

Impact of financial market development on the CO₂ Emissions in GCC countries

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ABSTRACT

Financial development market (FMD) may have positive or negative environmental consequences. This research investigated the effects of FMD and income on CO₂ emissions in Gulf Cooperation Council (GCC) countries during 1980-2018. We found that income had positive effect but FMD had insignificant impact on emissions in GCC panel. Then, we tested these effects in the individual country time series and found that income had positive impact in Saudi Arabia, Kuwait and Oman and had insignificant effect in other GCC countries in long run. Effect of FMD was positive in Oman, was negative in UAE and was insignificant in rest of GCC countries. Effect of income was positive in Saudi Arabia and Kuwait and was insignificant for other countries in short run. The effect of FMD was positive in Kuwait and was negative in UAE. We recommend UAE to expand the financial market and suggest Oman and Kuwait to have a check on the financially supported pollution-oriented activities.

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1. Introduction

Claessens and Feijen (2007) claimed that one of the most important objective of millennium goals is to provide clean environment to the societies to be benefitted from the modern and clean technologies. Otherwise, the pollution promotion technologies can be dangerous for the world in terms of pollution and just providing short run welfare to communities. For the long run sustainability, the clean technologies are almost pertinent to support clean environment. Therefore, financial sector should classify the loans for the promotion of clean technologies. Otherwise, the ignorance will result in pollution and FMD will lead to unsustainable development in the world. The GCC countries' financial market is expanding sharply which need attention to ensure the net positive welfare out of FMD, which is only possible with environment friendly supported green project and avoiding to finance dirty projects. The hypothesis of relation among pollution and FMD has got a great attention in the literature (Jalil & Feridun, 2011). In positive environmental aspect of FMD, a seminal study of Birdsall and Wheeler (1993) claimed that FMD would support clean-environmental technologies and innovation. It was also argued that FMD would increase the innovation capacity and size of the industry to innovate the efficient technology which would reduce pollution pressure in the country. In the extension of this argument, Jalil and Feridun (2011) investigated and found the positive contribution of FMD in the environmental quality of largest pollution emitter China and originated that FMD has been leading in reducing pollution.

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In the same way, Shahbaz et al. (2013) investigated this relationship in Malaysia and also corroborated the negative effect of FMD. Hence, this study also supported the argument of positive environmental effect of FMD. On the other hand, Zhang (2011) explored the relation among FMD and pollution, but he indicated that FD enhanced the pollution. Thus, existing literature fails to provide vivid evidence on this hypothesis. Therefore, there is an ample gap in the existing literature to investigate such relationship that has rather been neglected specially in the GCC region. FMD accelerates the industrial growth and urbanization which may be considered good for overall economic growth but it can have bad effects in terms of pollution if ignored its environmental side. Therefore, it is pertinent to test the influence of FMD on pollution on urgent basis to control the growth of dirty industry, if financed to increase their business activities which may damage environment consequently.

