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科研论文	Nonlinear impact of municipal solid waste recycling and energy efficiency on environmental performance and economic growth: evidence from non-parametric causality-in-quantiles. <i>Environ Sci Pollut Res</i> 29 , 16066–16081 (2022).	代表性成果
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Nonlinear impact of municipal solid waste recycling and energy efficiency on environmental performance and economic growth: evidence from non-parametric causality-in-quantiles

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Abstract

Waste recycling significantly contributes to reducing carbon emissions and other greenhouse gases, leading to enhanced environmental performance and safeguards natural resources. Therefore, this study examines municipal solid waste recycling and energy efficiency's impact on the environmental performance and economic well-being of the USA. Some studies have emphasized the usefulness of MSW and its indicators, but most of them are survey-based and illustrate the scientific process of disposing of waste. Hence, the study intends to analyze the connection among considered variables using the recently developed and advanced estimation procedure of nonparametric causality in quantile approach by analyzing the quarterly dataset for 1990(Q1) till 2018(Q4). Through this technique, we have examined the causal relationships in different quantiles. The causality-in-quantile outcome indicates the acceptance of the null hypothesis in different quantiles, especially at low and high tail quantiles, while at some quantiles, the null hypothesis rejection is highlighted. This study suggests valuable implications for future studies, government, environmentalists, and policymakers.

Keywords Municipal solid waste recycling · Energy efficiency · Environmental performance · Carbon emission · Causality-in-quantile

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Introduction

The world needs to focus on various environmental issues such as increasing population, industrial growth, urbanization, and global warming. Policymakers need to plan and formulate policies for sustainable development. According to Gleim et al. (2013) and Smith (2010), these issues are the leading cause of the increasing production of abnormal wastage; therefore, businesses and industries need to implement green practices to manage such issues. Uddin et al. (2017) stated that due to the harmful effects of waste production, natural deposits and preservation of the environment are at risk. The harmful effects of wastage on human beings, dynamics of social-economic, and frequent climatic change have further turned the situation worse and challenging for the treatment process.

Similarly, waste management has become a worldwide concern; hence, minimizing and controlling the current situation circular economy is considered the best possible way. Circular economy (CE) is based on the following practices: refuse, rethink, reduce, reuse, repair, refurbish, remanufacturing, repurpose, recycling, and recover (Potting et al. 2017). In simple

words, the circular economy principles primarily focus reduce, reuse and recycling practices to attain economic development and societal effect (Lieder and Rashid 2016).

According to World Bank report (2019)¹, “What a Waste 2.0,” worldwide 2.01 billion tons of municipal solid waste (MSW) is generated, which is predicted to increase by 3.4 billion tons till 2050 as for low-middle income economies, the production would increase by 40% while for high-income economies by 19%. Considerably, Ahsan et al. (2015) stated that the entire municipal solid waste of about 67% is disposed of through unsustainable procedures like landfilling, open dumping, and combustion, which leads to 1.6 billion tons of CO₂. Therefore, the MSWM cost is estimated to increase by 376 billion USD in 2025 from 205 billion. The inadequate management of world MSW is credited to the government’s segregation infrastructure absence and inappropriate environmental policies (Hoornweg and Bhada-Tata 2012; D-Waste 2014; Kaza et al. 2018). Although, the recently invented waste infrastructural plans globally since 2014 till 2019 delivered up to 243 million (MT) in which 45% was transported in industrialized countries, in China 37.5%, and in the remaining economies 17.5% mainly by thermal treatment of 57% and 8% of landfilling (Maalouf et al. 2020). According to the concentration ratio of municipal solid waste, framework services are found in the developed countries. The USA and China both represent 50% of the total delivery. However, it excludes the constant increase in unrestricted disposal due to the gap between infrastructure delivery and changes in MSWM.

Based on the report, global waste data revealed that the USA alone produced the highest municipal solid waste, estimated to 12% of world municipal disposal with 4% of the world’s inhabitants. Simultaneously, India and China contribute to 27% of worldwide waste, with 36% populace (World Bank 2019). Noticeably, for such issues, the waste treatment infrastructure under the “Resource Conservation and Recovery Act” (1976), legitimized in the USA, intends to control waste production and sustainable scrapping for economic development and sustainability by reducing the ecological footprint (Razzaq et al. 2021). Likewise, the United Nations under “responsible consumption and production” aims to attain “the environmentally sound management of chemicals and all wastes throughout their life cycle” (UN 2020). In this background, dangerous waste dumping and emission are hurdles to achieving economic growth objectives and effectively utilizing natural resources. Therefore, supporting industries, SMEs, and societies to minimize and recycle waste is vital in sustainable consumption by 2030.

Moreover, Lino and Ismail (2013), Rajaeifar et al. (2017) highlighted that through the organic process like recycling

(recovering and reprocessing), maximum benefit from resources can be achieved by economies with the lowest feasible additional cost to the environment. Also, to maintain sustainability between resources and the atmosphere, recycling waste is significant. Recycling safeguards mineral deposits, protects natural deposits, and supports durable environmental protection globally (Steward et al. 2019; Govindan et al. 2015). Toxic waste and environmental pollution can be eliminated through recycling for the betterment of living creatures. Geng et al. (2016) and Kumar et al. (2017) claimed that municipal solid waste recycling could lead to sustainability in the long term, which can be used as a significant plan. It would enhance the productivity benefits the environment. For instance, it is useful in shifting from traditional dumping practices to appropriate waste management methods to preserve useful resources within the economy.

Furthermore, it is considered that waste is energy that can be converted but cannot be used or consumed in the process of performing something useful (Badgett and Milbrandt 2020). Likewise, noxious waste is a negative force because it needs more energy to eliminate the harmful effect of air and water contamination. Müller (2019) and Hinchliffe et al. (2013) stated that waste is inescapable, but recycling can reduce waste as it effectively minimizes energy wasted. Similarly, Fernández-González et al. (2017) determined that recycling assists in shielding and guarding the environment and enduring humanity by decreasing environmental carbon emissions estimated by LCA (lifecycle assessment). Indeed, Bing et al. (2015), Sanjeevi and Shahabudeen (2015) argued that presently, the danger of global warming is due to the increase in carbon emission from immense consumption of energy and fossil fuel which needs to be handled resourcefully through recycling. Recycling paper and forest products can save forests by restoring organic soil matter and recycling biological waste. Recycling both elements decreases, whereas carbon elimination in mud and forestry increases, which will act as a facilitator to balance energy loss.

While on the other hand, recycling is ecologically beneficial, but recycled products merchandised are vital for economic contribution. Industries incorporating recycling methods can reduce economic costs like financial costs and operational wastefulness (Gardiner and Hajek 2020; Badi and Murtagh 2019). According to Tsai et al. (2020), circular economic practices, including recycling activities used in the industrial and logistic sector, intend to decrease waste generation by the green supply chain. Zelbst et al. (2010) and Zhang and Yang (2016) highlighted that industries could opt for recycling and remanufacturing methods to achieve financial benefits. Kumar and Samadder (2017) examined the present worldwide situation of waste to energy technological opportunities like burning, dumping grounds, and other similar practices for efficient energy reclamation and the difficulties that industrialized and emerging economies face. Outcomes revealed that

¹ https://datatopics.worldbank.org/what-awaste/trends_in_solid_waste_management.html

unsanitary landfilling is an extensively practiced method for disposing of waste, particularly in emerging economies. Although, the industrialized economies have recognized the waste-to-energy as prospective for efficient recycling of MSW. Thus, to attain sustainability and enhance environmental performance, waste-to-energy can be used as a substitute source of energy that will also fulfill the energy needed and safeguard the efficient disposal of MSW.

Above all, recycling contributes significantly to economic activities as material recycling in the USA was reported to have produced 0.757 million jobs which amounted to 36.6 billion wages and collected tax of 6.7 billion (REI, 2016). It reflects that recycling material created 1.6 vacancies on every 1000 tons of material processing. According to Redling (2021)², waste management earnings for the ending quarter 31 December 2020 amounted to 4.067 billion USD with an increase of 5.75% year over year, represents the immense growth of this industry. ST (2020) explained that the waste management industry primarily emphasizes collection, transportation, transfer stations, disposal, landfill ownership, and SW and recycling material management. Due to the favorable results and contribution to the economic development of municipal solid waste recycling, it is considered vital for sustainable development (CDEEP 2012). Although some of the studies like Kreiger et al. (2014); Chen et al. (2016); and Lonca et al. (2020) emphasized recycling the waste in the supply chain process, food waste, and recycling material in metropolitan growth. This research set considers that it is vital to attain sustainable development as it is evident from the ecological and economic perspective growth of the US recycling industry. However, still, this industry is lagging in achieving milestones set.

Apart from various benefits and sequester events of law and awareness among people and fines, the domestic waste in the USA increases and extends to 267.8 million tons, out of which 94 million tons is recycled (EPA 2020a)³. However, the recyclable US waste is 75%. In contrast, the recycling relative share is only 35% of the entire MSW, far behind traditional waste management methods like landfilling, which is 53% of the entire waste. Friedrich and Trois (2011) and Bilal and Iqbal (2019) highlighted that due to dumping grounds, the economy suffers the loss of waste value and produces a huge amount of carbon dioxide and methane. Despite this fact, the conditions began to deteriorate when China imposed a ban on importing plastic waste in 2018 from the USA, leading to accumulating waste within the USA and shortfall in China due to high domestic consumption. The scarcity could be balanced by cumulating the China, EU, and US capacity of

recycling domestic waste. Presently, the USA has switched its waste dumping spot to South Asian countries while at the same time taking preventive measures like restriction on plastic in San Francisco and Seattle (Katz, 2019⁴; Cole, 2017⁵). Skinner et al. (2010) stated that as an immense amount of waste exporters, EU countries are also reducing single-use plastics and non-recycled plastic.

McDowall et al. (2017) and Geall (2015) emphasized that European Union countries and China strive to attain a circular economy to decrease the entire effect on resource utilization for efficient production procedures. However, in the course of action, European Union intends to restrict landfilling of MSW maximum to 10% and multiply the recycling of municipal waste from 50 to 65% of entire municipal solid waste by 2030. As reported by World Bank (2019), the same strategy is also under consideration in Japan as the main aim is to switch to managing solid waste disposal and minimize the percentage of burning waste where already 80% country's waste is burnt or destroyed in eleven hundred or more incinerator centers. Hence, having similar goals, the practices opt-in between Euro and China differ. As per China's aspect, the circular economy is vast with the prime objective to handle environmental pollution, which is produced from prompt industrial growth and expansion. Distinct from China, European Union emphasizes resources, waste, and prospective business chances. Huo (2019)⁶, Mathews and Tan (2016) revealed that China cannot attain circular economy benefits due to the absence of regularity checks, insufficient awareness of environmental well-being, and cultural values.

Although, if recycling capacity extends to the highest level, the effect of diminishing carbon dioxide would be near to fifty million cars on the US roads. However, with recycling, composting, combustion, the energy recovery, and landfilling of municipal solid waste have saved 184 million metric tons of CO₂. According to EPA (2020b)⁷, this is equal to the emission, which is decreased by reducing 39 million cars from the road yearly. As per the calculations landfilling, wastewater treatment, and composting released GHGs emissions equal to 110.56 million metric tons, 19.22 million metric tons, and 4.66 million metric tons, which are in combine 82.2%, 14.3%, and 3.5% of the entire waste of carbon emission whereas entire MSW produces 4% of the total US secretion of organic carbon footprint.

However, various studies have addressed the issues regarding waste production, disposal, and the harmful effect

² <https://www.wastetodaymagazine.com/article/waste-management-earnings-2020/>

³ <https://www.epa.gov/facts-and-figures-about-materials-waste-and-recycling/national-overview-facts-and-figures-materials>

⁴ <https://e360.yale.edu/features/piling-up-how-chinas-ban-on-importing-waste-has-stalled-global-recycling>

⁵ <https://www.weforum.org/agenda/2017/10/china-has-banned-foreign-waste-so-whats-the-future-of-world-recycling/>

⁶ http://english.gov.cn/policies/policy_watch/2019/01/28/content_281476498146346.htm

⁷ <https://cfpub.epa.gov/ghgdata/inventoryexplorer/#waste/allgas/source/current>

generated due to unsanitary practices. However, there is a lack of empirical analysis to determine the connection between recycling waste and carbon emissions, particularly at the state level, which is limited. Secondly, the domestic waste “municipal solid waste” repercussion on sustainability for the USA needs to be examined because of high waste production. The studies were based on recycling focus on businesses, industries, society, or survey-level research that illustrated the scientific process, materials, and comparative efficiency. Some studies emphasized the causal relationship between economic enhancement and waste production without focusing on their ecological effects and cause in both the long and short term (Li et al. 2018; Lee et al. 2016; Hajar et al. 2020; Jaligot and Chenal 2018; Fu et al. 2010; Ma et al. 2011; Yang et al. 2013; Dogan and Turkekul 2016; Umar et al. 2021). Considering this gap, researchers, policymakers, and government cannot evaluate the effect of recycling on carbon emission and economic development.

This study contributes to the present literature in the following manner. At first, this paper studies the connection between two independent variables named municipal solid waste recycling and energy efficiency. The dependent variables are environmental performance and economic growth. Secondly, the nonparametric causality-in-quantile of Balcilar et al. (2017) is used to study the causal connection between the selected variables. It is a new technique over methods as (i) the nonparametric technique finds the underlying dependence structure among the considered time series and is additionally determined robust to ambiguous inaccuracies, and (ii) this method not only provide causality in mean, which is the first-order moment but also computes the causality presence in the joint distribution tails of the variables. The effect of each quantile variable can be assessed individually, which would assist policymakers, government, and environmentalists in formulating appropriate strategies or plans.

The paper is organized as follows: Section II includes a theoretical background and literature review. Section III illustrates the detailed note on the technique applied and data acquired from the sources; section IV comprises the tables, graphs interpretation, and discussion. While in section V, the study results are summarized, and further policy implications with limitations are provided.

Literature review

Theoretical background

The theory of ecological modernization (EMT) hypothesizes that environmental issues derived from commercial events are nullified by enhancing the efficacy of resources via procedural advancement. Like circular economy (CE) environmental activities, they are simultaneously enhancing economies

(organization's) environmental and productive growth (Papargyropoulou et al. 2015; Diaz and Otoma 2013; Stahel 2016). Waste treatment and resource protection are highlighted in project management as they are intensely connected with the sustainability of the environment and enterprise's productivity (Yang et al. 2019; Canzaniello et al. 2017; Tse et al. 2016). Covering the fundamentals of EMT, we explore the productive and ecological effect of MSWM in the USA in this paper.

The process of city waste was initiated by human actions credited to economic development, increasing populace, and expansion (Bibi et al. 2021; Umar et al. 2020a, 2020b). To effectively administer communal waste flow, the model of waste management of the USA is governed by “Resource Conservation and Recovery Act 1976, i.e., RCRA.” Furthermore, following the environmental action program 1990, waste management refers to assortment, carrying, retrieval, and discard of remaining, supplemented by the administration of some activities and post-look-after disposal plants. Hence, the waste management theory is based on the anticipation that waste treatment is to avert waste being harmful to the health of people and the environment well-being to offer various favorable productive results (Xing et al. 2020).

Operations of waste treatment are mainly connected to environmental protection. However, ecological protocols are vital to standardize municipal solid waste disposal methods and the whole environment (Ali et al. 2021; Cervantes et al. 2018). Marino et al. (2018) stated that economic policies regarding duties and taxes are necessary for the waste sector because of the greater exposure of market failures and insufficient support. Whereas, Eurostat (2017)⁸ publicized that waste treatment and clearance operations are major sources that created a circular economy in the European Union. Also, it points that an effective MSWM technique/plant enhances human well-being and reduces duties imposed on waste management activities. Arbitration of price setting and policies of yardstick assist in prospective savings of 2 billion pounds out of 10.05 billion pounds of entire duties reserves in 2015.

The practical waste disposal methods focus on reducing sources and reusing/reprocessing as the suitable way to control scrap. That reserves resources for future generations, energy-saving, sourcing organic matter to organizations, providing employment, investing in environmental-friendly innovations, narrowing the requirement for new disposal areas and ignitions; overall, such elements assist in redeeming CO₂ emission and produce considerable economic benefit (Ji et al. 2021; Zhang et al. 2021). Another technique is ignition which denotes the incinerate MSW with the help of the control technology to produce energy; thus, this method causes various ecological threats if non-polluting ignition techniques are not employed. At last, dumping waste is a traditional and

⁸ Eurostat, 2017. Municipal waste. Stat. Explain. your Guid. to Eur. Stat.

moderately non-polluting process as remainings are discarded into open spaces or disposed of on allocated dumpsites to produce marsh gas, i.e., methane (Ekvall et al. 2007; EPA, 2020a). The methods discussed above are MSWM techniques. However, we emphasize municipal solid waste recycling/reusing, which acquires around 35% of the overall MSWM, which aid in ecological protection, reducing health threats, and enhancing economic performance directing to ecological enhancement.

