effect on industrialization and employment. Furthermore, the Granger causality indicates a unidirectional relationship going from industrialization and employment to energy transition. Our findings also support major differences in the relationship between the studied variables depending on the country being emerging or advanced. These results may have policy implications for the more energy-efficient system of countries.

Contribution/ Originality: The study contributes to the literature by using an energy transition index. The study is among the first studies that use GMM panel VAR to investigate the relationship between energy, industrialization, and employment.

1. INTRODUCTION

Climate change and global warming have become more concerns of contemporary societies. The multiple technological evolutions and a growing need for energy are among the first causes of the damage to the Ozone layer. This atmospheric dysfunction occurs at a time when the lives of all societies are related to the consumption of affordable and easily accessible energy. Indeed, energy crises highlight the vulnerability of the industrial world to energy gridlock. It is this strong energy dependency that seems to slow down the expansion of renewable energies in a world where fossil fuels account for more than 80% of primary energy production (OCDE/IEA, 2013).

However, environmental concerns and efforts to achieve less dirty development and industrialization are placing the control of the environmental consequences of energy consumption at the heart of national and international development policies. These concerns have increased interest in the issue of the energy transition for nearly two decades. There are multiple definitions and measurements for the energy transition. In this study, we consider the energy transition as a switch from one economic system depending on one or a series of energy sources and technologies to another (Fouquet & Pearson, 2012). In this line, the main energy transition that is encountered in most countries is the move from fossil and dirty energy to renewable energy. However, the energy transition is perceived differently in the countries and is generally manifested through investments to strengthen energy efficiency, the development of energy, solar and wind energy, and the adoption of legislation for the development of renewable energy. Besides, many instruments are put in place at the international level to promote energy transition. Thus, the flexibility mechanisms of the Kyoto Protocol, carbon credit trading, or dedicated funds such as the Clean Technology Fund, the Climate Investment Fund administered by the World Bank are all tools that support the energy transition. Nevertheless, this energy transition, which aims to reduce the overall ecological impact of populations has a considerable effect on the economy.

Many studies have in fact been interested in the effects of the energy transition through the study of the relationships between renewable and non-renewable energies on the one hand and economic variables on the other. Some of these works argue that there is a relationship both in the short term and long term between economic growth and energy consumption (Carfora, Pansini, & Scandurra, 2019; Hossein, Yazdan, & Hasan, 2012; Kyophilavong, Shahbaz, Kim, & Jeong-Soo, 2017; Pandey & Rastogi, 2019; Saud, Baloch, & Lodhi, 2018). Therefore it appears that Energy use is an important factor of production and is either the cause or the facilitator of economic growth (Ram, Aghahosseini, & Breyer, 2020). Moreover, other authors have shown the existence of a two-way relationship between renewable energy and economic growth (Al-Mulali & Sab, 2012; Dogan, 2015). Some studies highlight the existence of a positive effect of industrial production on energy consumption (Adom, Bekoe, Amuakwa-Mensah, Mensah, & Botchway, 2012; Keho, 2016; Shahbaz & Lean, 2012; Ubani, 2013). In fact, like energy transition simply means a shift of an energy system from dirty energies to renewable or less dirty ones, this implies job losses in fossil fuels and nuclear power sectors. But developing renewable energy generation and storage capacities can make a significant contribution to job creation in the long run with positive net jobs created (Ram et al., 2020). Studies that assess the net employment effects of renewable energy and energy efficiency generally report a positive net employment effect of such an energy transition (Blyth et al., 2014; Meyer. & Sommer, 2014). Still related to the subject of this study, other works have shown that the level of employment in a country is a determining factor of energy use in that country. Among these works we can mention (Breitschopf, Nathani, & Resch, 2011; Grogan & Sadanand, 2013; Ram et al., 2020; Rutovitz, Dominish, & Downes, 2015; Ubani, 2013).