The development of financial sector in GCC has made easy to increase the investment in different sectors. Approximately 90 percent (16 million tons/year) of discharges of pollution in Arab countries may be due to transports business (El Raey, 2006). According to Sadorsky (2010), Basheer et al. (2019) and Zhang (2011), FMD leads to enhance the efficiency of stock markets which support business to decrease their production costs. Moreover, it attracts Foreign Direct Investment (FDI) in industrial sector and provides conducive conditions for consumers' loan which increases the quantity of goods that leads to pollution. Consequently, emission of carbon dioxide also increases toxic gas which negatively affects the environment, humans, animals, plants, and all forms of life adversely. Moreover, GCC region is attracted a lot of portfolio inflows due to their stable currency rates. The traders keep a lot of reserves in the oil exporting countries like GCC to stabilize the foreign value of their wealth (Kilian et al., 2009). So, this foreign portfolio is also helped to develop the financial market of oil exporter countries. Moreover, GCC region is growing their financial market due to diversification policy. Therefore, testing the environmental effects of FMD is pertinent to verify its environmental effect in the region as a whole region and individual country as well. The GCC region is one of the most popular regions for oil production. This fact is also supporting and developing the regional financial sector which has encouraging effect in the consumer financing and investment in the industrial sector which are increasing environmental degradation in the region. In GCC, a limited literature reconnoitered drivers of pollution emissions in this region. For example, Al-Mulali and Ozturk (2014) and Qader (2009) investigated the electricity and pollution connection in GCC region. Rafindadi et al. (2018) and Salahuddin et al. (2018) probed FDI and pollution nexus in GCC region and Kuwait, respectively. Additionally, Salahuddin et al. (2018) also considered the effect of FMD on the pollution in Kuwait and Mahmood et al. (2018) investigate this relationship in Saudi Arabia in nonlinear cointegration settings. A comprehensive investigation of FMD and CO₂ emissions nexus is missing in the whole GCC panel. Moreover, investigation of individual country case of GCC region is needed to compare the effects of FMD in the GCC countries. We investigate FMD and CO₂ emissions relationship in the GCC panel during 1980-2018. Also, the time series analyses are targeted to remove the aggregation biasness of the whole GCC panel and to compare the FMD and CO₂ emissions nexus in the all GCC countries to have deep policy insight of this region.

2. Literature Review

Dasgupta et al. (2001) explored the FMD and pollution relationships and claimed that FMD was responsible for raising the overall business activities and would be contributing the pollution in the indirect relationship. FMD is signaling for more loans and funds available to business and households to increase the consumption and investment activities. These, in turn, increase the use of machineries which accelerate fuel consumption and leads to pollution. So, the FMD is becoming curse for quality of life in terms of bad environment. Sadorsky (2010) probed that FMD was raising the demand for the goods which led to raise the demand for fuel, that in turn led to pollution in the emerging economies. The demand for energy consumption majorly depends on the FMD as most of heavy vehicles and machineries need financing to be installed. These heavy types of goods used energy at massive levels in terms of fuel consumption which is increasing the pollution levels in countries. The FMD and CO₂ emissions relationship has been investigated in different ways in the global literature. For instance, Zhang (2011) utilized panel data of Chinese provinces and applied spatial panel econometrics approach to examine the impact of FMD on CO₂ missions. He found that spatial spillover effects of FMD play a vital role in Chinese provincial pollution. Extending this study on East Asia, Mahmood et al. (2019b) conducted the investigation of FMD and CO₂ emissions relationship by doing spatial analyses. They found the insignificant impact of FMD on the emissions but the negative environmental spillovers were observed from the neighboring countries' FMD. Moreover, trade, FDI and intensity of energy were found responsible for higher pollution emissions in East Asia. Some studies seek the non-spatial influences of FMD including conventional factors on pollution. For example, Jalil and Feridun (2011) scrutinized and corroborated negative effect of FMD on pollution in China. On the other hand, trade, income and energy usage contributed in the pollution of China. Shahbaz et al. (2013) investigated the FMD and pollution nexus in Malaysia. They originated positive influence of income and negative influence of FMD on emissions. In Saudi Arabia, Senan et al. (2018) established positive linkages in FMD, income and electricity. Hence, FMD could have environmental concern at well. Mahmood et al. (2018) extended the analysis by investigating the nonlinear relationship between FMD and emissions in Saudi Arabia. They found that falling FMD had accelerated the emissions in Saudi Arabia and rising FMD had insignificant effects. Tamazian et al. (2009) provided a clear empirical evidence of unfavorable environmental influences of FMD and resultant growth on the pollution in case of BRICS counties. The pollution comes from the direct channel from nurturing business activities with FMD on one hand. Further, the FMD has pleasant influence on economic growth and in turn nurturing income levels would increase demand for the products which might responsible for higher pollution. Mahmood