Studies grounded on the management of waste and reusing/composting examined diverse scopes. The first group of studies stressed the systematic process of municipal solid waste composting and their ecological efficacy over several businesses and commodities (None 2017), like a malleable waste (Hundertmark et al. 2018), building, and destruction (Yu et al. 2020a, 2020b), metallic retrieval (Morf et al. 2013), leftovers (Amicarelli et al. 2020), sewerage (Ghosh et al. 2019), and others. In contrast, the other ones emphasized lessening emission and scrap in the supply chain dynamic via the organization's green supply chain activities/processes (Nandi et al. 2020; Wang et al. 2021). The harmful impact of industrial activities on the atmosphere is eliminated through practicing circular economy methods, including reusing, recycle, and eco-friendly layout of commodities. The circular economy follows the fundamentals of resource preservations in which a circular outlook of products empowers producers to reduce resource reliance via reusing and reprocessing practices (Rajput and Singh 2019). Further, the CE plan escorts to reduce the remaining/surplus from the manufacturing that decreases reliance on resources and energy use and reduces financial expense (de Sousa Jabbour et al. 2018; Morais and Silvestre 2018).

Empirical analysis

The study of Razzaq et al. (2021) examined the MSW disposal impact on environmental sustainability and economic development by applying the bootstrapping autoregressive distributed lag technique on the sample from 1990 to 2017. The results indicated that solid recycling waste reduces carbon dioxide in the long and short term and enhances energy efficiency, significantly contributing to economic growth. Magazzino et al. (2020) highlighted that waste reclamation consisting of recycling and composting are prime elements in reducing GHG discharge. Based on the Tree-model, there are chances that modification in waste recycling can mitigate GHG emissions by 87% while analyzing the connection between municipal waste productions, emission of GHG, and economic development for Switzerland over the period from 1990 to 2017 through time-series technique and Machine Learning method. Furthermore, a study evaluated different waste-to-energy technologies introduced recently, highlighting that MSW is likely to escalate by 2.2 billion tons per year

by 2025 globally. In emerging economies, waste reclamation is the biggest issue, whereas industrialized economies are adapted to generate different secondary products like heat, electricity, composite, and biofuels from new technologies (Moya et al. 2017). Tan et al. (2014) indicated that inefficient waste disposal like ground dumping and landfilling damages natural deposits and releases CH₄ (methane gas), which is more dangerous than GHG and CO₂. Burning waste also discharges poisonous chemicals like dioxin. Hence, MSW viewpoint such methods make the situation more detrimental to safeguard the environment and sustainability. In such situations, waste-to-energy is considered an efficient plan to deal with these challenges as recycling waste decreases landfilling waste and increases renewable energy generation.

Recycling enhances production effectiveness which is beneficial for economic well-being. As Potting et al. (2017) highlighted, recycling is advantageous for the economy as it increases total input. In China and Pakistan industries, recycling practices with other green supply chain methods positively affect profitability and environmental performance (Khan and Qianli 2017). Similarly, when businesses operate on green practices, the effectiveness, share of the market, sales, and profitability are increased (Çankaya and Sezen 2019). According to Rehman Khan and Yu (2021), a positive connection is examined among eco-friendly practices like recycling with organization financial and environmental sustainability in Pakistan. Recycling and environmentally friendly practices enhance an organization's reputation, and the acceptance of social responsibility improves the performance of business (Yu et al. 2020b).

In the context of waste management, the study of Cherubini et al. (2009) examined energy efficiency and waste management practices like a landfill with biogas, combustion for electricity production, and others on the environment for Roma through the LCA approach. The results indicated that recycling energy is vital for environmental sustainability, and through recycling material, energy efficiency in treatment projects can comply with up to 15% of electricity demand. These factors can contribute significantly to economic development by reducing the ecological footprint. Furthermore, the GHG discharge resulting from recycling waste is a major issue in the waste management industry. However, compared to other practices, MSW recycling decreases such gases, excluding paint and plasterboard (Turner et al. 2015). However, no single procedure can be determined as the only solution due to the different sorts of solid waste found within regions. Above all practices of managing waste, municipal solid waste management is the most appropriate option (Khandelwal et al. 2019).

Another study based on a survey revealed that waste production depends on the European Union's economic condition (Minelgaitė and Liobikienė 2019). The recycling attitude of the local population has a considerable impact on waste production, whereas reprocessing and reducing attitudes have an inconsiderable impact. Likewise, the study on a comparative level emphasized municipal solid waste management in NYC and Seoul highlighted that environmental laws for recycling are necessary, particularly for industrialized economies (Lee-Geiller and Kütting 2021). The study of Castillo-Giménez et al. (2019) evaluated the municipal waste practices in terms of convergence and performance in European countries through cumulative performance indicators recycling, landfill, incineration, and composting. The results revealed that the Northern and Central EU performed better, whereas the Eastern EU region is the worst performer in MSWM.

However, various studies have examined diverse waste disposal techniques like composting, ignition, waste dumping, and numerous reusable products and associate its connection with financial and ecological features via applying business, sector, or survey form assessment. Thus, the literature is limited to specific organization/sectors, systemic practices, outputs, and metropolitans. Furthermore, there is a lack of empirical studies in the context of the state-level combined effect of reusing/recycle on ecological value and economic development utilizing state-level measure consistent determinants. Therefore, this paper determines to measure the economic and ecological impact of MSWM in the USA in the short and long term.

Methodology

In this study, we have applied a new method of Balcilar et al. (2017) to analyze the nonlinear causality. The approach named as causality in quantile binds the Nishiyama et al. (2011) k th order nonparametric causality and Jeong et al. (2012) nonparametric quantile causality models and contrasting the standard causality test, it is beneficial in following ways: (i) the technique is vigorous towards misspecification errors because it identifies the underlying dependence structure among the selected series. Then, through this technique, besides only estimating 1st moment causality in mean, we can also assess the presence of causality in the tails of the joint distribution of the variables. At last, the causality-in-variance can be examined, in this way the impact on volatility there are chances to have high order interdependencies still when causality in the conditional-mean does not exist.

Where y_t symbolizes RCY and EEF while X_t represent CEM and GDP. The quantile-based causality

referring Jeong et al. (2012) is expressed as⁹: in the θ th quantile X_t does not Granger causes y_t concerning the lag vector of $\{y_{t-1}, \dots, y_{t-p}, X_{t-1}, \dots, X_{t-p}\}$ if:

$$Q\theta = y_t(y_{t-1}, \dots, y_{t-p}, X_{t-1}, \dots, X_{t-p}) = Q\theta(y_t, y_{t-1}, \dots, y_{t-p}),$$

Apparently, X_t is the cause of y_t in the θ -quantile with respect to $\{y_{t-1}, \dots, y_{t-p}, X_{t-1}, \dots, X_{t-p}\}$ if:

$$Q\theta = y_t(y_{t-1}, \dots, y_{t-p}, X_{t-1}, \dots, X_{t-p}) \neq Q\theta(y_t, y_{t-1}, \dots, y_{t-p}),$$

In equation 2 $Q\theta = (y_t, \dots)$ represents the θ -quantile of depending on y_t depending on t and $0 < \theta < 1$.

Hence, the conditional distribution functions of y_t as Z_{t-1} and y_{t-1} are expressed as $y_{t-1} \equiv (y_{t-1}, \dots, y_{t-p})$, $X_{t-1} \equiv (X_{t-1}, \dots, X_{t-p})$, $Z_t = (X_t, y_t)$ and $F_{y_t|Z_{t-1}}(y_t | Z_{t-1})$, and $F_{y_t|y_{t-1}}(y_t | y_{t-1})$. $F_{y_t|Z_{t-1}}(y_t | Z_{t-1})$ the conditional distribution is considered to completely continuous in y_t for practically all Z_{t-1} . We stated $Q\theta(Z_{t-1}) \equiv Q\theta(y_t | Z_{t-1})$, and $Q\theta(y_{t-1}) \equiv Q\theta(y_t | y_{t-1})$, the $F_{y_t|Z_{t-1}}\{Q\theta(Z_{t-1}) | Z_{t-1}\} = \theta$ was formed which holds the probability 1. So, the tested hypotheses according to definitions H_0 and H_1 are as follows:

$$H_0: P\{F_{y_t|Z_{t-1}}\{Q\theta(y_{t-1}) | Z_{t-1}\} = \theta\} = 1, \\ H_1: P\{F_{y_t|Z_{t-1}}\{Q\theta(y_{t-1}) | Z_{t-1}\} = \theta\} < 1,$$

The distance measure of Jeong et al. (2012) stated as $J = \{ \varepsilon_t E(\varepsilon_t | Z_{t-1}) F_Z(Z_{t-1}) \}$ in which the error term is represented as ε_t and marginal density as $F_Z(Z_{t-1})$ of Z_{t-1} . ε_t as regression error term is derived according to the H_0 in Eq. (3) that can be hold true if and only if $E[1\{y_t \leq Q\theta(y_{t-1}) | Z_{t-1}\}] = \theta$ or equivalent to $1\{y_t \leq Q(y_{t-1})\} = \theta + \varepsilon_t$ in which the indicator function is $1\{\cdot\}$. Following Jeong et al. (2012), the distance measure is stated as:

$$J = E[\{F_{y_t|Z_{t-1}}\{Q\theta(y_{t-1}) | Z_{t-1}\} - \theta\}^2 F_Z(Z_{t-1})],$$

It is significant to notice in Eq. (3) that $J \geq 0$ in other words the equality holds if and only if null hypothesis in Eq. (5) is true, whereas $J > 0$ holds under the alternate hypothesis in (4). The feasible kernel-based sample analog of J defined by Jeong et al. (2012) is stated as:

$$\hat{J}_T = \frac{1}{T(T-1)h^{2p}} \sum_{s \neq p+1}^T \sum_{s \neq p+1}^T s \neq t K\left(\frac{Z_t - 1 - Z_s - 1}{h}\right) \hat{\varepsilon}_t \hat{\varepsilon}_s,$$

In Eq. (6), $K(\cdot)$ means the kernel-function with h (bandwidth), sample size as t , lag-order as p , while the estimate of the unknown regression error is $\hat{\varepsilon}_t$ that is illustrated below:

$$\hat{\varepsilon}_t = 1\{y_t \leq \hat{Q}\theta(y_{t-1})\} - \theta,$$

⁹ 1 The exposition in this section closely follows Nishiyama et al. (2011) and Jeong et al. (2012)

As in the above mentioned equation, the θ -conditional quantile estimate of y_t as y_{t-1} is denoted by $\hat{Q} \theta(y_{t-1})$. In mentioned equation, $\hat{Q} \theta(y_{t-1})$ is estimated by nonparametric-kernel approach which is as follows:

$$\hat{Q} \theta(y_{t-1}) = F_{y_t|y_{t-1}}^{\Lambda-1}(\theta y_{t-1}),$$

Hence, the Nadarya-watson kernel estimator is $F_{y_t|y_{t-1}}^{\Lambda-1}(y_{t-1})$ stated as:

$$F_{y_t|y_{t-1}}^{\Lambda-1}(y_{t-1}) = \frac{\sum_{s=P+1, s \neq t}^T L\left(\frac{y_{t-1} - y_{s-1}}{h}\right) \mathbf{1}(y_s \leq y_t)}{\sum_{s=P+1, s \neq t}^T L\left(\frac{y_{t-1} - y_{s-1}}{h}\right)},$$

Where $L(\cdot)$ refers to the kernel-function and bandwidth is h .

Jeong et al. (2012) expanded framework, the test for second-order moment is derived. Where specifically, the volatility causality is tested running from RCY, EEF to CEM and GDP. k th-moment causality usually indicates m th-moment causality for $k < m$. At first, the nonparametric Granger-quantile-causality technique (Nishiyama et al. 2011) is applied. To explain the higher order moments causality, based on the stated process for y_t as:

$$y_t = g(y_{t-1}) + \sigma(X_{t-1}) \varepsilon_t,$$

Thus, white noise process is ε_t and unknown functions are $g(\cdot)$ and $\sigma(\cdot)$ and satisfy conditions for stationary function. Although, the stated specification does not permit for Granger-type causality testing from X_{t-1} till y_t . Still, it can likely predict the “predictive power” from “ X_{t-1} till y_t ” when unknown function “ $\sigma(\cdot)$ ” is general nonlinear function. Thus, the definition of the Granger causality-in-variance does not need an explicit description of squares for X_{t-1} . Equation 10 as H_0 and H_1 hypothesis has been rewritten as follows:

$$\begin{aligned} H_0: P\{Fy_t^2 | Zt-1\{Q\theta(y_{t-1}) | Zt-1\} = \theta\} = 1, \\ H_1: P\{Fy_t^2 | Zt-1\{Q\theta(y_{t-1}) | Zt-1\} = \theta\} < 1, \end{aligned}$$

In order to attain the test, H_0 in Eq. (10) through feasible test statistic, y_t^2 has replaced y_t in Eqs. (6)–(9). Following the approach of Jeong et al. (2012) to solve the issue, causality-in the conditional first moment (mean) denotes causality in the second moment (variance). Therefore, to solve this issue, the causality in high-order moments according to the model is as follows:

$$y_t = g(X_{t-1}, y_{t-1}) + \varepsilon_t,$$

Hence, high-order quantile causality can be stated as follows:

$$\begin{aligned} H_0: P\{Fy_t^k | Zt-1\{Q\theta(y_{t-1}) | Zt-1\} = \theta\} = 1 \text{ for } k = 1, 2, \dots, K, \\ H_1: P\{Fy_t^k | Zt-1\{Q\theta(y_{t-1}) | Zt-1\} = \theta\} < 1 \text{ for } k = 1, 2, \dots, K, \end{aligned}$$

Incorporating the entire framework, we explain that x_t Granger causes y_t in the θ th quantile up to the k th moment by using Eq. (14) to devise the equation 6 test statistic for every k . Although, it can be portrayed that it is not simple to chain the different statistics for every $k = 1, 2, \dots, K$ into single statistic for the joint H_0 in Eq. (14) as the statistics are equally correlated (Nishiyama et al. 2011). To overcome this problem, a technique of Nishiyama et al. (2011) includes a sequential-testing with few alterations. At first, the nonparametric Granger causality in the first moment, i.e., $K = 1$ is tested. Then, when the null hypothesis of non-causality is rejected, we can stop and explain this outcome as a strong sign of possible Granger quantile causality-in-variance. However, if H_0 is not rejected for $k = 1$, it does not spontaneously directs to no-causality in second moment, but the test for $k = 2$ can still be created.

At last, the presence of causality-invariance or the causality in-mean and variance is tested. To empirically implement causality test through quantiles requires stating the following significant options: (i) h the bandwidth (ii) p the lag-order (iii) K (\cdot) and $L(\cdot)$ kernel types in Eqs. (6) and (9). In this study, lag order of 1 is utilized following the Schwarz Information Criterion (SIC) under a vector autoregressive (VAR) including recycling, energy efficiency, carbon emission, and economic growth. The Schwarz Information Criterion being parsimonious when it is time to select lags instead of another alternative lag-length choosing criterion, assists in overcoming problems of overparametrization usually connected with nonparametric methods. The h value is designated by applying the least squares cross-validation approach. Finally, we use Gaussain-type kernel for $K(\cdot)$ and $L(\cdot)$.

Data

The quarterly data¹⁰ of the USA from 1990 (Q1) till 2018 (Q4) has been utilized comprising of carbon emissions as CEM for environmental performance (metric tons per capita), municipal solid waste recycling as RCY (tons), energy efficiency as EEF, and economic growth as the gross domestic product (constant 2010 US\$). The following variables exhibit different estimating units; thus, it is vital to use a single estimating unit to solve distributional characteristics issues. Considering the past studies of Paramati et al. (2017), Shahbaz et al. (2020), the variables used in this study are changed in logarithm that produces results in the form of elasticities due to which explaining the output becomes easier. The data of the energy efficiency and gross domestic product are acquired from

¹⁰ To solve the problem of shorter duration, we have applied the quadratic match-sum technique to change annual data to quarterly data of Shahbaz et al. (2020). Shahbaz et al. (2017) stated that the quadratic match-sum technique needs to be examined carefully to modify cyclical variation in the sample. Seasonality problems can be minimized in the dataset as this process minimizes the point-to-point data variations.

World Bank, while the sample of carbon emission to represent environmental performance and municipal solid waste recycling has been gathered from the British Petroleum and the US environmental protection agency. The variables used in this study are converted into a natural logarithmic form for empirical analysis exhibited in Figure 1.