All these studies have interested in the relationship between energy (non-renewable and renewable ones) and economic variables like employment, industrialization, and economic growth. Some of these studies used separately different renewable energy to capture the effects of the energy transition on industrialization and employment. To our knowledge, the relationship between industrialization, employment, and energy transition using a global indicator of the energy transition is not beforehand analyzed. It is therefore the task of the present paper which examines a panel of 101 developed and developing countries depending on the availability of data on energy transition. Our work goes far by specifying the relationship between the studied variables in developed and developing countries. On the other hand, the previous works have in majority used computable general equilibrium methods, Input / Output methods, and survey-based analytical methods. We use a different methodology (GMM panel VAR approach) in our study and expect particular results because methodology can affect the results of net employment estimation (Stavropoulos & Burger, 2020).

The remainder of the paper is organized as follows. Section 2 reviews the empirical literature regarding the relationship between energy, employment, industrialization. Section 3 presents the methodology. Section 4 discusses the empirical results while section 5 summarizes the major findings of the study and gives some policy recommendations.

2. LITERATURE REVIEW

In recent years and a context marked by energy transition, many economic studies are focused on the relationship between types of energy and economic variables. Most of these studies focused on the nexus between energy and other variables like economic growth (Al-Mulali & Sab, 2012; Arango-Miranda, Hausler, Romero-

Lopez, Glaus, & Ibarra-Zavaleta, 2018; Kyophilavong et al., 2017) financial development (Zhang, Wang, & Wang, 2017) Trade (Dedeoğlu & Kaya, 2013) and urbanization (Pata, 2018). However, the most of the growing studies are also interested in employment and industrialization impacts of energy transition (Garrett-Peltier, 2017; Jacobson et al., 2014; Jacobson. et al., 2017; Markandya, Arto, González-Eguino, & Román, 2016). Some of these authors like Jacobson et al. (2014); Jacobson. et al. (2017) have shown that long-run sustainable energy infrastructure for clean energy without fossil fuels, biofuels, and nuclear power, would create millions of permanent and full-time jobs across 139 countries. Their estimation of baseline jobs per unit of energy uses an economic input-output model with several assumptions and uncertainties. The study of Markandya et al. (2016) has also found a positive impact of the transition to renewable energy on employment. These authors have shown that between 1995 and 2009, a shift from the more carbon-intensive sources to gas and renewable energy has positively affected job creation. Moreover, Garrett-Peltier (2017) analyses the contribution of energy transition and shows that investment in fossil fuels relatively creates less full-time equivalent jobs than investment in renewable energy.

(Ram et al., 2020) to meet the Paris Agreement objectives, adopt an analytical approach to estimate jobs created in an energy transition scenario. They conduct a study of projections of the net jobs created by an accelerated uptake of renewable electricity generation with 100% electricity deriving from renewable sources between 2015 and 2050. Their result indicates that global the energy transition will considerably increase the number of jobs. The authors thus support that renewable energy technologies create more jobs than dirty energy technologies.

Several other studies utilized the employment factor approach to estimate jobs in an energy transition scenario (Breitschopf et al., 2011; Ram et al., 2020; Rutovitz et al., 2015). The employment factors method consists of the number of jobs derived from an energy technology capacity addition or investment. This method presents the advantage of simplicity, and it efficiently estimates direct employment-related to energy generation, storage, and transmission.

In the rural African context where there are no electricity, household cook with wood and light their homes using the candle. The energy transition can then be considered as electrification. Some studies focused on the effects of electrification on employment. Dinkelman (2011) shows in the context of South Africa, by using instrumental variables and fixed effect approach that household electrification raises employments by releasing women from home production and enabling microenterprises. These results are confirmed by Grogan and Sadanand (2013) who show in the case of Nicaragua that electrification increase the propensity of rural Nicaraguan women to work outside the home by about 23%. But the last authors have not found any evidence of electrification effect on male employment. This difference is justified by the methods and contexts of the two studies.