et al. (2020a) probed oil and non-oil sectors and environment nexus in Saudi Arabia and corroborated positive influences of oil, non-oil and urbanization on emissions. Mahmood et al. (2020b) investigated and corroborated the positive influence of income on emissions in Saudi Arabia. In case of GCC region, Qader (2009) investigated the electricity and pollution relationship in the GCC region. They found that most of pollution is stemmed from the oil and electricity generation in the GCC region. Al-Mulali and Ozturk (2014) inspected and found two-way connections in electricity and GDP relation in GCC region. Hence, it could have environmental consequences as well. Rafindadi et al. (2018) explored energy, FDI and pollution connections in GCC region. They found that energy usage was increasing but FDI helped to reduce emissions. In the same way, Salahuddin et al. (2018) investigated and corroborated the positive environmental role of FDI in Kuwait. In case of Saudi Arabia, Mahmood et al. (2019a) explored the role of agriculture in emissions' reduction by exploring nonlinear relationship. Agriculture sector showed negative effects and rising agriculture was found more fruitful for environment than the negative environmental effect of falling agriculture sector.

The brief literature suggests that existing literature is inconclusive concerning FMD and pollution emissions relationship. Moreover, literature has investigated the FMD and pollution emissions relationship in case of some GCC countries. However, a comprehensive study on this relationship is missing in whole GCC region. Hence, this study tries to bridge this gap doing panel and time series analyses for the GCC countries from 1980-2018.

3. Methods

This research is intended to explore the influence of FMD on CO₂ emissions in GCC countries. FMD may raise activities through financing and would contribute to CO₂ emissions. However, it can also reduce the CO₂ emissions if supported the clean energy consumption or production projects. The second important driver of the CO₂ emissions is the income level of country which represent the overall economic activities of a country. So, the following initial model is hypothesized:

$$CO_{it} = f(Y_{it}, FMD_{it}) \quad (1)$$

CO_{it} = Natural log of CO₂ emissions per capita

Y_{it} = Natural log of Gross Domestic Product (GDP) per capita

FMD_{it} = Natural log of domestic credit percentage of GDP

i = six GCC countries

t = 1980-2018

Data on FMD_{it} and Y_{it} are sourced of World Bank (2020) and CO_{it} is sourced from Global Carbon Atlas (2020). At first, unit root would be tested on the series following Dickey and Fuller (1981) in following way:

$$\Delta W_t = \alpha + \delta W_t + \sum_{i=0}^k \Delta W_{t-1} + \zeta_t \quad (2)$$

The Eq. (2) would be tested for unit root with H₀: unit root in the equation 2 of Augmented Dickey Fuller (ADF). This equation can be tested for each series of each country separately for time series analyses. After testing equation on one variable of each country, their p-values can be aggregated following Maddala and Wu (1999) in the following way to test the unit root in the panel series:

$$-2 \sum_{i=1}^N \log_e(p_i) \quad (3)$$

Testing of Eq. (2) and Eq. (3) for panel series is called Fisher-ADF test. After this step, we may proceed for cointegration analysis. For time series' analyses, we are succeeding Autoregressive Distributive Lag (ARDL) of Pesaran (2001) in following way:

$$\Delta CO_t = \delta_0 + \delta_1 CO_{t-1} + \delta_2 Y_{t-1} + \delta_3 FMD_{t-1} + \sum_{j=1}^p \phi_{1j} \Delta CO_{t-j} + \sum_{j=0}^q \phi_{2j} \Delta Y_{t-j} + \sum_{j=0}^r \phi_{3j} \Delta FMD_{t-j} + \omega_t \quad (4)$$

$$\Delta CO_t = \beta_0 + \sum_{j=1}^p \beta_{1j} \Delta CO_{t-j} + \sum_{j=0}^q \beta_{2j} \Delta Y_{t-j} + \sum_{j=0}^r \beta_{3j} \Delta FMD_{t-j} + \beta_4 ECT_{t-1} + \psi_t \quad (5)$$