Data analysis

The results of the descriptive statistics are exhibited in Table 1. The results comprise the following outcomes: mean, maximum, minimum, standard deviation (Std. Dev.), skewness, Kurtosis, J-B, and ADF (Augmented Dickey-Fuller test). According to the results, recycling has the highest mean, 16.664, while energy efficiency has the lowest mean, which is 0.291. To analyze the skewness and distribution of the data, we consider the statistics of skewness and kurtosis, which indicate that the data is a highly skewed and fat-tailed distribution for the selected series. The J-B test also indicates that the data is not normally distributed because the null hypothesis (H_0) of normality at the 1% significance level confirms the non-acceptance of the hypothesis. The nonstationary properties of the data are then assessed through ADF to apply a nonparametric causality-in-quantile test; it is required that the variables be stationary. The result indicates that all the series are stationary at level after the null hypothesis at 1% is rejected. This confirms the suitability to apply the causality-in-quantile method rather than the standard linear Granger causality test.

Furthermore, the causal relationship between the following variables is assessed as follows: (i) recycling with carbon emission, (ii) recycling with economic growth, (iii) energy efficiency with carbon emission, (iv) energy efficiency with

economic growth or GDP by using linear Granger causality technique based on linear vector autoregression (VAR) model. The results in Table 2 indicate that all the variables display the insignificant F-statistic that refers to the acceptance of H_0 “null hypothesis.” According to H_0 , recycling does not Granger causes carbon emission-economic growth. The null hypothesis of energy efficiency assumes that energy efficiency does not Granger cause carbon emission and economic growth. Overall, as per the results, a linear VAR model at the significance level of 10% still exhibits no evidence to predict causality from recycling and energy efficiency to environmental performance and economic growth (Table 3).

Additionally, we applied the nonlinear unit test and nonlinear cointegration test of Kapetanios, Shin, and Snell (2003, 2006); the results are displayed in Tables 4 and 5. The KSS nonlinear unit root test outcome is at a 1% significance level; the variables under consideration, RCY, EEF, CEM, and GDP, reject the H_0 -null hypothesis, which determines that all the series are nonlinear stationary. However, the traditional unit root test considers the linear perspective, which might direct to ambiguous outcomes. Liu and He (2010) determined that the traditional technique of estimating unbiasedness is not verified and might lead to “spurious regression” if the data are nonstationary. The nonlinear stationary series present in these variables suggests that change in variables is not persistent and displays nonlinear attributes. Similarly, the KSS nonlinear cointegration test was used; the results are exhibited in Table 5. The KSS nonlinear cointegration test output indicates that the variables under consideration are stationary, which strengthens the robustness of our analysis as it refers to the variables are mean-reverting.

Moving on to the next test, before using the nonparametric technique, we assessed the nonlinearity in the connection of recycling, energy efficiency with environment performance

Fig. 1 Time series plot of all considered variables. The figure plots the natural logarithms of the series

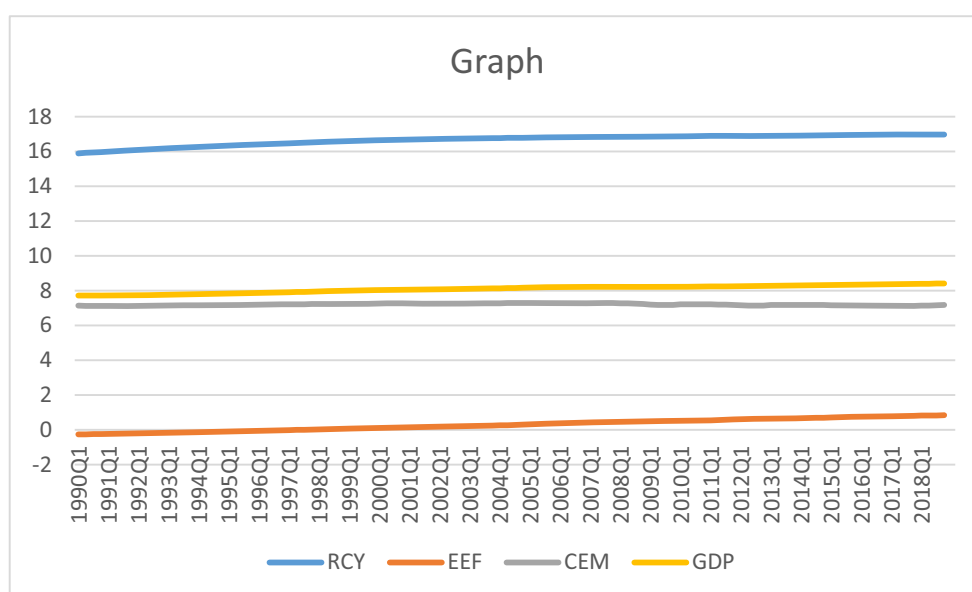


Table 1 Results of descriptive statistics in natural logarithms

Variables	Mean	Maximum	Minimum	Std. Dev.	Skewness	Kurtosis	J-B	ADF test
CEM	7.204	7.296	7.114	0.056	0.082	1.671	8.663***	− 5.843***
GDP	8.095	8.419	7.712	0.210	− 0.426	1.940	8.938***	− 3.528**
RCY	16.664	16.974	15.891	0.298	− 1.029	2.913	20.518***	− 4.895***
EEF	0.291	0.841	− 0.256	0.337	− 0.023	1.709	8.066**	− 5.217***

J-B Jarque-Bera test of normality, *ADF* augmented Dickey and Fuller (1979) test of stationary

***, **, and * denote the rejection of null hypothesis at the 1%, 5%, and 10% respectively

Source: authors' estimations

(carbon emission), and economic growth (GDP). For further analysis, the BDS test of Brock et al. (1996) is used on the residuals of the considered variables of the VAR (1) framework consisting of recycling, energy efficiency, carbon emission, and GDP. The outcomes are exhibited in Table 3 and revealed that the H_0 of i.i.d residuals at 1% significance level is rejected. The results indicate the presence of a nonlinear connection between the variables.

Furthermore, we employed the Andrews (1993), Andrews and Ploberger (1994) parameter stability test. The VAR (1) framework, including RCY-CEM, RCY-GDP, EEF-CEM, and EEF-GDP outcomes, is shown in Table 6. The results point that the stability of the null hypothesis at 5% is rejected, which is validated through three tests named Max-F, Exp-F, and Ave-F. The outcomes of Brock et al. (1996) test and parameter stability test the structural breaks and nonlinear connection between variables. The presence of structural breaks and the nonlinear connection is verified. Suggesting that the model centered on the “linear Granger causality test” is expected to suffer from incorrect outcomes. Therefore, the causality-in-quantile test has been applied to overcome this issue which is considered robust contrary to outliers, jumps, nonlinear dependence, and structural breaks (Balcilar et al. 2017; Su et al. 2020).

Table 2 Linear Granger causality test

Variables	<i>f</i> -stats	<i>p</i> -value
RCY → CEM	0.600	0.551
RCY → GDP	0.975	0.381
EEF → CEM	1.033	0.360
EEF → GDP	0.712	0.493

The table reports the F-statistic and prob. value for the no Granger causality restrictions imposed on a linear model under the null hypotheses H_0

All hypotheses indicate acceptance of the null hypothesis of no Granger causality at significance level of 5%

Source: authors' estimations

Further, to check the nonlinear Granger causality between recycling, energy efficiency with carbon emission, and gross domestic product, we utilized the Diks and Panchenko (2006) nonlinear Granger causality test. Table 7 depicts the outcomes of the following test. The robustness against the lag order applied is confirmed by the “nonlinear Granger causality test,” which is executed for “ $m = 2, 3, 4$ embedding dimension”. In Table 8, the outcomes are exhibited, suggesting that the nonlinear Granger causality H_0 for RCY-CEM and GDP, EEF-CEM, and GDP are rejected. As for the entire series, no proof of the absence of nonlinear Granger causality is observed; therefore, we moved on to the “nonparametric causality in quantiles tests.” This technique emphasizes the distribution center, all the quantiles distribution are also apprehended (Fig. 2).

The outcomes of quantile causality in mean for RCY-CEM, GDP, and EEF-CEM, GDP are shown in Figure 1. Figure 1 exhibits the quantile shown on the x-axis and nonparametric causality test statics on the y-axis. At 5% CV is 1.96 and at 10% CV is 1.65. The CV 5% is displayed through the thin horizontal lines, and the two-dashed thin lines represent the 10% CV. Figure 1 validates the presence of the quantile-causality-in-mean breakdown. Moreover, the results are considerably different for every relation.

For RCY-CEM, the quantile causality-in-mean result where the H_0 : “Recycling does not Granger causes environmental performance denoted as carbon emission” is rejected at 1.65 CV, i.e., 10% over the quantiles 0.15–0.85. The quantiles show the acceptance of H_0 at the low and high quantiles that

Table 3 Nonlinear unit root test results

Variable	KSS test static	<i>p</i> -value at 1%
RCY	− 1.634	0.000
EEF	− 2.601	0.000
CEM	− 1.653	0.000
GDP	− 1.931	0.000

The test was performed using the Kapetanios, Shin and Snell (2003) nonlinear unit root test function

Table 4 Nonlinear cointegration test results

Model	KSS test static	<i>p</i> -value at 1%
RCY vs CEM	− 2.445	0.000
RCY vs GDP	− 2.017	0.000
EEF vs CEM	− 3.032	0.000
EEF vs GDP	− 3.175	0.000

The test was performed using the Kapetanios, Shin and Snell (2006) nonlinear cointegration test function

are 0.1 and 0.9. Whereas, at 5% (1.96 CV), all the quantiles point towards the rejection of H_0 , excluding the quantiles within 0.1–0.2 and then 0.85–0.9. The result indicates that recycling municipal solid waste Granger causes environmental performance for the majority of quantiles.

Moreover, for RCY-GDP, the mean of quantile causality indicates the non-acceptance of H_0 for 0.2–0.75 quantiles at 1.65 CV. Subsequently, at 5% with 1.96 CV, the H_0 is accepted at 0.1–0.2 low and mid to high that is 0.65–0.9, expect 0.25–0.6 where the null hypothesis is rejected, indicating mixed results. Whereas, at 10% CV, the quantile within the range from 0.1–0.15 and 0.8–0.9 the H_0 is accepted, which show that for some quantile recycling does Granger causes economic growth while for low and high quantiles, recycling does not Granger cause economic growth; therefore, we summarize the results are mixed, and effect varies with time.

EEF-CEM mean quantile causality results, the H_0 : energy efficiency does not Granger causes carbon emission (environmental performance) is rejected at 10% CV for the quantiles ranging from low to mid quantiles 0.15–0.7 except for low 0.1 and high 0.75–0.9. However, at the 5% CV, the quantiles at 0.1 and from 0.6 to 0.9 show the acceptance of H_0 expect for quantiles ranging from 0.15 to 0.55. Similarly, in energy efficiency and carbon emission, the results vary with time as the cause and effect relation changes with quantiles; hence, we consider that result highlights the diverse effect.

To examine the connection between EEF-GDP when the graphic presentation of the quantile causality-in-mean is examined, the H_0 that energy efficiency does not Granger causes

economic growth denoted as GDP is accepted at the 1.65 CV for the quantiles from 0.55 to 0.9 that is middle to high quantiles expect for the low to middle quantile ranging from 0.1 to 0.5. At 1.96 CV, the H_0 is rejected for the quantiles within the range of 0.1–0.45 except for the mid-high quantiles covering the period from 0.5 to 0.9. Thus, we consider that energy efficiency for low to high quantiles Granger causes economic growth, but the mid to high quantiles energy efficiency does not Granger causes economic development.

Discussion

Therefore, we summarize that recycling municipal solid waste and energy efficiency affect environmental performance and economic growth. Although the linear framework observes no such Granger causality connection, the linear model produced ambiguous outcomes due to nonlinearity among the variables. The findings from the nonparametric causality-in-quantile method summarize that solid waste recycling affects environmental performance measured as carbon emission. As highlighted by Turner et al. (2015), Razzaq et al. (2021), and Lee et al. (2016), to attain the positive effect of recycling in terms of mitigating carbon emission and greenhouse gases, the recycling ratio needs to be elevated. The increase in recycling can enhance gross domestic product because recycling municipal solid waste is beneficial for the economy, particularly for providing jobs, mitigating carbon dioxide and other harmful gases. As in Florida, the 1% increase in recycling leads to 0.4% job opportunities (Liu et al. 2020). Likewise, policymakers predicted that the job growth would increase 36 times in Australia, producing green jobs due to recycling rather than landfilling (Davis 2013). The contribution of MSWM in economic development further aids in environmental sustainability by reducing carbon emission in two ways. At first, when the GDP increases, it elevates the financial development indicator, which can be used as a tool for ecological well-being by introducing financial regulation policies. Secondly, the government can allocate more budget for R&D to enhance further and promote the usage of environmental-friendly practices (He et al. 2021).

Table 5 BDS test for nonlinearity

Variables	<i>m</i> = 2		<i>m</i> = 3		<i>m</i> = 4		<i>m</i> = 5		<i>m</i> = 6	
	<i>z</i> -stats	<i>p</i> -value	<i>z</i> -stats	<i>p</i> -value	<i>z</i> -stats	<i>p</i> -value	<i>z</i> -stats	<i>p</i> -value	<i>z</i> -stats	<i>p</i> -value
CEM	51.000	0.000	53.843	0.000	57.283	0.000	62.368	0.000	69.586	0.000
GDP	42.525	0.000	45.344	0.000	49.062	0.000	54.588	0.000	62.167	0.000
RCY	28.971	0.000	30.896	0.000	33.306	0.000	36.814	0.000	41.615	0.000
EEF	54.924	0.000	58.500	0.000	63.265	0.000	70.352	0.000	80.214	0.000

The entries indicate the *z*-statistics BDS test based on the residuals of considered variables. *m* denotes the embedding dimension of the BDS test. All hypothesis are rejected at 1% of significance level

Source: authors' estimations

Table 6 Parameter stability testing

Variables	Maximum LR F Statistics		Exp LR F Statistics		Ave LR F Statistics	
	Stats.	Prob.	Stats.	Prob.	Stats.	Prob.
RCY → CEM	695.625	0.000	343.418	0.000	223.470	0.000
RCY → GDP	237.223	0.000	115.588	0.000	139.011	0.000
EEF → CEM	2451.838	0.000	1221.589	0.000	860.090	0.000
EEF → GDP	345.791	0.000	168.546	0.001	133.006	0.040

Parameter stability test by Andrews (1993) and Andrews and Ploberger (1994) with the null hypothesis of parameter stability

Source: authors' estimations

Simultaneously, the recycling municipal solid waste material reduces dependency on resources. Furthermore, it restores the hazardous impact on the environment as material recycling cuts down the huge amount of energy utilization needed to produce new material and products (Bueno et al. 2015). Also, recycling cause's energy efficiency to enhance economic value through energy conservation environmental performance which can be improved (Nabavi-Pelesaraei et al. 2017; Arora et al. 2020).

Further, Adebayo and Kirikkaleli (2021) stated that the government should make laws regarding the use of clean energy and provide more competitive resources and support for investing in energy-efficient resources/technology. Wang et al. (2020) highlighted that energy efficiency and renewable energy consumption are favorable to reduce environmental degradation particularly, in industrialized economies. The industrialized economies majorly depend on secondary industrial performance, which highly consumes energy and pollutes the environment. Therefore, the industries should initiate the use of advanced eco-friendly technology and stress the usage of such practices that ensure the sustainability of the environment (Dogan et al. 2020a; Ozcan et al. 2019; Dogan et al. 2020b), Kirikkaleli (2020). Moreover, Dogan et al. (2021) stated that energy efficiency positively affects economic development, mostly in developed counties, because these economies are wealthy and have a sound financial position and political support to advance with energy evolution by reducing the level of dependence on fossil fuel resources. Similarly, Kirikkaleli and Adebayo (2020) also claimed that

to enhance the quality of the environment and limit the hazardous impact of carbon emission on the environment, the government must impose strict regulations and laws for efficient use of energy, such as the use of clean and pure energy resources which fulfill the current and future needs (Su et al. 2021).

However, the study's findings sometimes contradict the statement of Soylu et al. (2021) that energy usage and economic development through trade openness increase carbon emission, leading to environmental degradation. While on the other hand, the increasing economic growth aid in the process of mitigating the emission effect and contribute significantly to finance in the R&D projects of MSWM.

Furthermore, the need for efficient energy use and reducing resource dependency is significant in developed economies because the transportation industry contributes to GDP. Due to the increase in transportation, the USA is severely facing environmental-related issues. The increasing ratio of environmental degradation is dangerous and damaging for ecological well-being and humans (Umar et al. 2021).