On the other way, energy in its different forms plays a crucial role and is pervasive for industrialization. Nevertheless, it is insufficient in the developing world and can appear as a lagging factor for industrialization in African countries. The literature concerning the effects of new energy generation on industrialization is more growing.

Neelsen and Peters (2011) study the nexus of electricity and firm performance in Uganda. Their findings show that modern energy has positive direct and indirect effects on firm performance, especially micro and small enterprises. The improvement of micro and small enterprise performance can then support employment. One reason is that the small and micro-enterprises are a crucial driver of job creation in developing countries (see for example: (Mandelman & Montes-Rojas, 2009; Mensah & Brown, 2007; Nichter & Goldmark, 2009; Reardon et al., 1998; Tybout, 2000).

Adversely to the previous studies that implicitly address the problem of renewable energy and industrialization, other authors are directly focused on the industrialization impact of modern energy. Thus Rud (2012) uses the panel of Indian states for 1965 to 1984 to show that an increase in one standard deviation of electrification, can be associated with an increase of around 14% in manufacturing output for a state.

Very few studies have directly addressed the relationship between energy transition and industrialization. Works that have linked renewable energy and industrialization has been much more limited to a simple study of the effect of industrialization on energy intensity and CO2 emissions (Appiah, Du, Yeboah, & Appiah, 2019). Since the energy transition emphasizes the control of greenhouse gas emissions, many other authors have begun by analyzing the link between these toxic emissions and industrialization (Raheem & Ogebe, 2017).

However, the literature abounds with works highlighting the crucial place of energy efficiency in the industrialization process. Thus, several studies carried out in different contexts, over different periods and using various econometric models show that energy is a powerful source to execute the production process, increase the volume of production and attain efficiency (Altinay & Karagol, 2005; Iyke, 2015; Odhiambo, 2009; Stern, 2000).

3. ECONOMETRIC METHODOLOGY

3.1. Data Description

The data used for this empirical study and its sources are provided in Table 1. This table provides some descriptive statistics. The average energy transition index is 58.616%, while maximum and minimum values are 33% and 80% respectively. The same details on the other endogenous variables are shown in Table 1. Giving the short dimension of the data on the energy transition index (2013-2017), we covert our data in quarterly form using the method of Denton. Our time dimension, therefore, stands for 2013Q1 to 2017 Q1. Due to data unavailability, we restrict our analysis to the following countries: Algeria, Argentina, Armenia, Australia, Austria, Bahrain, Belgium, Bolivia, Botswana, Brazil, Brunei-Darussalam, Bulgaria, Cambodia, Cameroon, Canada, Chile, China, Colombia, Costa Rica, Cote d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt Arab Republic, El Salvador, Estonia, Ethiopia, Finland, France, Georgia, Germany, Ghana, Greece, Haiti, Hungary, Iceland, India, Indonesia, Iran, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kazakhstan, Kenya, Korea Republic, Kuwait, Kyrgyz Republic, Latvia, Lebanon, Malaysia, Mexico, Mongolia, Morocco, Mozambique, Namibia, Nepal, Netherlands, New Zealand, Nicaragua, Nigeria, Norway, Oman, Pakistan, Panama, Paraguay, Peru, Philippines, Poland, Portugal, Qatar, Romania, Russian Federation, Saudi Arabia, Senegal, Singapore, Slovak Republic, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Tajikistan, Tanzania, Thailand, Tunisia, Turkey, Ukraine, United Kingdom, United States, Uruguay, Vietnam and Zambia.

Table-1. Descriptive statistics.