Eq. (4) is tested for bound test on $H_0: \delta_1 = \delta_2 = \delta_3 = 0$. Then, long and short run results could be generated by normalizing procedure from Eq. (4) and by estimated coefficients of differenced variables from Eq. (5), respectively. ECT in equation 5 is error correction term, which is lag of error form Eq. (4). Eq. (4) and Eq. (5) would be performed for time series' analyses. Moreover, ARDL can be applied on the panel series' model as per methods of Pesaran et al. (1999) as follows:

$$\Delta CO_{it} = \alpha_0 + \alpha_1 CO_{it-1} + \alpha_2 Y_{it-1} + \alpha_3 FMD_{it-1} \quad (6)$$

$$+ \sum_{j=1}^p \alpha_{4j} \Delta CO_{it-j} + \sum_{j=0}^q \alpha_{5j} \Delta Y_{it-j} + \sum_{j=0}^r \alpha_{6j} \Delta FMD_{it-j} + e_{it} \quad (7)$$

$$\Delta CO_{it} = \gamma_0 + \sum_{j=1}^p \gamma_{1j} \Delta CO_{it-j} + \sum_{j=0}^q \gamma_{2j} \Delta Y_{it-j} + \sum_{j=0}^r \gamma_{3j} \Delta FMD_{it-j} + \gamma_4 ECT_{it-1} + v_{it}$$

At first, negative coefficient of gamma would corroborate the long run relationship in the panel model. Then, long and short run results could be generated by normalizing procedure from Eq. (6) and by estimated coefficients of differenced variables from Eq. (7), respectively.

4. Data Analyses

We test the panel results for GCC countries. Table 1 shows results of Fisher-ADF and all panel series are non-stationary at level but stationary at first difference. Hence, integration order is one and suitable to proceed the PMG analysis.

Table 1
Fisher-ADF Test

Variable	Level		1 st difference	
	C	C&T	C	C&T
CO _{it}	18.0004 (0.1157)	19.4128 (0.1221)	162.0300 (0.0000)	142.5270 (0.0000)
Y _{it}	3.7228 (0.9869)	14.6303 (0.2623)	97.4648 (0.0000)	76.1406 (0.0000)
FMD _{it}	10.5021 (0.5720)	30.9418 (0.0020)	98.5655 (0.0000)	75.4783 (0.0000)

Table 2 displays PMG results. In long run, income positively affected CO₂ emissions. 1% increase in the income expands the 0.1424% of CO₂ emissions. Hence, increasing income is facilitated energy-oriented consumption which harms environment. FMD has insignificant effect in panel of GCC countries. So, FMD could not damage or improve environment because of increasing financing in GCC region. It also shows the heterogeneous nature of financial market in different countries in which it may have effect in some countries and may not in others. So, it needs the time series analysis for each single country separately. In short run, ECT coefficient shows a short run relationship in the model and all effects are found insignificant. Though, lag of FMD has negative effect and FMD is improving the environment of subsequent year.

Table 2
PMG Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Long Run				
Y _{it}	0.1424	0.0815	1.7481	0.0821
FMD _{it}	0.1016	0.0965	1.05267	0.2939
C	0.2876	0.0847	3.3960	0.0008
Short Run				
ΔCO _{it-1}	-0.0569	0.0759	-0.7489	0.4549
ΔY _t	0.2181	0.1354	1.6106	0.1089
ΔY _{it-1}	-0.0889	0.0958	-0.9283	0.3544
ΔFMD _{it}	0.1419	0.1386	1.02437	0.3070
ΔFMD _{it-1}	-0.1725	0.0636	-2.7124	0.0073
ECT	-0.2193	0.0742	-2.9554	0.0035

The panel estimates give the insignificant effect of FMD which may be due to aggregation biasness. So, we conduct time series analysis for each single country using ARDL technique. For this, we test the unit root of each series for all countries. All series are non-stationary at level except FMD_t in Saudi Arabia and Kuwait. However, the all series are first difference stationary.

Hence, integration order is mix for Saudi Arabia and Kuwait, and one for rest of countries. In the both cases, we may move to ARDL which is efficient in both cases.