As seen in Figure 1, the hump-shaped pattern across quantiles indicates the strength of the causality between variables. This outline of causality is a novel result, and it also highlights the advantage of utilizing the nonparametric causality-in-quantile approach. This method generates outcomes at different quantiles, so the scholar and academicians that only emphasize on conditional distribution median of carbon emission and gross domestic product will notice the confirmation of the predictive authority of recycling and energy efficiency on the dependent variables but might not be able to observe that this connection becomes fragile when the quantiles at distant from the median are computed. In Figure 1, the asymmetric nature based on the hump-shaped curves and the non-causality is fragile at the right tails is also exhibited.

Although, the emphasis on recycling, reusing, and reprocessing policies is usually stressed worldwide because it is a helpful tool to mitigate the harmful effects of carbon emission. The municipal solid waste management recycling protects a considerable area of land and links greenhouse gases emission, i.e., carbon and marsh, from the disposal area.

Table 7 Diks and Panchenko (2006) nonlinear Granger causality test

Variables	$m = 2$		$m = 3$		$m = 4$	
	Stats.	<i>p</i> -value	Stats.	<i>p</i> -value	Stats.	<i>p</i> -value
RCY → CEM	1.468	0.071	1.633	0.051	1.693	0.045
RCY → GDP	1.615	0.053	1.681	0.046	1.671	0.047
EEF → CEM	1.381	0.084	1.355	0.088	1.581	0.057
EEF → GDP	1.304	0.096	1.392	0.082	1.771	0.038

m denotes the embedding dimension

Source: authors' estimations

Table 8 Results of causality in mean

Quantile	RCY \rightarrow CEM	RCY \rightarrow GDP	EEF \rightarrow CEM	EEF \rightarrow GDP
0.10	1.247	1.102	1.459	6.559
0.15	1.676	1.510	1.971	5.494
0.20	1.775	1.940	2.324	4.382
0.25	2.365	2.380	2.226	3.770
0.30	2.999	2.005	2.232	3.158
0.35	3.314	1.792	2.338	2.876
0.40	4.196	2.382	2.261	2.461
0.45	4.306	2.077	2.465	2.130
0.50	4.638	2.169	2.658	1.865
0.55	4.887	2.236	2.544	1.630
0.60	6.515	2.000	1.943	1.412
0.65	5.686	1.912	1.669	1.241
0.70	5.001	1.989	1.835	1.221
0.75	5.696	1.667	1.389	0.874
0.80	2.156	1.206	1.589	0.592
0.85	1.715	1.535	1.373	0.516
0.90	0.659	1.307	1.472	0.502

Entries correspond to the quantile causality test statistic for the null hypothesis that considered environmental variable does not Granger cause ecological footprint

** and * indicate rejection of null of hypothesis no-causality at 5 and 10% levels respectively

Source: authors' estimations

Such impacts in the context of natural resources protection and efficient energy use are complex; although, it has the significant impact of MSWM on environmental well-being. Moreover, the proportion of disposal areas can be reduced by utilizing diverse managing and ecological practices like green-electricity tariffs and a recycling process to treat waste. Hence, MSWM requires a massive budget comparative to dumping grounds and ignition, because of which a setup/structure gap is formed in this procedure. Thus, environmentalists' and policymakers' plans and strategies for MSWM implementation in terms of investment are vital to enhance environmental quality and reduce harmful effects from waste disposal.

Conclusion

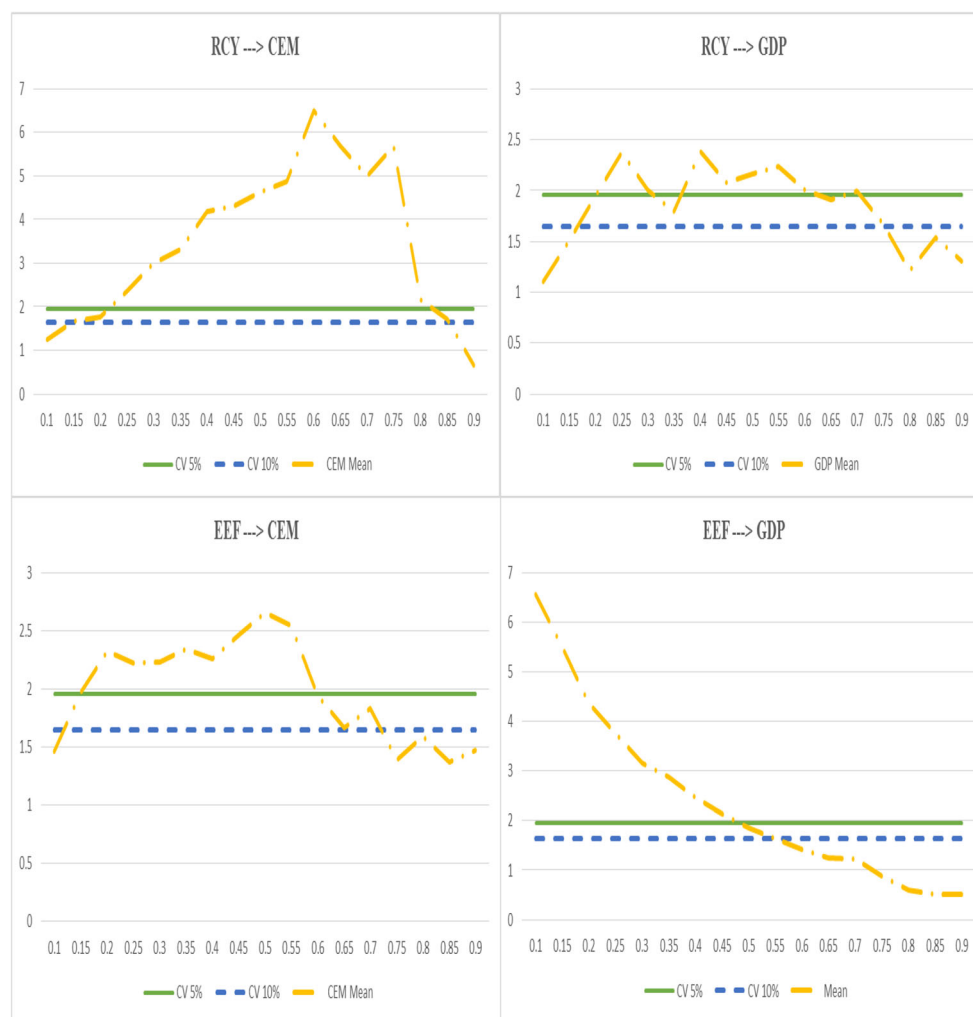
The indirect connection between recycling, energy efficiency, environmental performance, and economic growth is examined in past studies. However, some studies have focused on exploring the direct relationship between the concern variables. Hence, this paper analyzes the connection between the variables by acquiring the annual data and then transforming it into a quarterly dataset from 1990 (Q1) to 2018 (Q4). First, the standard linear Granger causality test is used that indicates no causal connection presences among variables. After that, the nonlinear tests are applied, indicating that the connection between the selected variables is nonlinear, and the linear test

approach might produce doubtful estimations. Balcilar et al. (2017) method, "nonparametric causality-in-quantile," is used to solve this problem. This method authorizes for analyzing the quantile causality in mean. The findings of nonparametric causality in quantiles method demonstrate the H_0 rejection that suggests that recycling causes environmental performance and economic growth and energy efficiency for some quantiles. Furthermore, the quantile causality-in-mean for some quantiles indicates the acceptance of the H_0 .

Policy implication and limitation

This analysis delivers valuable implications for researchers, policymakers, and the government. The connection between the variables points that recycling affects carbon emission and gross domestic product, while energy efficiency also affects environmental performance and economic growth; hence, the USA, besides emphasizing other methods of disposal, should focus on municipal solid waste recycling and energy efficiency as it enhances economic development and decreases the amount of carbon dioxide in the short term long-term. The strict implementation of green practices may be one of the possible plans. Additionally, reprocessing and reusing enhance the value of the product to be sustained throughout the longer duration, reducing waste, and materials utilized. Hence, policymakers can motivate businesses and entrepreneurs to escalate the recycling, reusing, and reprocessing of

Fig. 2 Results of causality in mean analysis. The figure plots the estimates of the nonparametric causality tests at various quantiles. Horizontal thin solid and thin two-dashed lines represent the 5% and 10% critical values, respectively



waste considerably by offering incentives, benefits in terms of grants or duties.

Further, the following suggestions are stated to lessen/reduce the impact of municipal solid waste on the environment, such as elevating energy production by the burning of solid waste can recover the gases. Furthermore, upgrade the recycling plants/machinery with a particular system for detaining the carbon emission released during the burning of waste. Moreover, ventilate/freshen municipal solid waste disposal areas for decomposing naturally under the higher oxygen places.

The study has some limitations in terms of data and duration. First, prospective studies can enlarge this analysis by examining other variables or comparing the environmental performance of household or business waste collection systems with other substitute systems such as single or dual stream commingled collection. Secondly, other substitutes to represent the environmental degradation can be utilized by future studies like ecological footprint and greenhouse gases emission. Moreover, different advanced methodologies can be

applied by scholars to study the connection among the variables in future studies.

Author contribution Sun Guoyan: **conceptualization, writing – original draft, writing – review & editing, methodology, formal analysis**

Asadullah Khaskheli: **conceptualization, writing – original draft, writing – review & editing, data curation, methodology, formal analysis**

Syed Ali Raza: **writing – original draft, writing – review & editing, supervision**

Maiyra Ahmed: **writing – original draft, writing – review & editing, data curation**

Data availability The datasets used and/or analyzed during the current study are available from the corresponding author on reasonable request.

Declarations

Ethics approval and consent to participate Not applicable.

Consent for publication Not applicable.

Competing interests The authors declare no competing interests.

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Analyzing the association between the foreign direct investment and carbon emissions in MENA countries: a pathway to sustainable development

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Abstract

Currently, sustainable development has become one of the inevitable requirements for the country's economic evolution, as it encourages healthy and sustainable ecology for their people. To achieve this development, there is a need to decarbonize the energy system and minimize carbon emissions (CEM) because it brings a hazardous impact if left unabated. The motivation for this study is to analyze those factors that affect the CEM and threaten a sustainable environment. Precisely, this research explores the nonlinear association between CEM and FDI in the Middle East and North Africa (MENA) countries using the yearly data of 1995–2016. The Panel Smooth Transition Regression Model (PSTR) is applied, and the result confirmed that the nexus between the two variables is nonlinear. Moreover, it also shows that at a low regime, FDI increases the CEM, but as the economy progress to the high regime, the relationship between the two variables becomes negative and significant. The study also confirms that FDI can reduce CEM once it reaches a certain threshold point. Based on these findings, new insights are provided for the policymakers, and several policies are suggested to improve the environmental quality in MENA countries. It is also suggested that CEM and FDI should be considered while designing sustainable environmental policies.

Keywords FDI · CEM · PSTR · MENA Countries

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1 Introduction

Sustainable development is considered one of the best substitutes for nations to maximize their well-being with limited resources against unlimited wants (Ulucak et al., 2020). It is based on societal, environmental, economic aspects and cannot be achieved by only focusing on one dimension (Bilgili & Ulucak, 2018). However, despite the importance of all three dimensions of sustainable development, the environmental dimension has become the focus of serious consideration because of the uprising environmental distresses (Ulucak et al., 2020). It has become the fundamental policy and the prime objective of minimizing greenhouse gas emissions because of climate change (Umar et al., 2020).

Today, climate change has gained much attention due to its destructive effects on human beings (Chen et al., 2019). The instrumental record showed that the worldwide temperature has increased by around 0.8 °C in the last 100 years. To overcome this weather change, several contracts from Kyoto Protocol (1997) to Paris Agreement (2015) have been processed and more focus has been given to control greenhouse gas emissions as it is among of the prime reason behind this global warming (Chen et al., 2019; Nordhaus, 2013). Among all the greenhouse gas emissions, carbon emissions are identified as the main culprit contributing to global warming, which is extensively recognized by the scientific community (Xu et al., 2019a, 2019b; Zeng & Chen, 2016). Sequel to this, excessive work has been devoted to identifying the factors of carbon emissions (CEM) (Ahmad et al., 2020a, 2020b; Muhammad, Long, Salman, & Dauda, 2020; etc.). Studies have asserted that along with energy usage, economic growth (EG), factors like foreign direct investment (FDI), urbanization (URB) are also the prime causes of CEM (Ahmed et al. 2019) which threaten sustainable development, human health, and poverty (Akinlo, & Dada, 2021; Asongu & Odhiambo, 2019).

FDI is identified as the key source of CEM (Ahmed et al. 2019). The relation between the FDI and CEM also grasps the attention of scholars, and significant studies have been carried out. The studies have generally been divided into two strands, but the results are still uncertain and controversial (Xie et al., 2020). The first strand of literature studied the relation between the CEM and inward FDI, and two different viewpoints have been generated. The first view is pessimism and supports the pollution haven hypothesis (PPH), which suggested that due to weak ecological rules in host economies, some enterprises with high levels shifted through FDI cause an upsurge in CEM (Nasir et al., 2019; Sarkodie & Strezov, 2019). The second viewpoint is optimism and supports the pollution halo hypotheses. This hypothesis suggested that multinationals that involve in FDI bring in advanced technologies and follow high standards in productions to the host economies, causing a reduction in CEM (Xu et al., 2019a, 2019b). The second strand of literature stated that the association between the FDI and CEM is not only linear but also nonlinear. This stated that the association between FDI and CEM is inverted U-shaped (Ji et al. 2015). The in-depth studies explored the internal mechanism of the FDI effect on CEM. Panayotou (2000); Grossman and Krueger (1991) stated that FDI affects CEM in host countries through comprehensive effects, including scale, technical, and structural effects. Bao et al. (2010) explored the FDI scale and income effect on CEM and stated that scale effects increase it and income effect decreases it. Cao et al., (2018) examined the FDI and sulfur dioxide emissions (SO₂) in China and reported that FDI technical and scale effects negatively impact SO₂ emissions. Leng et al., (2015) also stated that FDI scale, structural, and growth affect environmental quality.

Apart from FDI, URB is also identified as the key source of CEM. URB is the method of social and economic modernization. It not only involves the conversion of an agricultural-based economy (rural areas) into an industrial-based economy (urban areas) but also included the shifting of people from rural regions to urban regions (Muhammad et al., 2020). URB affects in four aspects, i.e., population, social, land, and economic. It, directly and indirectly, impacts the environment by changing the industrial structure, human activity patterns, and land utilization layout. Firstly, it causes the shifting of population from rural to urban vicinity, enhancing the consumption level and population density in those areas (Sharma, 2011). The correspondence change in the resident's lifestyles in respect of entertainment, transportation, and housing causes an upsurge in energy consumption. Simultaneously, the agglomeration effect upsurges the energy consumption, which causes the CEM. Secondly, the URB involves altering agricultural practices into non-agricultural practices and the up-gradation of industrial structures. This industrial structure evolution affects CEM. (Chen et al., 2013). Thirdly, URB involves expanding urban areas and increasing the number of cities, and to support these changes, a large amount of land is required. When property types transform, the differences in the CEM of different property categories may cause a transformation from carbon sinks to carbon sources, thus influencing emissions (Xu et al., 2018). Thus, it involves a large amount of public infrastructure and construction, affecting the CEM's upsurge.

Concerning environmental degradation literature, numerous studies have recognized those variables that cause CEM (Hanif et al., 2019; Lin & Xu, 2018). Numerous studies identified and explored the relationship between the CEM and EG, but the link is still unclear due to the ignorance of some important variables such as FDI (Xie et al., 2020). Concerning FDI and CEM, numerous studies have focused on global economies (Muhammad & Khan, 2019), and some are country specific (Mukhtarov et al., 2020; Blanco et al., 2013). Most of them use the traditional techniques, linear models, but the association using nonlinear techniques is sparsely discussed (Haug & Ucal, 2019). Pazienza (2019), to examine the U-shaped nonlinear association between the CEM and FDI, added the square root of FDI. Similarly, Sarkodie and Strezov (2019) developed the third-order polynomial model to inspect the nonlinear association of CEM and FDI. However, the spillover effect of FDI is still at a growing stage. Sinha et al. (2017); Liobikienė and Butkus (2019) changed the polynomial model by adding the interaction term of FDI and income in the emission model to check the nexus of CEM and FDI through EG. Similarly, Xie et al. (2020) investigate the nonlinear association between the variables using the Panel Smooth Transition Regression Model (PSTR) technique in emerging economies. Hence, this research studies the nonlinear association between CEM and FDI using the PSTR technique in the Middle East and North Africa (MENA) countries.