Variables	Unit of measurement (Source)	N	Mean	S.D.	Min	Max
ETI	Energy transition index measure by global energy architecture performance index (World Economic Forum 2013-2017).	515	58.616	10.244	33	80
Industry	Industry, value added (% of GDP)- (World Bank, 2017).	510	28.450	10.586	9.887	73.899
Empl	Employment Authors' calculation from employment to population ratio, 15+, Total (World Bank, 2017) and total population (World Bank, 2017).	515	57.744	10.775	33.312	87.749
GDP	GDP per capita, PPP (constant 2017 $) (World Bank, 2017)	515	25373.54	20228.05	1165.409	99133.72

3.2. Model Specification

Although the different results obtained by previous studies on employment effects of energy transition can mainly be attributed to their context, the methods used by these studies are also an element of these differences. The authors use a computable general equilibrium (CGE) modeling framework, input-output (I/O) methods, and survey-based analytical methods. Our study utilizes the panel VAR model in the GMM framework (Abrigo & Love, 2016) to investigate the relationship between energy transition, industrialization, and employment in selected 102 developed and developing countries of the world. This model was introduced by Holtz-Eakin, Newey, and Rosen (1988) in a micro-study based on the times series VAR model of Sims (1980). This model is more appropriate for the objective of this study. Giving that the objective of our paper is to analyze the relationship between energy intensity, industrialization, and employment, the PVAR model framework is especially suitable It builds an endogenous system and treats all the variables in an unrestricted way, which is more appropriate in cases where the variables are strongly related and interact with each other (Canova & Ciccarelli, 2013; Love & Zicchino, 2006). Also, the unknowing relationship of the nature of the causal relationship makes this PVAR model particularly suitable for our study.

Following Abrigo and Love (2016) and considering the absence of exogenous in our model, we specify a four-variate panel VAR of order p specified as follows:

$$Y_{it} = Y_{it-1} A_1 + Y_{it-2} A_2 + ... + Y_{it-p+1} A_{p-1} + Y_{it-p} A_p + \mu_i + e_{it} \quad (1)$$

$$i \in \{1,2,...N\}, t \in \{1,2,...T_i\}$$

Where the subscripts i and t stand for country and period respectively; Y_{it} is a ($1x4$) vector of dependent variables including energy transition index, industrialization, employment, and GDP. A_j (with j=1, 2, …, p) are coefficients of the (4x4) matrices; μ_i captures individual heterogeneity or fixed-effects between different cross-sectional units. ε_{it} are idiosyncratic errors with the following characteristics $E[e_{it}] = 0$, $E[e'_{it} e_{it}] = \sum$ and $E[e'_{it} e_{is}] = 0$ for all t > s.

The reduced-form of our VAR model specifying in Equation 1 can be written as follow:

$$Y_{it} = \overline{Y_{it}^*} A + e_{it}^* \quad (2)$$

Where * denotes the first difference transformation of the original variables.

$$Y_{it}^* = \left[Y_{it}^{1*} \ Y_{it}^{2*} \ ... \ Y_{it}^{k-1*} \ Y_{it}^{k*} \right] \qquad \overline{Y_{it}^*} = \left[Y_{it-1}^* \ Y_{it-2}^* \ ... \ Y_{it-p+1}^* \ Y_{it-p}^* \ X_{it} \right]$$

$$e_{it}^* = \left[e_{it}^{1*} \ e_{it}^{2*} \ ... \ e_{it}^{k-1*} \ e_{it}^{k*} \right] \qquad A' = \left[A_1' \ A_2' \ ... A_{p-1}' \ A_p' \ B' \right]$$

Considering Z_{it} a row vector of $L \geq kp + l$ instruments, where $X_{it} \in Z_{it}$, the GMM estimator of Equation 2 is given by:

$$A = \left(\overline{Y^{*'}} Z \hat{W} Z' \overline{Y^*} \right)^{-1} \left(\overline{Y^{*'}} Z \hat{W} Z' Y^* \right) \quad (3)$$

Where $\hat{W}$ is a symmetric, positive semi-definite, and non-singular (LxL) matrix selected to maximize efficiency (Hansen, 1982). The GMM estimator is robust under the assumption that $E[Z'e] = 0$ and $E[\overline{Y^{*'}} Z] = kp + l$ and the Wald test is implemented to examine the direction of the causal relationship among the variables.