Table 3
ADF Test

Country	Variable	Level		1 st difference	
		C	C&T	C	C&T
Saudi Arabia	CO _t	-2.0285 (0.2739)	-3.1647 (0.1068)	-6.9624 (0.0000)	-6.9886 (0.0000)
	Y _t	-0.3767 (0.9031)	-2.9247 (0.1665)	-3.8453 (0.0056)	-4.4405 (0.0058)
	FMD _t	0.1443 (0.9639)	-5.3533 (0.0005)	-5.3130 (0.0001)	-5.2790 (0.0007)
UAE	CO _t	-2.0260 (0.2749)	-2.9800 (0.1180)	-7.5268 (0.0000)	-7.4182 (0.0000)
	Y _t	-1.4587 (0.5433)	-2.680 (0.2469)	-5.3348 (0.0000)	-5.6856 (0.0002)
	FMD _t	-1.2631 (0.6362)	-3.1721 (0.1056)	-4.4636 (0.0010)	-4.4178 (0.0062)
Bahrain	CO _t	-2.1077 (0.1344)	-3.2737 (0.1002)	-7.6219 (0.0000)	-7.6251 (0.0000)
	Y _t	-0.1959 (0.9304)	-2.0897 (0.5348)	-5.6650 (0.0000)	-5.6711 (0.0002)
	FMD _t	-0.6964 (0.8356)	-2.0696 (0.5456)	-5.4104 (0.0001)	5.3645 (0.0005)
Kuwait	CO _t	-2.3105 (0.1740)	-2.7492 (0.2240)	-6.5905 (0.0000)	-6.5173 (0.0000)
	Y _t	-1.2702 (0.6330)	-2.7886 (0.2102)	-4.0646 (0.0032)	-4.0080 (0.0173)
	FMD _t	-2.7341 (0.0780)	-2.9513 (0.1591)	-3.7061 (0.0080)	-3.6775 (0.0367)
Oman	CO _t	-1.3505 (0.5953)	-0.5053 (0.9787)	-6.8770 (0.0000)	-7.0248 (0.0000)
	Y _t	-1.2702 (0.6330)	-2.7885 (0.2102)	-4.0646 (0.0032)	-4.0080 (0.0173)
	FMD _t	-0.8785 (0.7842)	-3.0610 (0.1304)	-4.9053 (0.0003)	-4.8262 (0.0021)
Qatar	CO _t	-1.6255 (0.4601)	-1.6427 (0.7567)	-5.1656 (0.0001)	-5.0851 (0.0011)
	Y _t	-0.7537 (0.8206)	-1.7999 (0.6850)	-6.3516 (0.0000)	-6.2600 (0.0000)
	FMD _t	-2.3330 (0.1673)	-2.5316 (0.3121)	-5.7511 (0.0000)	-5.6907 (0.0002)

Table 4 shows bound test and diagnostics of each country's model. Critical F-values are 4.0934-4.9199, 3.0836-3.8155 and 2.6175-3.2969 at 1%, 5% and 10%, respectively and are sourced from Kripfganz and Schneider (2019). Diagnostic tests clarify the ethnicity of models as p-value is greater than 0.1 in all tests. The bound test corroborates the cointegration in Bahrain at 5% and in UAE and Kuwait at 1%. For other countries, bound test could not verify cointegration but parameters of ECT in Table 5 verified cointegration in Saudi Arabia and Oman. Table 5 shows the ARDL results. Income positively affected CO₂ emissions in Saudi Arabia, Kuwait and Oman. So, increasing income is facilitated energy-oriented consumption, particularly fossil fuel, which harms environment. These countries' electricity production is mostly depended on the fossil fuel so have great environmental consequences. The positive effect of three countries shows that increasing income explodes the economic activities and spoils environment consequently. This effect is insignificant in rest of GCC countries so their income growth could not damage environment. The effect of FMD is positive in Oman and is negative in UAE. It means that financial market of Oman is financing the energy and pollution intensive projects and financial market of UAE is financing the clean projects. The heavy reliance of Oman on the financial market leaves the environmental consequences. Hence, Oman needs to think about the sustainable and green future of country to keep the level of financial growth up to sustainable level or tracing policies to support green project financing. The UAE financial market is found supportive for environment. It may be due a reason that

UAE's economy mostly depends on the trading activities instead of manufacturing activities. So, the FMD leaves the pleasant environmental consequences.