Concerning MENA countries, several studies have been carried out. Some studies search the causal association between CEM and FDI (Abdouli & Hammami, 2017; Kahia et al., 2019). Some studies explore this association using traditional techniques (Shahbaz et al., 2019). To the best of our understanding, no research has been done exploring the nonlinear relation between CEM and FDI nexus in the MENA nations by using the advanced economic technique. This study fulfills this gap by examining the nonlinear nexus between the FDI and CEM in MENA countries using the PSTR. This technique has numerous advantages over other regression techniques. (i) It allows the coefficients of FDI and CEM to vary for both countries and time. (ii) The countries may move among time and groups with the variation in the threshold variable. (iii) It overcomes the cross-country heterogeneity present in a nonlinear model. (iv) It accounts for the potential outlier effects that can impact the outcomes. (v) It allows the variable coefficients to be changed smoothly

from one regime to another because those parameters change smoothly as a function of a transition variable.

Generally, this research contributes to the existing studies in many ways. (i) This is the first research that studies the nonlinear relationship between CEM and FDI in the context of MENA countries. (ii) This is the first study exploring the relation between FDI and CEM using the PSTR technique. Previously, the association between these variables in MENA countries has been examined using the traditional techniques, but the PSTR technique has not been used. (iii) This study also provides practical implications to the policymakers and the government.

The remaining study follows the following pattern: Literature review is explained in Sect. 2, the econometric technique is explained in Sect. 3, Sect. 4 gives the information related to data, Sect. 5 explains the results, and Sect. 6 explains the conclusion and recommendations.

2 Literature review

2.1 URB and CEM

Excessive studies have examined the link between URB and CEM. One viewpoint supports the positive relationship between the variables, such as Parikh and Shukla (1995) in 83 nations, Cole and Neumayer (2004) in 86 economies, Wang, Chen, and Kubota (2016) in Southeast Asian Nations, and Azizalrahman (2019) in different income level economies, whereas Liu and Bae (2018), Wang et al. (2019) in the Chinese economy, Pata (2018) in Turkey, Nathaniel (2019) in Nigeria, and Ali et al. (2019) in Pakistan. However, the second viewpoint supports the negative association between the variables, such as Fan et al. (2006) and Sharma (2011) in different income levels economies, Azam and Khan (2016) in South Asian economies, Saidi and Mbarek (2017) in emerging nations, Lv and Xu (2018) in 55 middle-income countries, and Ali et al. (2017) in Singapore.

2.2 FDI and CEM

The relationship between the CEM and FDI is extensively explored, and the mixed result is reported. The first strand of the literature reported the positive connection between the two variables and supported the PHH. Ren et al., (2014) explored the PPH in 18 industries of China and applied the two-step GMM model. They concluded that FDI is the prime source of CEM. Neequaye and Oladi (2015) used the data of 27 developing economies and reported that FDI deteriorates the environment by increasing CEM. Aller et al., (2015) also confirmed the PPH in 177 economies. Seker et al., (2015) used the ARDL technique on the dataset of Turkey and reported the positive association between the CEM and FDI. Riti et al., (2016) also concluded a positive association between the two variables in Nigeria. Abdouli and Hammami (2017) explored this phenomenon by using the data of MENA nations. They stated that increase in pollution-intensive industries increases the CEM and validates the PHH. Hanif et al. (2019) also supported the PPH in 15 emerging Asian economies. Shahbaz et al., (2019) used the MENA economies data and reported the positive association between the CEM and FDI. Essandoh et al., (2020) also studied the connection between the CEM and FDI in 54 developing and developed countries. They reported a negative association between the two variables in developed economies and

positive in developed economies. Xie et al., (2020) also supported both pollution halo and haven hypotheses in emerging economies. Joshua et al., (2020a, 2020b) also supported the PPH in the case of Nigeria. Khan and Ozturk (2020) also supported that PPH in 17 Asian countries.

The second strand of literature reported the negative association between the two variables and supported the pollution halo hypothesis. Haisheng et al. (2005) studied the association between the CEM and FDI and concluded that FDI brings in new technologies that help to reduce pollution. Al-Mulali and Tang (2013) stated that the relationship between CEM and FDI is negative in well-developed infrastructure economies. Zhang and Zhou (2016) used the data of Chinese regions and supported the pollution halo hypothesis. Paramati et al., (2016) stated that FDI encourages clean energy consumption in 20 emerging economies. Joshua et al., (2020a, 2020b) and Joshua and Alola (2020) used the ARDL technique and reported that FDI minimizes the CEM in South Africa.

2.3 EG and CEM

While analyzing the EG and CEM nexus, Halicioglu (2009) employed the data of Turkey and concluded that the causality found between the two variables is bidirectional. Acharya et al. (2009) also stated a positive association between EG and CEM. Narayan et al., (2016) stated that out of 181 economies, the 49 countries show a positive association between the two variables. Kais and Sami (2016) also reported the same positive association between EG and CEM in the global panel dataset. Omotor (2016) also reported a positive association in the Economic Community of West African States (ECOWAS) nations. Adedoyin et al. (2020) also reported the positive association between the two variables in BRICS countries. Salahuddin et al. (2016) used the Organisation for Economic Co-operation and Development (OECD) economies dataset and reported no link between EG and CEM. Richmond and Kaufmann (2006) also reported no association between EG and CEM. Saint Akadiri et al., (2019) reported that EG helps to improve the environmental quality in South Africa. Boopen and Vinesh (2011) also reported that the association between EG and CEM is negative. Appiah-Konadu et al., (2016) also stated that the association between the EG and CEM is negative. In Ghana, inferring that EG helps to improve the ecology. Sharif et al., (2020) reported the positive association between EG and ecological footprint in Turkey.

2.4 POP and CEM

The POP is also considered as one of the significant predictors that affect CEM. The studies such as Uddin et al., (2016); Liddle and Lung (2010) used the stochastic impacts by regression on population, affluence, and technology (STIRPAT) model and specified POP as the most significant factor. Lacheheb et al., (2015) employed the autoregressive distributed lag technique (ARDL) on Algeria data and reported a positive association between the POP and CEM. Jawara and Liadi (2016) explored those socio-economic factors that affect CEM in the Gambia. They reported that POP influences the CEM. Morales-Lage et al., (2016) identified the determinants that affected CEM in 28 EU countries and indicated that POP increases it. Zheng et al., (2016) used the 73 Chinese cities data and reported the positive association between POP and CEM. Kebede (2017) applied the ARDL technique to explore the association between the POP and CEM and concluded that their association

is positive. Aye and Edoja (2017) also stated a positive association between the POP and CEM.

3 Methodology

In this study, the PSTR technique given by Gonzalez et al., (2017) is employed on the dataset. According to Gonzalez et al., (2017), the technique can be applied as a linear heterogeneous or a nonlinear homogeneous panel and is a simplification of the panel threshold regression (PTR) technique developed by Hansen in the year 2002. This model is a fixed-effect techniques having exogenous regressors and addresses the issue relating to heterogeneity present in the nonlinear technique. It is a panel technique that allows for heterogeneity in the regression coefficients, in which coefficients vary over countries and time. Thus, we assume the fact that coefficients are continuous of an observable variable through a bounded function referred to as the transition function of such variable and changes between extreme states. Equation 1 explains the two-regime basic function of PSTR:

$$y_{i,t} = u_i + \beta_0 x_{i,t} + \beta_1' x_{i,t} g(q_{i,t}, \gamma, c) + \varepsilon_{i,t} \quad (1)$$

In Eq. (1), $T=1 \dots T$; $i=1, \dots N$, where number of cross sections are shown by N , time dimensions is shown by T , independent variable is explained by $y_{i,t}$, and the fixed individual effect is shown by u_i . The vector of control and explanatory variables is explained by $x_{i,t}$, and the transition function is shown by $g(q_{i,t}, \gamma, c)$ which depends on the threshold variable ($q_{i,t}$). The threshold parameter is represented by C , γ is the parameter, and $\varepsilon_{i,t}$ denotes the error term.

Here, we want to test the relation between the FDI and CEM by using the yearly data of 17 MENA countries consisting of 1995–2016. It is assumed that the relationship between them is nonlinear, and to cross-check it the nonlinear technique is applied. URB, POP, and EG are also considered in this study as they are also considered as the potential factors that affect this association (Wang et al., 2019; Acheampong, 2019; Inglesi-Lotz & Dogan, 2018). Equation 2 explains the basic PSTR function:

$$CEM_{i,t} = u_i + FDI x_{i,t} + FDI_1 x_{i,t} g(q_{i,t}, \gamma, c) + \beta_1 URB_{i,t} + \beta_2 POP_{i,t} + \beta_2 EG_{i,t} + \varepsilon_{i,t} \quad (2)$$

In Eq. (2), i shows the number of cross Sects. (17 MENA economies), and T is the time period (1995–2016). CEM is the carbon emissions, FDI means foreign direct investment, URB means urbanization, POP means population, and EG is the economic growth. The transition function is shown by $g(q_{i,t}, \gamma, c)$ in which FDI is used as a threshold variable and is denoted by $q_{i,t}$ and the values are bounded between 0 and 1. The slope parameter is explained by g which displays the transition's smoothness from one regime to other.

In Eq. 3, the logistic function is specified based on Gonzalez et al., (2017):

$$g(q_{i,t}, \gamma, c) = \frac{1}{1 + \exp[-\gamma(q_{i,t} - c)]} \quad (3)$$

In Eq. (3), the C shows the threshold parameter and the slope of the transition function is $\gamma > 0$ which changed into an indicator function when $\gamma \rightarrow \infty$. Moreover, if $q_{it} \geq c$ the $g(q_{i,t}, \gamma, c) = 1$, and if $q_{it} < c$ and $g(q_{i,t}, \gamma, c) = 0$. The PSTR model follows a fixed-effect panel model when $\gamma \rightarrow 0$. With an upsurge in threshold variable (FDI), the FDI and CEM coefficients change gradually and smoothly from first regime (β_0) corresponding to low

levels of FDI to second regime ($\beta_0 + \beta_1$) corresponding to high levels of FDI. In this technique, the parameter relies on the threshold variable and changes across time and countries. Thus, at the given level of $q(\text{FDI})$, the sensitivity of FDI to CEM for a particular time (t) and number of countries (i) is described by Eq. 4:

$$\varepsilon_{it} = \beta_0 + \beta_1 xg(q_{i,t}, \gamma, c) \quad (4)$$

In PSTR, to explore the parameters the three steps are performed. The model linearity is confirmed in the first step. In this test, whether the association between the FDI and CEM is elucidated by the linear or nonlinear models, i.e., PSTR, is investigated. The null hypothesis (H_0) in the linear technique is appropriate and the alternate hypothesis (H_1) in PSTR with two regimes is appropriate. ($H_0 : \gamma = 0$), i.e., null hypothesis is tested against the H_1 . As stated by Gonzalez et al., (2017), the correlated test is non-standardized because of the existence of unidentified nuisance in the parameter of the H_0 . To address this problem, Eq. 5 is developed in which the transition function of Eq. (1) ($q_{i,t}, \gamma, c$) is replaced by the first-order Taylor expansion around $\gamma = 0$.

$$y_{i,t} = u_i + \beta_0^* Z_{it} + \beta_1^* Z_{it} q_{it} + \beta_2^* Z_{it} q_{it}^2 + \dots + \beta_m^* Z_{it} q_{it}^m + \varepsilon_{it}^* \quad (5)$$

In Eq. (5), $\beta_0^* \dots \beta_m^*$ (parameters) are multiple of γ and $u_{it}^* = u_{it} + R_m \beta_1 Z_{it}$ where R_m shows the remainder of the Taylor function. In this scenario, checking $H_0 : \gamma = 0$ in Eq. 1 is same to check it in Eq. (5) $H_0^* = \beta_1^* = \dots = \beta_m^*$. The H_0 of the linearity is tested by three tests: (i) Fischer LM, (ii) Wald, and (iii) likelihood and are shown in Eqs. 6, 7, 8.

$$\text{Fischer LM test} = \text{LM}_f = \frac{\frac{\text{SSR}_0 - \text{SSR}_1}{K}}{\frac{\text{SSR}_0}{NT - N - K}} \quad (6)$$

$$\text{Wald LM test} = \text{LM}_w = \frac{NT(\text{SSR}_0 - \text{SSR}_1)}{\text{SSR}_0} \quad (7)$$

$$\text{Likelihood ratio test} = -2 [\log(\text{SSR}_1) - \log(\text{SSR}_0)] \quad (8)$$

In Eqs. (6), (7), (8), the sum of squared residuals is elucidated by SSR_0 in H_0 , and the sum of squared residuals is elucidated by SSR_1 in H_1 . In the Fischer LM test, $F(K, NT - N - K)$ distribution is used and K is the no. of explanatory variables. N is the no. of countries, and T shows time. $\chi^2(K)$ distribution is used in both tests, i.e., Wald and likelihood.

The rejection of null hypothesis implies that the relationship between the variables is nonlinear and can be tested by at least two regimes of PSTR. The no remaining nonlinearity is performed in the second step. The H_0 of this test in PSTR with two extreme regimes is appropriate, and H_1 in PSTR with at least three regimes is appropriate. Equation 9 explains the regression model for this:

$$y_{i,t} = u_i + \beta_0 Z_{it} + \beta_1 Z_{it} g_1(q_{it}; \gamma_1, c_1) + \beta_2 Z_{it} g_2(q_{it}; \gamma_2, c_2) + \varepsilon_{it} \quad (9)$$

In Eq. (9), the $H_0 : \gamma_2 = 0$ is used as null hypothesis. In this model, again the problem of identification is found which is addressed by the using the Taylor expansion of $g_2(q_{it}; \gamma_2, c_2)$ around $\gamma_2 = 0$. The new equation is explained below:

$$y_{i,t} = u_i + \beta_0^* Z_{it} + \beta_1^* Z_{it} g_1(q_{it}; \gamma_1, c_1) + \beta_{21}^* Z_{it} q_{it} + \cdots + \beta_{2m}^* Z_{it} q_{it}^m + \varepsilon_{it}^* \quad (10)$$

In Eq. (10), the null hypothesis ($H_0 : \gamma_2 = 0$) is changed as $H_0^* : \beta_{21}^* = \cdots = \beta_{2m}^* = 0$. It is also performed by the Wald, Fischer, and likelihood tests. We end this procedure if the null hypothesis is accepted and in case if it is rejected the procedure is repeated unless the no remaining nonlinearity null hypothesis is accepted. Once the regimes are selected in the last step, the parameters of the model are determined by employing the nonlinear least-square method.

3.1 Data

To investigate the link between the FDI and CEM, the yearly data consisting of 1995–2016 are taken for the MENA countries. The time frame is selected on the bases of available data, and the countries information is depicted in Table 1. Regarding variables, the CEM are taken in metric tons per capita, URB is taken in % of the total population, and FDI is taken as net inflows % of GDP. EG is measured in GDP per capita, and the POP is measured in total population. The data are extracted from the World Bank database. Moreover, to interpret the independent variables coefficient estimates regarding the dependent variable, the data have been changed into a natural logarithm.

4 Data analysis

4.1 Descriptive statistics

At first, the descriptive statistics is applied to explore the data features. Table 2 explains the results and shows that CEM show the maximum and the minimum value of 70.042 (Mt) and 0.390 (Mt) with a mean value of 12.141 (Mt). POP shows the maximum and the minimum value of 94.447 and 0.377 with a mean value of 17.952. EG shows the maximum value of 69,679.090 and the minimum value of 694.152% with a mean value of 17,656.820. URB shows the maximum value and the minimum value of 100% and 23.760% with a mean value of 75.272%. The FDI shows the maximum value and the minimum value of 451.639% and -11.144% with a mean value of 7.562%.

Table 1 List of countries

S. No	Name	S. No	Name
1	Algeria	10	Malta
2	Bahrain	11	Morocco
3	Egypt, Arab Rep	12	Oman
4	Iran, Islamic Rep	13	Qatar
5	Israel	14	Saudi Arabia
6	Jordan	15	Tunisia
7	Kuwait	16	United Arab Emirates
8	Lebanon	17	Yemen, Rep
9	Libya		

Table 2 Descriptive statistics (before taking logarithm) *Source:* Authors' Estimation

Variable	CEM	POP	GDP	URB	FDI
Mean	12.141	17.952	17,656.820	75.272	7.562
Median	6.707	6.563	8779.891	79.209	1.888
Maximum	70.042	94.447	69,679.090	100.000	451.639
Minimum	0.390	0.377	694.152	23.760	-11.144
Std. Dev	13.676	23.027	18,424.980	18.886	36.941
Skewness	1.897	1.668	1.310	-0.906	9.538
Kurtosis	6.731	4.753	3.764	3.142	100.248
Jarque–Bera	441.324	221.215	115.996	51.523	153,045.600
Probability	0.000	0.000	0.000	0.000	0.000
Observations	374	374	374	374	374

4.2 Cross-sectional dependence (CD)

After the descriptive statistics, the CD test is applied. This test is given by Pesaran in 2004 and explains the existence of cross-sectional dependence in the variable series. As argued by Dogan and Seker (2016) while conducting a panel study, the existence of cross-sectional dependence should be analyzed. The null hypothesis for the CD test is the absence of cross-sectional dependence. From the CD test outcomes reported in Table 3, there is sufficient evidence to reject the null hypothesis as the p value is less than 1% and shows the acceptance of the alternative hypothesis, thus confirming the existence of cross-sectional dependence among variables.