4. RESULTS AND DISCUSSION

Based on the objective mentioned above, we empirically determine the relationship between energy transition, industrialization and employment in the 102 selected developed and developing countries over the period 2013-2017. The choice of period and countries is based on the availability of data on the energy transition index.

4.1. Unit Roots Tests and Model Selection Technique

Like many time-series studies, we begin our empirical analysis by the unit root tests for ovoid spurious regression. The results of Levin, Lin, and Chu (2002) verified by Im, Pesaran, and Shin (2003) are reported in Table 2. The results of the LLC test show that all variables are I(0) while the IPS ones rather support that all variables are

I(1). For more robustness and giving the importance of stationary variables for the VAR model, the study supposes that the series under consideration are all integrated of order one.

Table-2. Unit root tests.

	Level		First difference	
Variables	Levin et al. (2002)	Im et al. (2003)	Levin et al. (2002)	Im et al. (2003)
ETI	-1.0701 (0.879)	-1.2023 (0.999)	-10.6701*** (0.0000)	-3.021*** (0.0013)
Industry	-1.1552 (0.4532)	-1.1615 (1.0000)	-4.1557***(0.0000)	-2.9406*** (0.0024)
Empl	-1.5068 (0.1244)	-0.7165 (1.0000)	-4.5068*** (0.0000)	-4.6818*** (0.0013)
GDP	-1.4790 (0.3452)	-1.6442 (1.0000)	-4.4790*** (0.0000)	-3.3948*** (0.0002)

Note: P-values are in parentheses; *** stand for 1% significance levels.

For model selection, Andrews and Lu (2001) proposed MMSC for GMM models based on Hansen (1982) J statistic of overidentifying restrictions. This MMSC is analogous to Akaike information criteria (AIC) (Hirotugu Akaike, 1969) the Bayesian information criteria (BIC) (H. Akaike, 1977; Rissanen, 1978; Schwarz, 1978) and the Hannan-Quinn information criteria (HQIC) (Hannan & Quinn, 1979). Then Table 3 report the result of order selection based on the three model-selection criteria by Andrews and Lu (2001). The results of the table show that the first-order panel VAR is the preferred model because it has the smallest MBIC, MAIC, and MQIC. However, the two first-order panel VAR models do not reject Hansen's overidentification restriction at the 10% level. It thus supports the absence of misspecification in the model in the selected first-order panel VAR.

Table-3. Panel VAR lags order selection.

Lag	J	J pvalue	MBIC	MAIC	MQIC
1	40.91363	0.7559326	-293.7715	-55.08637	-145.5173
2	32.42022	0.4460435	-190.7032	-31.57978	-91.86708
3	0.9946299	0.0975425	-87.91639	-8.354685	-38.49834

4.2. GMM panel VAR Results

The table reports the results of the estimation of the reduced form panel VAR 4. The variables horizontally are the dependent variables, while the vertically and lagged variables are the explanatory variables.

The first column of the table shows that industrialization negatively affects energy transition. Also, the energy transition does not have any influence on industrialization. It appears that a 1% increase in industrialization reduced energy transition by 0.336%. This result is counter-intuitive and shows that industrialization does not always support the energy transition. However, investments related to energy transition contribute to the strengthening of the capital stock of the economy. We can justify this result by the increase in demand and energy intensity entailed by industrialization. Indeed, industrialization increases energy consumption and leads to the burning of fossil fuels. This result is consistent with Sadorsky (2013); Sadorsky. (2014) who show that industrialization can compromise energy transition through an increase of energy use and energy intensity. However, this finding contradicts (Li & Lin, 2015) who supported that industrialization decreases energy consumption in middle-/low-income countries and thereby can contribute to the energy transition. These differences can be explained by various methodologies approaches and different contexts. Furthermore, we find a negative effect of employment on energy transition. It means that a 1% increase in the stock of employment leads to a reduced energy transition by -2.718%. As for industrialization, an increase in the energy transition index does not significantly affect the level of employment. This result is contrary to the findings of Jacobson et al. (2014) and Jacobson. et al. (2017). It also contradicts the results of Ram et al. (2020) who show a positive net job created of an accelerated uptake of renewable electricity generation with 100% electricity deriving from renewable sources from 2015 to 2050. Finally, GDP positively affects the energy transition, and one time again, energy transition do not influence GDP. Indeed, the result of our table shows that a 1% increase in GDP augments the energy transition index by 16.49% while the energy transition does not impact the GDP level. This result contradicts Hernandez et al. (2014) who support that promoting renewable energy technology over other forms of generation is counterproductive to economic growth by driving down productivity through increase cost. Our last findings also invalidate the previous studies that show a positive and significant effect of renewable energy on GDP and economic growth (Carfora et al., 2019; Frondel, Ritter, Schmidt, & Vance, 2010; Hannesson, 2014; Hillebrand, Buttermann, Behringer, & Bleuel, 2006; Kyophilavong et al., 2017).