Table 4

Bound Test

Country	F-value	Heteroscedasticity	Serial	Normality	Functional Form
Saudi Arabia	3.6667	2.1992 (0.1061)	2.0204 (0.1492)	0.0515 (0.9746)	0.0378 (0.9701)
UAE	9.1557	1.2874 (0.2944)	0.5477 (0.5936)	1.4663 (0.4813)	0.0103 (0.9199)
Bahrain	4.2050	0.1259 (0.9721)	0.6139 (0.5477)	0.0487 (0.9759)	1.8471 (0.1836)
Kuwait	9.2370	1.3298 (0.2877)	0.3102 (0.7357)	3.2093 (0.2010)	1.5772 (0.1249)
Oman	1.0473	0.7309 (0.5407)	2.4140 (0.1056)	1.9050 (0.3858)	1.2998 (0.2625)
Qatar	2.2356	1.6934 (0.1656)	0.1338 (0.8753)	0.1594 (0.9234)	0.4541 (0.6530)

Table 5

ARDL Results

Country	Saudi Arabia	UAE	Bahrain	Kuwait	Oman	Qatar
Long Run						
Y_t	0.2253 (0.0140)	-0.1050 (0.2410)	-0.1912 (0.1218)	0.2476 (0.0112)	0.3777 (0.0147)	-1.4714 (0.5881)
FMD_t	0.0887 (0.3084)	-0.3254 (0.0000)	0.1494 (0.4438)	-0.2017 (0.1277)	0.4531 (0.0347)	3.3529 (0.5867)
Intercept	0.3343 (0.6316)	5.5631 (0.0000)	4.4080 (0.0000)	1.4839 (0.0858)	-3.0084 (0.0145)	4.5661 (0.5323)
Short Run						
ΔY_t	0.1130 (0.0592)	-0.0881 (0.2717)	-0.1070 (0.1473)	0.7087 (0.0000)	0.0881 (0.1554)	0.0862 (0.6486)
ΔFMD_t	0.4445 (0.2942)	-0.2730 (0.0000)	0.0836 (0.7557)	0.2894 (0.0470)	0.1057 (0.1205)	0.1959 (0.0498)
ECT	-0.5014 (0.0016)	-0.8388 (0.0000)	-0.5596 (0.0011)	-0.5749 (0.0000)	-0.2333 (0.0489)	-0.0584 (0.5258)

The short run relationships are corroborated in all GCC countries except Qatar as per negative coefficient of ECT. Income positively affects emissions in Saudi Arabia and Kuwait and has insignificant effects for rest economies. This again realizes a fact that increasing income is facilitated energy-oriented consumption even in short run which is harming environment. These countries' electricity production is mostly depending on the fossil fuel so short run negative environmental consequences are observed. This effect is insignificant in rest of GCC countries so their income growth could not damage environment in short run. Influence of FMD is positive on CO₂ emissions in Kuwait and is negative in UAE. It means that FMD of Kuwait is financing the energy and pollution intensive projects and FMD of UAE is financing the clean projects.

5. Conclusions

The financial market is necessary for economies but its environmental consequences cannot be ignored. The effects of FMD and income are tested in the GCC country panel using a period 1980-2018. In long run estimates of GCC panel, income positively affected emissions and FMD has insignificant effect. In the time series analyses, income has positive effects in Saudi Arabia, Kuwait and Oman and has insignificant effect in other GCC countries. The positive effects of three countries show that increasing income explodes the economic activities and spoils environment consequently in these countries. FMD is positively affected emissions in Oman and negatively in UAE. It means that financial market of Oman is financing the energy and pollution intensive projects and financial market of UAE is financing the clean projects. In the short run, effect of income is positive in Saudi Arabia and Kuwait and is insignificant for other countries. FMD is positively affected emissions in Kuwait and is negatively affected in UAE. It means that financial market of Kuwait is financing the energy and pollution intensive projects and financial market of UAE is financing the clean projects. Based on results, we recommend UAE to expand the financial

market to support the clean environment. Moreover, the financial market of Oman and Kuwait need qualitative and quantitative checks to protect the environment in these countries.

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