4.3 Unit root test

After the CD test, the unit root is applied which explains the stationary properties of the variables. Table 4 explains the results and shows that all the variables are non-stationary at the level and stationary at first difference I(I).

4.4 PSTR technique

In this technique, the linear test is performed at the first step to identify either the nexus between the variables is analyzed by the linear or nonlinear models. Table 5 explains the linearity test linearity result and shows that both Fisher test and Wald test have p value less

Table 3 Results of Pesaran (2004) cross-sectional dependence test *Source:* Authors' Estimation

Variables	Test statistics	p value
CEM	42.059	0.000
POP	52.697	0.000
GDP	33.201	0.000
URB	45.278	0.000
FDI	25.118	0.000

All variables are significant at 1% level

Table 4 Results of stationary analyses *Source:* Authors' estimation

Variables	Im, Pesaran and Shin			
	I(0)		I(1)	
	C	C&T	C	C&T
CEM	1.002	−0.025	−5.222***	−4.667***
POP	−0.587	−0.658	−4.378***	−4.127***
GDP	−1.001	−0.857	−3.990***	−4.104***
URB	1.058	0.019	−4.124***	−5.049***
FDI	3.257	−0.055	−3.994***	−4.014***

*, **, ***, indicate, respectively, the significance levels at 1%, 5%, and 10%

Table 5 Linearity test *Source:* Authors' Estimation

Threshold variable	Lagrange multiplies-Wald tests (LMW)		Lagrange multiplies-Fisher tests (LMF)	
	Statistics	<i>p</i> value	Statistics	<i>p</i> value
FDI	106.815	0.000	22.512	0.000

H₀: Linear panel model

H₁: PSTR model with at least two regimes

Table 6 Test of no remaining nonlinearity *Source:* Authors' Estimation

Threshold Variable	Lagrange multiplies-Wald tests (LMW)		Lagrange multiplies-Fisher tests (LMF)	
	Statistics	<i>p</i> value	Statistics	<i>p</i> value
FDI	7.497	0.382	1.201	0.598

H₀: PSTR model with two regimes

H₁: PSTR model with at least three regimes

than 1% implying the rejection of the null hypothesis of linearity model and the acceptance of the alternative hypothesis, thus concluding that the FDI employs a nonlinear and threshold effect on CEM and should be explored by the PSTR model.

Once the nonlinearity is confirmed in the second step, no remaining nonlinearity test is applied, assuming a two-regime model. Table 6 shows the rejection of the alternative hypothesis, and the null hypothesis of using PSTR with two regimes is accepted at 10% significance level. This result implies that the association between the FDI and CEM has one threshold and two regimes, and the PSTR technique with two regimes is enough to study this nonlinear association.

Table 7 shows the PSTR outcome, and in this result, the estimated values are more important than the estimated signs as they are not directly interpretable (Gonzalez et al., 2017). As seen from the results, the association between the FDI and CEM is significant and positive in low regimes, but as the economy progresses to the high regime the relationship becomes negative but significant. The least threshold value above which the association becomes negative is 4.228. The core idea behind this result is that a threshold point

Table 7 PSTR model estimations with financial system deposits

Variables	β_0	<i>t</i> -stats	β_1	<i>t</i> -stats
POP	0.632***	3.027	1.124***	2.965
GDP	0.758***	4.129	-1.286***	4.895
URB	0.359**	1.992	0.502**	2.125
FDI	0.159**	2.291	-0.338***	2.908
Threshold (<i>c</i>)	7.928***	4.228		
Slope parameter (γ)	23.255***	5.201		

β_0 , and β_1 stand for regime 1 and regime 2, respectively. ***, **, * indicate, respectively, the significance levels at 1%, 5%, and 10%

above which the FDI involves diminishes CEM. The result affirmed that at the initial level of development, economies are in a great need to receive FDI to achieve income and EG. To stimulate this, economies lower down their environmental standards, and under these conditions, the high-pollution industries are transferred to the host country which increases CEM. Moreover, the FDI inflows also improve the production capacity of the host economies and a large number of resources are consumed causing an upsurge in CEM. This finding is consistent with the work of You and Lv (2018), Ali et al. (2020) who claimed that using FDI developed countries shift their production to those underdeveloped countries who have weak environmental regulations. However, once reaching the desired level of EG, the economies start paying consideration to the quality of the FDI inflows and prioritized the entry of multinational corporations represented by the high-tech industry, advanced manufacturing jobs, and new service sectors and focus to invest funds to curb pollution, thus resulting in diminishing CEM. Likewise, the upsurge in FDI also improves the domestic industries production capacity and efficiency and subsidizes energy utilization in high-pollution firms resulting in a decrease in CEM. To sum up, this study supports both the pollution halo and haven hypotheses' which is in accordance with the work of Xie et al. (2020).

To sum up, the findings of these studies are different from previous studies which reported that FDI is negatively or positively correlated with CEM (Sun et al., 2017; Sung et al., 2018; Zhu et al., 2016). Our findings show that the association between the FDI and CEM is not simply negative or positive but varies dynamically with its own accumulation.

The control variable POP shows the positive and significant and association with CEM in both regimes. The outcome is similar with the work of Zhang et al., (2018); Salman et al., (2019); Acheampong (2019) and contrast with the study of Lv and Xu (2018) who reported the negative association. The upsurge in POP demands more energy utilization, deforestation, and extension of urban areas which consequences in CEM and environmental pollution. Moreover, POP growth effects in the depletion of natural resources much faster, deforestation, and extension of urban areas (Muhammad et al., 2020). In addition to this, an upsurge in POP leads to a greater demand for producing goods and large amount of energy use, and thus acts as prime reason for CEM (Xie et al., 2020).

The urbanization and CEM association is consistent in both regimes. It implies that urbanization has a significant and positive association with CEM. The outcome is similar with the work of Pata (2018); Ali et al. (2019). The outcome affirmed with environmental transition theory claimed that URB leads to an increase in energy consumption, infrastructure development, and transportation activities, which in turn increases environmental contamination (Sadorsky, 2014). The process of URB involves more traveling of people from rural and urban areas, across the cities which increases fuel demand, more traffic, and

pollution. Moreover, URB increases the infrastructure development and investment and mobility of the POP which upsurges the demand for energy usage and enhances the CEM (Shahbaz et al. 2017). However, the finding contrast with the study of Nathaniel and Adeleye (2021) who reported that as more population become urbanized there is an inclination to opt renewable sources which in turn declines environmental pollution.

The control variable EG shows the positive and association with CEM in the low regime, but the association between the two variables becomes significant and negative in the high regime. The result shows that a surge in EG upsurges the CEM, but after reaching a certain level, it minimizes the CEM which are consistent with the work of Saud et al., (2019); Mosikari and Eita (2020). The result implies that at early stage of development these countries are at early stage of industrialization and their activities upsurge the CEM level; however, after reaching a certain level their activities bring in negative effect on CEM level. The rationale behind this is after reaching a certain level of income, the MENA countries start pursuing in environmentally friendly industries. In other words, these economies have attained that level of income to minimize CEM through economic development.

5 Conclusion and recommendations

Considering the environmental degradation issue, the aim to achieve sustainable development has now become a priority and common goal worldwide. It is a policy to promote sustainable development for both society and the economy (Rusiawan et al., 2015). To achieve this sustainability, environmental degradation has gained the attention of scholars as it brings a hazardous effect on human lives and sustainability. However, CEM alone does not affect sustainable development; several factors act as the main root for CEM, among which FDI is identified as the significant predictor. Previously, the association between the variables has been explored using the linear association, but very limited studies have examined the nonlinear association. Therefore, this study gives new visions into the effect of CEM and FDI in MENA countries by using the yearly data comprised of the years 1995–2016. The results have been analyzed by using the PSTR technique. The result confirmed that the association between the variables is nonlinear. Secondly, the association between the FDI and CEM is positive and significant in low regimes. However, as the economy progresses to a high regime, the relationship between the two variables becomes negative and significant. Based on the results, several policies are suggested for MENA countries.

The study indicates that the FDI relationship with the environment is not durable as CEM can only lessen when the FDI reaches a certain threshold point. Thus, this means that the MENA countries should strengthen FDI usage in improving environmental quality. The government should cooperate with the rating organizations to choose efficient investments and impose strict obligations on foreign financiers. During the investment process, the financiers should be asked to share information related to the CEM.

Due to the threshold effect of FDI, the MENA countries should frame high standards related to the FDI and increase the threshold for FDI entrance. It should also be suggested that the government should give entry to those multinational companies that use and foster clean and green technologies and should also encourage foreign investors to use their capital inefficient and high-tech production. Moreover, to improve the existing industries' production process, the FDI should be used in technological innovation and up-gradation of

the existing industries into low-emissions industries. Lastly, the knowledge spillover from FDI multinationals to local companies' should be facilitated.

The result shows that URB increases CEM. To overcome the negative effect, it is suggested that the government should aggressively invest in human capital formation and rural infrastructures. This will help the smart cities emergence that focuses on innovation, sustainability, and efficient energy use in production, transportation, housing, and other economic activities. Moreover, the government should encourage industry agglomeration and green infrastructure investment. The industry agglomeration encourages economies of scale and industry collaboration which minimize energy usage and ultimately CEM. Moreover, the green infrastructure investment minimizes the extensive usage of steel, cement, and iron, resulting in a reduction of CEM.

The outcome also shows that the POP increases CEM. It is suggested that the government should implement regulatory policies that increase public awareness toward the adoption of renewable energy sources and motivate them to implement its usage in daily life by using solar water heaters, solar planes, etc. All these outcomes will minimize nonrenewable energy consumption and diminishes the CEM.

5.1 Limitations and Future recommendations

The research suffered from some limitations can be addressed in future research. The foremost limitation is related to the data availability resulting from which some factors of CEM such as ecological footprint and carbon footprints are not considered in the given model. Secondly, the threshold variable used in this study is FDI; other variables can affect the FDI and CEM nexus, so this study can be re-studied by considering them. This study focuses only on 17 MENA countries; the research can be extended by adding more MENA countries. The research can also be expanding by divided the MENA countries according to the micro and macro characteristics. Moreover, the study can be carried forward using the other region's dataset or using a single-country dataset.

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检索报告

委托人: 孙国岩
委托人单位: 南京审计大学会计学院
检索要求: 孙国岩发表的论文被 SCIE、SSCI 数据库收录情况及论文发表期刊的 JCR 分区情况。
检索时间: 2023 年 11 月 13 日

检索结果

本次检索根据委托人 孙国岩 所提供的论文目录及其检索要求, 通过对相关数据库进行检索, 结果如下:

1、收录情况

孙国岩以第一作者发表的论文被 SSCI 数据库收录 3 篇 (其中 2 篇同时被 SCIE 数据库收录);

2、分区情况

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检索结果详见附件 (共 5 页)。

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Teachers' self-efficacy and continuance commitment towards online teaching in the COVID-19 pandemic: A comparative analysis

作者

Sun, GY (Sun Guoyan) [1]; Khairi, M (Hakim, Faiza) [3]

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摘要

The coronavirus pandemic causes sickness and death, shutting down economies, damaging health care systems, and closing educational institutions. It has a profound effect on the education sectors, and most importantly, teachers' lives have been affected. This sector has been facing an immense change from traditional in-person classroom education to virtual education to alleviate its impact. Hence, the present study is designed to examine the impact of teachers' self-efficacy and system quality on teachers' continuance commitment towards online teaching in the COVID-19. Also, teachers' mental well-being has been added as a moderating variable. During a crisis like COVID, teachers are expected to show higher engagement through commitment. Both in Malaysia and Pakistan, the degree of loyalty in the teaching profession is a distinguishing characteristic. Hence, teachers of both countries are targeted for the comparative analysis. The results depict that the e-learning system quality and instructors' self-efficacy are critical factors in making the teachers willing to continue their online practices. However, assurance and educational quality do not play a significant role in the context of Pakistan. However, in the Malaysian context, results differ and reveal that instructors' responsiveness and information quality do not play a promising role.

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摘要

Currently, sustainable development has become one of the inevitable requirements for the country's economic evolution, as it encourages healthy and sustainable ecology for their people. To achieve this development, there is a need to decarbonize the energy system and minimize carbon emissions (CEM) because it brings a hazardous impact if left unabated. The motivation for this study is to analyze those factors that affect the CEM and threaten a sustainable environment. Precisely, this research explores the nonlinear association between CEM and FDI in the Middle East and North Africa (MENA) countries using the yearly data of 1995–2016. The Panel Smooth Transition Regression Model (PSTR) is applied, and the result confirmed that the nexus between the two variables is nonlinear. Moreover, it also shows that at a low regime, FDI increases the CEM, but as the economy progress to the high regime, the relationship between the two variables becomes negative and significant. The study also confirms that FDI can reduce CEM once it reaches a certain threshold point. Based on these findings, new insights are provided for the policymakers, and several policies are suggested to improve the environmental quality in MENA countries. It is also suggested that CEM and FDI should be considered while designing sustainable environmental policies.

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进一步了解

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Nonlinear impact of municipal solid waste recycling and energy efficiency on environmental performance and economic well-being of the USA

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摘要

Waste recycling significantly contributes to reducing carbon emissions and other greenhouse gases, leading to enhanced environmental performance and safeguards natural resources. Therefore, this study examines municipal solid waste recycling and energy efficiency's impact on the environmental performance and economic well-being of the USA. Some studies have emphasized the usefulness of MSW and its indicators, but most of them are survey-based and illustrate the scientific process of disposing of waste. Hence, the study intends to analyze the connection among considered variables using the recently developed and advanced estimation procedure of nonparametric causality in quantile approach by analyzing the quarterly dataset for 1990(Q1) till 2018(Q4). Through this technique, we have examined the causal relationships in different quantiles. The causality-in-quantile outcome indicates the acceptance of the null hypothesis in different quantiles, especially at low and high tail quantiles, while at some quantiles, the null hypothesis rejection is highlighted. This study suggests valuable implications for future studies, government, environmentalists, and policymakers.

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基于总体战略导向的勘察设计类企业财务转型研究 *

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摘要:新冠肺炎疫情导致实体基建项目减少、订单难以按时交付等问题对我国勘察设计类企业提出了新的要求。财务作为企业的重要职能支持者,其正确高效的转型已经成为勘察设计类企业未来发展的强大助力。鉴于此,文章聚焦于勘察设计类企业财务转型困境,在论述企业财务转型动因的基础上引入企业总体战略,探究以实现企业总体战略为根本目标的勘察设计类企业财务转型路径,并从业务流程、财务共享以及智能管理等方面为勘察设计类企业财务转型提供可行方案,以期促进我国勘察设计类企业的成功转型。

关键词:企业战略 财务转型 财务共享 勘察设计

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一、引言

勘察设计行业属于智力与技术密集型产业,是贯彻落实国家发展规划、产业政策和先进技术向现实生产力转化的关键环节,随着我国经济高速发展十余年后,勘察设计行业的整体增速开始放缓,整个行业进入变革期。依据住建部发布的《2020年全国工程勘察设计统计公报》来看,2020年全国勘察设计企业收入总计72496.7亿元,较上一年有所下降,其中作为新兴支柱业务的工程总承包收入同比减少1.7%,工程设计业务收入占比连续四年走低,从2016年的10.9%降至2020年的7.5%,行业净利率也达到了3.5%的历史最低点,行业整体从业人员也同比减少了5%。目前针对勘察设计行业而言,一方面,行业内部竞争加剧、固定资产投资增速下滑、新冠肺炎疫情引起的订单量萎缩以及回款困难等状况对勘察设计类企业发起了挑战,整个行业营业收入骤降成为不争的事实^[1];另一方面,“一带一路”倡议的实施、乡村振兴与交通强国计划的提出、大智移云物等新兴技术的成熟应用也在业务来源与技术提升方面为勘察设计类企业提供了宝贵的机遇。在机遇与挑战并存的大背景下,为了应对激烈的市场竞争,提高对环境的适应能力,企业需要在明确自身战略定位的基础上进行持续的经营理念与组织架构变革以谋求生存发展,转型升级成为了勘察设计类企业的必然选择,2015年发布的《中国制造2025》也明确提出了勘察设计行业要坚定不移走数字化与智能化转型升级的发展道路。