Table-4. GMM panel VAR estimates.

Variables	Deti	Dindustry	Dempl	Dlgdp
L.dETI	0.688***	-5.591	-0.00655	0.00325
	(0.120)	(10.33)	(0.0190)	(0.00931)
L.dindustry	-0.366**	22.27	-0.000395	0.0264*
	(0.151)	(13.76)	(0.0251)	(0.0136)
L.dempl	-2.718***	1.961***	0.501***	0.211***
	(0.954)	(75.21)	(0.142)	(0.0789)
L.dlgdp	16.49**	1,389***	0.832	1.955***
	(6.607)	(533.7)	(1.590)	(0.726)
Observations	1,358	1,358	1,358	1,358

Note: Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1.

It appears from our result that employment and GDP positively impact industrialization. A 1% increase in employment augments industrialization by 1.96%. The same augmentation in GDP contributes to a 1.389% augmentation of industrialization. None of the endogenous variables affect employment. Finally, it can be noted from the results that industrialization and employment positively affect GDP. A 1% increase in any of these two variables leads to 0.0264% and 0.211% for industrialization and employment respectively.

4.3. Panel VAR Stability

It is crucial for the coefficients on the reduced-form panel VAR to be interpreted as a causal influence, to calculate the moduli of companion matrix based on the estimated parameters. The results of Table 5 show that the model is stable like all the moduli are smaller than one.

Table-5. Eigenvalue stability condition.

Eigenvalue		
Real	**Imaginary**	**Modulus**
0.9184285	0	0.918429
0.6425181	0	0.642518
0.5720835	0	0.572084
0.1840596	0	0.18406

The results of the table show that panel VAR satisfy the stability conditions.

4.4. Granger Causality Test

We summarize the result of the Granger causality test in Table 6. This table shows that there is a unidirectional relationship going from industrialization to energy transition, from employment to energy transition, and from GDP to energy transition. On the other ways, energy transition does not cause any of the three other endogenous variables.

Table-6. Granger causality test between endogenous variables.

Variables	ETI	Industry	Empl	GDP
ETI		0.293	0.120	0.122
		(0.588)	(0.730)	(0.727)
Industry	5.864**		0.000	3.752*
	(0.015)		(0.987)	(0.053)
Empl	8.115***	6.795***		7.188***
	(0.004)	(0.009)		(0.007)
GDP	6.227**	6.773***	4.685**	
	(0.013)	(0.009)	(0.03)	
ALL	11.328**	7.456*	0.089*	9.659**
	(0.010)	(0.059)	(0.060)	(0.022)

Notes: P-values in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

4.5. The Subgroups Results Panel VAR Results

We present now the results of the subgroup of our panel. We separate countries in advanced countries and emerging countries. The Tables 7 shows the different subgroup results.

Table-7. GMM panel VAR results for advanced countries.