财务部门作为企业重要的职能部门需要具有战略思维,以企业总体战略的实现为核心,关注企业的未来长远发展^[2],致力于提高财务工作效率和企业管理能力,进行满足企业战略需求的财务转型。总体战略,即企业长期的、整体的发展目标,使企业针对自身特点与行业走势所制定的包含诸多细分战略的宏观概念。所谓财务转型,本质上是基于价值创造的一种管理理念,是持续长期提升企业价值的动态过程^[3]。高效的财务转型不仅能够帮助企业提高短期的经营业绩,也有利于帮助企业打造核心竞争力,为长期战略目标的实现打下坚实的基础。目前,我国大部分的勘察设计类企业普遍面临着财务与业务脱节、数据标准不一、信息孤岛^[4]等问题,严重阻碍了相关企业的财务转型进程,且相较于一般企业,勘察设计企业由于其存在众多的分、子公司,且产品多为图纸等知识密集型产物,其财务管理以及财务转型具有一定的特殊性。鉴于此,本文拟结合勘察设计类企业自身特点,对勘察设计类企业所面临的财务困境进行梳理,并在此基础上对于总体战略与企业财务的关系进行理论分析,进一步基于理论分析论述勘察设计类企业进行财务转型的必要性,并提出切实可行的转型路径,以期为我国勘察设计类企业成功实施财务转型,实现总体战略目标贡献一份力量。

二、勘察设计类企业财务职能困境与转型动因分析

(一)财务职能困境探究

随着勘察设计行业的内外部竞争环境愈发恶劣,相

* 本文系 2020 年度全国统计科学研究项目(项目编号:2020LY050);2021 年江苏省研究生科研创新项目“多方博弈下民营企业参与乡村振兴 PPP 的风险管控研究”(项目编号:SJCX21_0847)阶段性研究成果。

关企业亟需进行战略变革,拓宽业务范围以谋求发展,然而现有的基本财务职能无法满足勘察设计企业提质增效,全面转型的战略需求。通过走访多家大型勘察设计企业并结合有关资料,本文对现阶段我国绝大多数的勘察设计企业财务职能的不足与所处困境进行了梳理总结。具体而言,目前我国勘察设计企业财务职能方面主要存在以下不足:

(1)财务人员青黄不接,“质”“量”堪忧。为了抓住战略发展机遇、进一步提升市场份额、打造新的利润增长点,我国绝大部分勘察设计类企业开始将业务重点转移到总承包、EPC以及PPP等新兴项目领域,这就对企业财务人员提出了更高的要求。一方面,现有财务人员仍拘泥于传统核算业务,整体能力相较于企业发展远景存在不足,对于企业业务方面的掌握欠佳,缺乏“从上观察”的手段,对企业愿景、战略以及业务没有进行深入了解,难以从企业战略目标出发为企业发展提供专业支持。另一方面,随着人口红利的衰退以及勘察设计行业盈利能力的下降,勘察设计企业对于人才的吸引力正在减弱,愈发难以吸纳具备综合财务能力的高端复合人才。新进人才数量短缺,原有核心人才大量流失的困境极大程度上阻碍了勘察设计企业的财务职能开展以及财务转型工作。

(2)业财协同错位错配,尚存提升空间。由于勘察设计企业的工程咨询、工程承包业务等专业性较强,财务人员往往对业务流程知之甚少,对业务活动的了解不深,使得一项新业务的事前事中分析评估仅停留在财务或业务数据表面,难以深入业务本质发现和分析问题。同时,业务和财务部门的目标难以协调,业务部门一般关注的是营业收入、市场拓展以及合同签订数量等与自身绩效相关的指标;而财务部门往往关注经济业务的价值、项目成本、预算以及风险等因素。由于双方的关注和侧重点不同,可能会引起矛盾,增加相互间的沟通成本。项目与财务由于数据口径不同,往往需要二次甚至多次加工才能得以有效使用,降低业务与财务部门效率的同时也可能由于及时性的缺失滋生新的风险。

(3)财务管理链条过长,智能化管理程度较低。目前,虽然各大勘察设计企业都相继建立了自己的财务管理信息系统,但由于勘察设计类企业所涉及到的生产对象差异较大,导致了单一项目的可复用程度极低,财务与业务数据之间的标准化难以得到保障;另一方面,勘察设计企业的财务管理系统仍处于照搬传统制造业财务管理系统的阶段,但是由于产出的不同,适用于传统制造业的量本利分析、作业成本法等财务分析方法并不适

用于勘察设计企业,财务管理智能化程度的低下在一定程度上阻碍了我国勘察设计企业的健康发展。现阶段各大设计院所通用的“两级管理,三级核算”财务管理体系,通过设立本部、事业部以及项目部对于合同签订、预算编制、收入确认、经费拨款进行分级财务核算,将核算链条拉得过长,各个部门以及各个核算流程之间常常发生数据口径不一、财务信息失真等问题,在一定程度上降低了勘察设计企业的财务工作效率,进而影响了企业总体战略的正确执行。

(二)财务转型动因分析

财务转型的实质是将财务工作的重心从会计核算转移到管理控制和决策支持。因此,企业财务工作不能局限于对业务活动进行核算、记录和辅助,财务部门需要从幕后的职能支持部门变换为业务伙伴,从原有的成本控制中心变成企业的价值创造中心。企业财务要从关注本职工作,积极向支持组织的管理控制、为各层级管理者提供决策信息转变。如图1所示,企业的财务转型是一个动态的、持续的转化过程,其核心是由核算型财务逐步转变为管理型、战略型财务,这就要求企业加强对新兴技术的使用,树立财务转型理念,由注重财务会计向重视管理会计、战略管理会计转变,即财务工作要从专注于本职工作转变为关注企业内部管理乃至外部的战略环境。

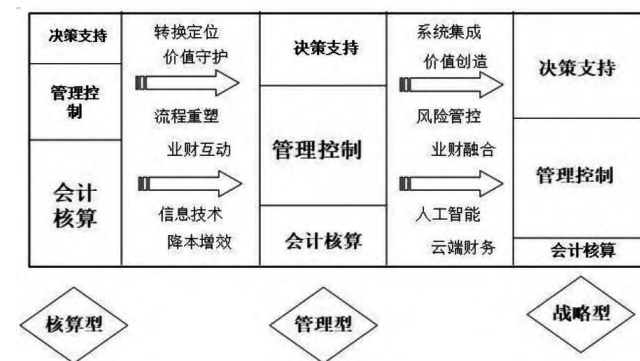


图1 财务转型趋势图

对于勘察设计类企业而言,宏观经济政策不确定性的加剧、“大智移云物”等新兴技术的发展以及外部竞争的白热化,使其面对日益复杂多变的外部环境。为了应对激烈的市场竞争,提高对环境的适应能力,勘察设计类企业迫切需要进行相应的战略、业务和组织架构调整,这一系列内外部环境的变化都对勘察设计类企业的财务工作带来了挑战。无论是企业整体的战略目标或是具体的战略执行,都要求财务部门提高基本会计核算和资金管理的业务处理效率以满足企业经营的日常需求,

增收机制以及提升企业分包议价能力成为了大行业背景给财务部门出的新考题,同时,为了加强对业务活动的支持,财务部门还需与业务部门进行高效沟通和协作,通过全面预算管理、经营绩效分析等活动为企业内部管理控制提供助力。最后,财务部门需要提升对业务、财务信息的整合利用能力,并通过投融资活动、税务筹划以及成本控制等手段,帮助企业进行价值创造,以提高财务工作对企业战略决策的支撑作用。综上所述,我国勘察设计类企业的财务转型已经刻不容缓,只有这样才能构建高效、精简的财务管理模式,进而帮助企业应对复杂的内外部环境,实现组织总体战略目标。

三、企业战略影响财务转型的“三重”路径解析

企业总体战略的核心目标是价值创造,要达成这一目标:一是通过资本进行价值创造;二是通过业务进行价值创造,两者都离不开财务部门的支持。具体而言,要实现组织战略目标,企业财务可以通过投融资管理、资本运营、纳税筹划等手段使现有资金实现增值;或者通过成本控制、绩效管理以及信息支持等手段助力核心业务以及相关支持性活动的开展,实现价值创造的目的。因此,一方面,企业的战略规划会对财务工作产生直接影响,对其提出更高的要求;另一方面,企业战略执行过程中的业务活动、支持性的职能活动以及组织结构的调整也会对企业财务产生“倒逼”影响。

企业战略对财务活动的影响路径见图2,企业需要在深入分析内外部环境的基础上,结合企业愿景和目标进行相应的总体战略规划,这对企业财务提出了整体要求,即企业财务需要发挥降本增效和价值管理的功能。企业战略的执行必然会落实到业务活动上,因此企业需要聚焦主业以塑造核心竞争力,以此助力战略目标的实现。而战略执行过程中开展的业务活动、支持性活动以及组织结构调整等都需要财务部门进行相应的支持,这就需要财务部门提高财务服务质量、加强相关风险管控,协助业务部门提高绩效。但由于企业现有财务管理模式难以满足相关要求,因此,企业需要进行财务转型,以构建适应企业战略需要的财务管理模式。下文将结合已有研究展开企业战略影响财务转型的理论分析。

(一)总体战略目标锚定财务转型方向

首先,外部竞争的加剧势必要求企业深化内部挖潜,降本增效,提升经营管理水平,倒逼企业财务转型。会计核算和财务管理是财务部门最基本的职能,在企业经营管理中起到重要支持作用。企业无论是开展业务,还是进行管理控制和战略决策,都离不开会计核算、财

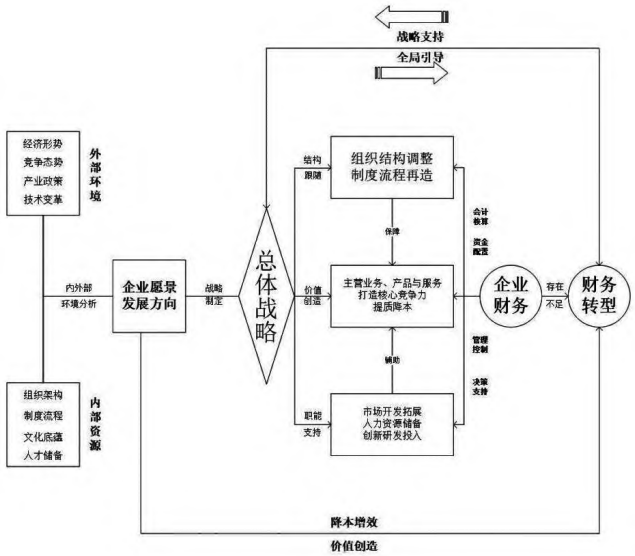


图2 企业战略对企业财务活动的影响

务分析以及资金的筹集和分配。因此,在企业竞争日益加剧的背景下,战略导向下的企业财务必须高效完成本职工作,提高基础业务处理和资金配置效率。

其次,企业财务不能仅局限于为企业经营发展提供资金支持与核算服务,还应具有一定的独立性,努力解决企业风险与收益、收益与成长性、偿债与盈利等一系列矛盾问题^[9]。随着经济环境日趋复杂,企业必须提升精益化管理能力,需要财务部门发挥管理控制和决策支持的作用,以提升企业的核心竞争力和价值创造力。财务部门应在高效完成财务本职工作的同时,参与到企业经营的风险评估、盈利测算过程中,充分发挥财务专业顾问的作用,成为企业的风险守护者与价值缔造者,通过为管理层和业务部门提供足够的数据分析、业务支持和决策辅助,助力企业战略目标的实现。

最后,企业的战略目标是企业对其战略执行结果的期望。因为企业是价值创造的实体,所以无论其具体的战略目标是行业领先还是市场引领,其终极的战略目标始终是持续的价值创造。而财务作为企业战略的一个子系统,必须支持并贯彻企业战略的总体要求和目标,所以财务管理和企业战略具有相同的目标:价值最大化。魏明海等^[10]认为企业财务需要在战略目标的统筹下,提高企业资金的营运和管理能力,以此保持企业长期、稳定的发展。因此,财务除了为战略提供会计核算和资金管理等基础服务,以及管理控制和决策支持等高价值服务外,还要充分发挥财务的主观能动性,通过投融资活动、税务筹划以及成本控制等手段,帮助企业直接进行价值创造。

(二)执行业务活动夯实财务转型细节

企业的战略目标是价值最大化,从战略决策到最终经营业绩之间需要经历一个价值创造过程,虽然财务部门可以通过资本运作、成本控制等手段直接创造价值。但若仅将资本运营作为财务工作的重心可能会导致不良后果,如为了短期的利润目标,而忽视创新研发、市场培育、人力资源开发等方面的投入,削弱企业未来的竞争力和成长性,导致企业长期利益受损。因此,企业必须聚焦主业,通过生产、经营等具体业务实现价值链增值,而这就需要财务部门强化服务理念,为业务活动以及相关辅助性的工作提供支持。

由于企业的内部资源、所处行业以及市场环境等内外部情况各不相同,企业需要在战略目标的指引下选择具体经营模式和业务战略,导致企业战略对财务提出不同的要求^[7]。例如,为了配合企业的多元化战略,公司在经营活动中需要关注创新与变革,因此,企业财务要善于利用外部融资和财务杠杆探索市场发展机遇,促进企业的创新投资。此外,多元化战略可能会分散企业的风险,导致企业财务选择低现金持有的策略^[8]。因此,企业财务需要根据相应的竞争战略以及业务特点,选择合适的投融资、资金分配策略。而除了具体的业务活动,企业财务也应为与业务相关的市场营销、人力资源、研发创新等支持性活动提供会计核算及财务资源分配等服务,以提高相关工作的效益。企业财务不能仅仅被动地满足业务部门的需要,而是要主动将财务工作延展至全业务流程,结合企业目标与业务,发挥财务的资源配置作用,加强内部控制,实现精益化管理的作用^[9]。通过深度的业财融合对实际经营情况进行精确的分析评估,进一步提高财务信息的真实性和全面性,为经营决策提供有效的信息支持。

(三)优化组织结构加快财务转型进度

Chandler^[10]提出了“结构跟随战略”这一命题,认为组织结构与企业战略的匹配有助于提高企业经营绩效。即组织结构应跟随企业战略进行相应调整。李力和陈龙^[11]研究发现我国企业战略执行力不强的原因主要是集团组织设计与战略管理相脱节,致使企业战略执行力缺乏组织保证。因此,为了企业战略的实施,实现企业运营成本的降低、财务效益的提升,企业有必要进行组织调整和财务流程再造。组织结构划分了财务部门、其它职能机构以及相关业务部门的权责关系,避免了由于职责不明确所导致的战略执行中的阻碍,使企业经营活动得以高效协调的展开,进而保障企业战略目标的实现。随着组织结构的变革,业务和部门逐渐分散化,若给每

一个分子公司都配备相应的财务结构可能会导致组织结构臃肿、效率低下。因此,可以考虑利用智能网络信息技术,做到互联网与传统财务会计管理深度融合,把财务会计服务职能从线下转移到线上,打破时间和地域限制,从而促进财务管理的自动化、智能化。

四、基于总体战略导向的勘察设计类企业财务转型具体措施

(一)总体目标层面推进制度流程再造,加速财务管理集约化

随着勘察设计企业规模的扩张和组织架构的调整,企业对于各分支机构的管控能力势必有所下降。因此,企业要重视制度流程的建设,对现有的企业规章制度和业务流程进行梳理再造,以此来提高财务工作效率和财务管控能力。

首先,企业需要完善顶层制度设计,加强内部控制制度建设,从而强化对下属分支机构的管理,以贯彻落实总体战略的执行。与此同时,财务制度作为企业总体战略在财务层面的具体体现,需要紧密围绕总体战略进行革新转型。进行财务转型,需要企业各层级和各部门间强化沟通协同,而为了提高财务与业务部门间的协同效率,企业还应建立相应的激励制度和定期沟通机制来促进各部门间的协作。勘察设计企业要从总体层面完善会计核算、资金、资产以及预算管理等规章制度,促使企业核算与财务管理等业务的标准化、规范化,从而降低由于组织规模的扩张和机构的调整引起的财务工作低效性与无序性。

其次,企业财务部门要提高服务意识,结合业务部门需要,遵循全局统筹和整体最优的原则,建立起完善、高效的财务工作流程,并将推行到下属分支机构。针对和业务部门密切相关的财务工作流程,如合同管理、资金划拨、财务报销以及预算管理等活动要形成详细、具体的操作细则,在提升财务工作效率的同时,使得业务部门能够充分了解相关的财务工作流程,降低业务、财务部门在日常工作中的沟通成本。

最后,企业需要在集团层面整合统一相关的技术、编码和定义标准,使集团总部与各事业部、区域中心以及分子公司等分支机构具有相同的会计科目、账套以及核算流程,进而消除财务信息孤岛,提高财务工作的处理效率,实现财务的集约化和标准化。