Variables	Deti	Dindustry	Dempl	Dlgdp
L.dETI	0.680***	-5.616**	-0.0349	-0.00598
	(0.104)	(2.307)	(0.0673)	(0.0201)
L.dindustry	-0.107	8.306***	0.0183	0.00373
	(0.761)	(2.227)	(0.0349)	(0.00972)
L.dempl	-0.922*	9.622***	0.774***	-0.0270
	(0.543)	(20.07)	(0.222)	(0.0614)
L.dlgdp	2.034	-3.282***	-1.037	0.499
	(2.482)	(83.28)	(1.265)	(0.373)
Observations	588	588	588	588
Panel	42	42	42	42

Note: Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

The Tables 7 reports the results of the estimation of the advanced countries of our panel. As for the former table, the variable horizontally is the dependent variable. The vertical and lagged variables are exogenous ones.

The first column of the table shows that industrialization always negatively affects energy transition but the coefficient is not significant. On the other way, energy transition negatively affects industrialization in advanced countries. Indeed, a 1% increase in the energy transition index conduces to a decrease of industrialization by 5.616%. This means that industrialization in the advanced countries does not necessarily imply an increase in dirty energy use. Also, the energy transition through the adoption of renewable energy constraints the industrialization in these countries. This result is justified by many stringent measures adopted in developed countries related to the quality of energy use. Furthermore, our table indicates a negative effect of employment on energy transition. It appears that a 1% increase in employment stock leads to a reduced energy transition by 0.922%. Moreover, the effect of employment on energy transition is not significant in advanced countries. These results contradict the findings supporting that accelerating uptake of renewable energy will have a positive net jobs creation effect (Jacobson et al., 2014; Ram et al., 2020). Finally, the effect of GDP on energy transition is not significant. And energy transition does not influence GDP in advanced countries. This last result is different from many studies that find a significant relationship between economic growth and renewable energy in the same category of countries. However, these differences can be explained by the variables used.

We summarize the results of the Granger causality test for advanced countries in the Table 8. It can be seen that there exists a unidirectional relationship going from industrialization to energy transition in advanced countries. In addition, the results reveal the bidirectional Granger causality between energy transition and employment for the same group of countries. Finally, it can be noted from this table that there exists no relationship between GDP and energy transition in advanced countries.

Table-8. Granger causality test between endogenous variables in advanced countries

Variables	ETI	Industry	Empl	GDP
ETI		5.924**	0.270*	0.089
		(0.015)	(0.075)	(0.766)
Industry	1.968		0.274**	0.147
	(0.161)		(0.045)	(0.701)
Empl	2.885*	2.298***		0.194
	(0.089)	(0.000)		(0.660)
GDP	0.671	1.553***	0.673	
	(0.413)	(0.000)	(0.412)	
ALL	3.720**	3.186***	0.686**	0.568
	(0.043)	(0.000)	(0.037)	(0.904)

Notes: P-values in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

We turn now on the results of the emerging countries of our panel. The results of the GMM panel VAR for the emerging countries are presented in the Table 9. Like for the other table, the variables horizontally are the dependent variables while the vertically and lagged variables are exogenous ones.

Table-9. GMM panel VAR results for emerging countries.

Variables	Deti	Dindustry	Dempl	Dlgdp
L.dETI	**0.667*** **	**-4.378**	**0.00262**	**0.00388**
	(0.186)	**(15.65)**	**(0.0250)**	**(0.0160)**
L.dindustry	**-0.396**	19.84	0.0212	-0.0317
	(0.360)	(34.12)	(0.0558)	(0.0349)
L.dempl	**-3.591***	263.1*	0.382	-0.295*
	(1.906)	(157.3)	(0.257)	(0.170)
L.dlgdp	**6.916***	-6,125*	7.455	7.154*
	(38.86)	(3,425)	(5.360)	(3.656)
Observations	770	770	770	770
Panel	55	55	55	55

Note: Standard errors in parentheses.
*** p<0.01, ** p<0.05, * p<0.1.

The first column of the table shows that industrialization always negatively affects energy transition but the coefficient is not significant. In the same way, energy transition does not have any effect on industrialization in emerging countries. These results can be explained by the weak level of energy transition index that is noted in these countries. Also in many of the emerging developing countries, especially in Africa, industrialization is facing the problem of energy deficit. This energy deficit relegates the objective of energy transition and the use of renewable energy to the background. At times again, like for all panels and the advanced economies, the results for emerging countries show that employment has a negative and significant effect on energy transition. A 1% increase in employment in emerging countries will lead to a 3.591% decrease in the energy transition. While energy transition has a non-significant effect on employment in emerging countries. The table also shows a positive and significant effect of GDP on energy transition and a non-significant of the energy transition on employment. Therefore, a 1% increase in GDP leads to a 6.916% augmentation of the energy transition index. This means that economic growth plays a crucial role in countries to ensure a good energy transition and more renewable energy use. It also explains the fact that the advanced economies with a higher level of GDP per capita perform well in the energy transition index classification than the emerging countries which in the majority have lower GDP per capita.

Finally, the summarization of Granger causality for emerging countries in Table 10 show that, contrary to the advanced countries, there exists no relationship between industrialization and energy transition index in emerging countries. A different result is also for the relationship between employment and energy transition

Table-10. Granger causality test between endogenous variables in emerging countries.

Variables	ETI	Industry	Empl	GDP
ETI		0.070	0.011	0.059
		(0.078)	(0.917)	(0.808)
Industry	1.212		0.145	0.827
	(0.271)		(0.704)	(0.363)
Empl	3.551*	2.798*		2.990*
	(0.060)	(0.094)		(0.084)
GDP	3.167*	3.198*	1.935	
	(0.075)	(0.074)	(0.164)	
ALL	5.225**	3.540*	2.415	4.097
	(0.043)	(0.069)	(0.491)	(0.251)

Notes: P-values in parentheses, *** p<0.01, ** p<0.05, * p<0.1.

The table shows a unidirectional Granger causality going from employment to energy transition in emerging countries. The result for advanced countries has revealed a existence of the bidirectional Granger causality between the same two variables. The result for emerging countries also shows unidirectional Granger causality from GDP to energy transition which contrasts with the no Granger causality between the same two variables finds in advanced countries.

5. CONCLUSION

Energy transition is the main objective pursued by both developed and developing countries. It implies moving from the dirty energy sources to renewable energies. In developing countries, the energy transition is still very early. The challenge is to move from energy sources such as coal and candles to less dirty systems to gas and electricity. The objective in these last countries is therefore the one of greater electrification. Because of the crucial role of an efficient energy system in a well-functioning economy, one is led to believe that a poorly managed energy transition could hamper industrialization, employment and economic growth.

This study examines the relationship between energy transition and economic variables like employment and industrialization in a panel of developed and developing over the period 2013Q1-2017Q1. The present research makes valuable contributions by study the relation between a heterogenous energy transition measure like energy transition index, industrialization and employment. Also, the study differentiates the analysis in terms of advanced and emerging countries.

Our findings suggest that industrialization and employment negatively affect energy transition while the energy transition does not affect any of the two other variables. Therefore, industrialization does not always support the energy transition and can even compromise the resort to renewable energy by increasing energy use and energy intensity. Second, the Granger causality highlight that the relationship between the energy transition and the other endogenous of our study is only unidirectional going from industrialization and employment to energy transition. However, the distinction between advanced and emerging countries underlines some differences between the two groups of countries. In advanced countries, the energy transition negatively affects industrialization while the transition to renewable energy does not affect industry value added in these countries. This results contrast with the findings in emerging countries where the effects of industrialization to energy transition are just non-significant in the two ways. The Granger causality test also show some differences on the relationships between energy transition, industrialization and employment in emerging countries and advanced countries.

These results have several implications for economic and energy policies of countries. Energy transition policies must integrate the demands of companies in terms of energy use. It is also important to adapt a country's jobs to the requirements of the energy transition. Therefore, the energy transition should be implemented differently depending on the level of development of the country.

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