(二)组织结构层面建立财务共享中心,缓释人员调配压力

要实现财务转型,财务人员必须将工作的重心从会

计核算转移到企业管理控制、决策支持以及价值管理等高附加值的财务工作中。建立财务共享中心是实现财务转型的重要一环。传统的财务会计核算模式工作效率较低,且信息处理速度较慢,难以对企业管理和战略决策提供助力。对于勘察设计企业而言,其下属的区域中心以及分支设计院往往数量众多,混乱的合同管理以及数据口径不一等问题严重削弱了财务工作效率,并且由于勘察设计企业现金流前置的业务特点,相较于其他企业更需要准确及时的财务分析。通过建立财务共享中心,企业可以实现财务数据的及时共享、合同文件的统一审批,并批量处理总部与各下属子公司的账务工作,有助于对财务数据进行更为高效和及时的分析,为企业的经营管理和战略决策提供更精准及时的信息支持。就勘察设计类企业而言,其建立财务共享中心可能存在以下收益:在集团统一的会计政策框架下和财务处领导下集中规范的处理会计核算业务,减少人为干预,防范财务舞弊和政策执行偏差,进而加强对分支机构的财务管控;优化业务流程,减少中间环节及其可能存在的风险,保证财务信息的准确和及时性;利用少量财务人员集中处理大量重复的基础核算业务,无需向各分子公司再委派财务主管,降低财务核算成本的同时有助于解决财务人员配置难题;利用信息化系统处理业务优化流程,提高效率,使财务人员能够腾出精力,帮助企业实现管理能力的提升,为各层级管理者提供及时有效的信息支持;在项目开展初期,进行未来原料价格走势分析,买入看涨或看跌期权,套期保值以缓释现金流前置带来的资金回收风险。

(三)业务执行层面充分利用新兴技术,打造智能财务管控模式

结合现阶段我国大部分勘察设计类企业发展情况来看,完善制度流程,实施财务共享,已经能够基本满足其提高财务工作效率和企业管理水平的需要,但还无法帮助其实现“弯道超车”,建立核心竞争力,达成组织的战略目标。因此,企业需要进一步提高财务工作效率,加强财务工作对企业管理和决策的支持。随着“大智移云物”等新兴技术的发展,企业财务信息化已逐步演化到财务智能化阶段,虽然现阶段的财务智能还处于探索阶段,并没有真正意义上的人工智能型财务,但一些能够处理简单重复核算工作的财务机器人已经开始得到应用。对于企业而言,在这一阶段要充分利用新兴技术,如利用图像识别进行凭证的录入和处理,将企业财务服务由线下拓展到线上,打破财务工作的地域与时间约束,进一步提高财务工作的效率。



通过引入RPA(机器人流程自动化)实现集团预算管理和审批流程自动化,会计凭证与财务信息数字化,账务处理与财务分析智能化,可以推动企业财务活动和数据的公开化、透明化,为各层级人员提供信息支持。在这一阶段,企业一般的事务性财务工作均可以由财务机器人完成,如智能的税务筹划、预算管理以及风险提示,自动的凭证录入、审核、报表生成和分析,通过云端进行线上的会计业务处理,智能型财务可以24小时全天候的运行,不仅大大提高了效率,节约人力成本,且基本可以实现零失误。对于勘察设计企业而言,通过综合利用大数据以及云计算等技术,可以在招投标阶段更好地评估合作方的资信与财务状况;在合同签订阶段可以根据对方的履约记录、信用等级来调整相应细节条款;在项目实施阶段,可以综合捕捉并分析市场数据,整合物价上涨、通货膨胀以及利率波动信息并做出效应财务调整。

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Teachers' self-efficacy, mental well-being and continuance commitment of using learning management system during COVID-19 pandemic: a comparative study of Pakistan and Malaysia

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ABSTRACT

The coronavirus pandemic causes sickness and death, shutting down economies, damaging health care systems, and closing educational institutions. It has a profound effect on the education sectors, and most importantly, teachers' lives have been affected. This sector has been facing an immense change from traditional in-person classroom education to virtual education to alleviate its impact. Hence, the present study is designed to examine the impact of teachers' self-efficacy and system quality on teachers' continuance commitment towards online teaching in the COVID-19. Also, teachers' mental well-being has been added as a moderating variable. During a crisis like COVID, teachers are expected to show higher engagement through commitment. Both in Malaysia and Pakistan, the degree of loyalty in the teaching profession is a distinguishing characteristic. Hence, teachers of both countries are targeted for the comparative analysis. The results depict that the e-learning system quality and instructors' self-efficacy are critical factors in making the teachers willing to continue their online practices. However, assurance and educational quality do not play a significant role in the context of Pakistan. However, in the Malaysian context, results differ and reveal that instructors' responsiveness and information quality do not play a promising role.

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1. Introduction

The early spring of 2020 in the Education sector has been experiencing an exceptional and immense change from traditional in-person classroom education to virtual education (Daniel, 2020). It resulted from the widespread coronavirus (COVID-19). This massive modification in an ancient practice of teaching changed many educational theories and practices worldwide. In a short period, millions of teachers continued their jobs by sitting in front of a screen, as their students have to stay at home and complete their courses through the internet (Abeyaratne et al., 2020). This practice became a success in present situation, but it highlighted numerous issues and drawbacks of the educational sector (Holmes et al., 2020). However, in international institutions, e-learning is a normal practice. Even before the pandemic, many universities were offering online programs but in developing countries such as, Pakistan, relying completely on online education require rapid implementation of advanced technologies (Buglio et al., 2014).

Human rights, suicide, domestic abuse, and feudalism all play a role in Pakistan's socioeconomic status. Malaysia has effectively decreased severe poverty and developed shared prosperity during the last 50 years. However, other concerns include being abused, committing crimes, facing challenges to work, housing conditions, and overcoming challenges to education. Over the last two decades, Pakistan's economy has grown steadily. The annual per capita increase has been around 2% on average. On the other hand, Malaysia's economy is now on the rise since the Asian financial crisis. Similarly, education sectors of both countries are different from each other. Pakistan is ranked 152 out of 189 countries in the United Nations Development Programme's (UNDP) Human Development Index (HDI) ranking, according to the Human Development Report, 2019. Unfortunately, Pakistan has not exhibited improvement in key educational indicators, such as literacy rate, gross enrolment ratio, and expenditure on education. In contrast, the Malaysian Education system is following international standards. Many international universities have their campuses in Malaysia as well. Their system is based on European and American standards. They have almost Top 10 World's best universities. There are campuses of Universities of USA and Australia. These universities are offering the twinning program as well i.e. you can do one semester in one country and can transfer into another university for remaining semesters. The Malaysian government is especially focusing on quality education. Therefore, Malaysia has become an attraction for lots of students in the South Asian region.

Introducing Learning Management Systems (LMS) in Pakistani institutions has given a chance to re-evaluate the whole educational system at a higher educational level. Education is not limited to physical learning anymore; modern technical developments have allowed offering education easily. Within this circle, it is particularly necessary to assess the views of teachers as their concerns relating to LMS and online learning would be beneficial in making this an efficient educational practice (Farid et al., 2015). Unlike the Pakistani government, the Malaysian government took an urgent step towards the online learning program in the global pandemic. However, the issues faced by both Malaysian and Pakistani teachers are more or less the same. According to several types of research, the teaching profession face a high rate of discomfort, dissatisfaction, a higher workload, and stress. These issues have leveled up within this pandemic and made online teaching difficult for several teachers. Due to COVID-19, teachers around the world faced numerous and continuous negative changes in their teaching structures. The comparison of Pakistani institutions within this perspective is made with Malaysia. This research, therefore, identifies the approach of Pakistani and Malaysian teachers' commitment towards online teaching with a keen reference to their self-efficacy and mental being.

The core variables of the research are the teachers' self-efficacy and system quality. According to Haverback (2020), the common beliefs of teachers' self-efficacy may show differences in terms of their teaching on a virtual platform. Regarding the past research, these differences and changes are worth demonstrating as the self-efficacy changes have proved to be effective in students' performance. Before this pandemic, past research based on teachers' self-efficacy shows that higher self-efficacy is correlated to positive educational practices (San-Martin et al., 2020). At the same time, the lower self-efficacy of teachers has proved to be a drawback for students' classroom performance. In terms of teachers' self-efficacy, assurance, empathy, and responsiveness in a pandemic are studied in depth in this research. The difference in teachers' self-efficacy is due to systematized experiences. Therefore, in this pandemic situation, the experiences are different from past experiences (Allen et al., 2020). Some of the changes in this experience are related to the usage of new technical changes, uncomfortable with the screen time, and limitations with feedbacks, etc. These pointers are discussed in detail with the tenants of self-efficacy theory.

A growing number of universities both in Pakistan and Malaysia have adopted the practice of online learning. Using an online portal requires teachers' dedication to learn new technology. Sudden change results in several negligence and hurdles in the path of learning. Teachers often face such issues because of the lack of guidance, shortage of resources, poor services by administration, and inadequate trainings. Hence, it is necessary to ensure system quality. According to

Butcher and Wilson-Strydom (2013), the system quality in online learning relies on concentrating on the prominent measures, a well-maintained systematic approach, continuous improvements, and emphasis on the investment process. Apart from these pointers, several particular challenges are problematic for teachers.

Usage of LMS in covid-19 has helped in examining the mental well-being and continuance commitment of teachers. Teaching in covid-19 is carried out using a Learning Management System (LMS), an interactive and real-time platform on the internet that aims to provide a high-quality educational experience. This platform connects students to resources while also encouraging the formation of a virtual relationship between teachers and students. Establishing an e-learning system at an educational institution is a lengthy process that demands a large amount of time and effort. There are several crackups of e-learning that might affect teachers' mental well-being but once they learn the LMS so ultimately it will result in efficient performance. Hence, LMS decrease the human work and allow teachers to utilize time effectively. So, proper guidance, relevant trainings, resources, and support are the crucial factors that foster teachers' commitment. In the form of a significant financial commitment and institutional acknowledgment of devotion, institutional support is also required for successful implementation.

This paper aims to study the teachers' continuance commitment towards online teaching in the COVID-19 pandemic within the dimensions of educational quality, information quality, service quality, and technical system quality, along with teachers' assurance, empathy, and responsiveness. During a crisis like COVID, teachers are expected to show higher engagement through commitment. Both in Malaysia and Pakistan, the degree of loyalty in the teaching profession is a distinguishing characteristic (Rashid et al., 2020). Additionally, Pakistan and Malaysia are the major targets of the present study because both countries are developing states. Also, both countries collaborate in many sectors, especially in higher education. In Malaysia, thousands of Pakistani students are doing Masters and PhDs. Malaysia is considered to be an essential asset as it provides human resource development for Pakistan. Further, in Malaysian universities, many famous professors of Pakistan are serving. Thus, a collaboration between two brotherly nations is excellent and will grow further in the future.¹ It is crucial to compare both countries at this stage because it will give us an insight into how teachers of both nations are different from each other. Also, the efficiency of the LMS system can be assessed based on mental well-being, service quality, and self-efficacy. Hence, through this research, we can analyze how the teachers of developing countries commit to using LMS.

This study contributes to the educational literature in three ways. Firstly, this research provides an in-depth analysis of the role of teachers' mental well-being and self-efficacy in the COVID-19 pandemic situation. Secondly, this is a comparative analysis as the purpose is to compare the teachers' continuous commitment in both countries, i.e. Pakistan and Malaysia. Hence, it will provide new insights into how in this pandemic both countries' teachers respond and whether they will depict commitment in the upcoming time. Lastly, we have incorporated teachers' mental well-being as a moderating variable because, recently, educational practices have shifted, and teachers are working day and night. Educational institutions are demanding more efficiency and hard work; thus, mental well-being is the primary factor. However, the major modification in this research is related to the recent pandemic of COVID-19. Previous papers related to online learning have not yet explained the implications of online learning on teachers. So, this study will provide new insight, and also it will contribute to the international forum as well.

Following the introduction, the second chapter, literature review, discusses an analysis of the research question, emphasizing the theoretical foundations of the paper's hypothesis. Further, the third chapter, methodology, illustrates the techniques used for the investigation of analysis. The fourth chapter discusses the data collection and the outcomes that are gathered. Finally, the fifth chapter concludes the research that reflects the research outcomes, with future suggestions.

2. Literature review

2.1. Theoretical background

Many kinds of research are available that show how efficiency and competitiveness are improved in the teaching sector. These researches have proved that continuance commitment is a dynamic pointer that highlights a successful performance (San-Martín et al., 2020). The theory of continuance commitment is a psychological state that characterizes the relationship between an employee and an organization; it also reflects the recognition of costs related to leaving that organization.

The theory of continuance commitment has been studied in both education and human resources. In literature, this commitment has influential factors on the performance of an individual. Existing literature has found how this commitment is related to continuing an individual's traits within an organization (Meyer et al., 2019). Overall, these researches are also related to the commitment towards traditional teaching in academia. Within this research, teachers' continuance commitment is highlighted in virtual teaching as it has an important role in higher education. From the perspective of online teaching, numerous findings from the literature show the consequences and impacts that affect teachers' commitment.

This aspect has also attracted several individuals to educational research during COVID-19. According to, San-Martín et al. (2020) application of online teaching has shown various important ideas in an educational institution and how these institutions recognize the contributions that teachers perform. Normally, in traditional teaching, professional competency results in continuance commitment (Ahluwalia & Preet, 2018). Similarly, this perspective is mentioned by numerous researchers as it is also interrelated with the well-being of teachers. However, the continuance commitment theory is studied by various researchers in the context of traditional teaching that is why the researches related to continuance commitment theory are limited. To date, the present researches related to continuance commitment to online learning narrates the success of online technology in the field of education (San-Martín et al., 2020; Raza et al., 2021a). Discussed literature proposes that to utilize online portals for teaching, teachers must be developing a personalized continuance commitment towards it. This theory of continuance commitment suggests that after initially accepting an LMS, teachers continue their teaching activities in a well-performed pattern. According to Kiral (2020), continuance commitment is driven by the cognitive beliefs of teachers as it is useful for predicting future activities. Overall, the whole e-learning platform is affected by several factors that can change many teachers' experiences. To understand these factors and their relationship with the continuance commitment, several models and hypotheses are generated.

Previous papers have involved prominent theories and models in explaining a similar concept. The used model within this research explains the research topic by considering the previous theories and similar models. The core variables mentioned in this model are self-efficacy and system quality. Within the dimensions of self-efficacy, the variables are the instructor's assurance, the instructor's empathy, and the instructor's responsiveness. Secondly, within the dimensions of service quality, the variables are educational quality, information quality, service quality, and technical system quality. As mentioned before, the moderator of the model is the teacher's mental well-being. Two of the most common theories within this perspective discussed in previous papers are Organizational Support Theory and Psychological Contract Theory. The first theory proposes that employees always form a generalized perception that concerns how an organization values the contributions and cares about their well-being. Moreover, Gökyer (2020) proposed that the Psychological Contract Theory is about the beliefs of obligations between individuals and their exchange partners. These theories are incorporated within usage continuance commitment during COVID-19 (Sariwulan et al., 2019).

2.2. Hypotheses development

2.2.1. Teachers' assurance and continuance commitment

Teachers' assurance is an indicator of knowledge and skills that inspire confidence as a professional in a teacher. This variable is one of the most common tools to evaluate the quality of teachers. Instructors' assurance can measure the ability and clarity of the course content on the instructors' part (San-Martin et al., 2020). Xiao and Wilkins (2015) stated that the assurance of the instructor is considered an important factor in both traditional and online learning. It leads to the positive effects on the experience of users towards e-learning (de Araújo et al. 2016). Furthermore, Klassen and Chiu (2011) claim that continuous assurance of instructor is considered a predecessor of continuance commitment. Khan et al. (2014) highlight the role of institutions in increasing the assurance of instructors; this includes the commitment and satisfaction towards teaching.

H1: Teachers' assurance influence and impact their continuance commitment

2.2.2. Teachers' empathy and continuance commitment

The empathy of a teacher is related to the concerns, understanding nature, and attention provided on an individual level to their students. It helps the students in confidence, encouragement, and critical thinking skills (Kimiloglu et al., 2017). The empathy of an instructor has a direct impact on the continuous commitment. According to Farid et al. (2015), if an instructor understands a student's issues and difficulty level, it is easy to produce a high level of continuance commitment. As endorsed by Allen et al. (2020), this further includes the social and emotional issues faced by the instructors on an international level.

Moreover, various explored researches highlight how empathetic teachers are more motivated towards their tasks, resulting in high continuance commitment (Ashrafzadeh & Sayadian, 2015). Empathetic instructors are beneficial and valuable for the institution and students' future; this further determines how individuals influence others on a higher level (San-Martín et al., 2020). Meyers et al. (2019) suggested that medical students have shown more interest in their courses if the instructor was more empathetic towards them. Likewise, it is a possibility that empathetic teachers could make online learning an easy process.

H2: Teachers' empathy influence and impact their continuance commitment

2.2.3. Teachers' responsiveness and continuance commitment

The teachers' responsiveness is also related and impacts the quality of LMS and continuance commitment. It means the willingness to help students on time and provide them rapid facilities (Kolluri et al., 2020). According to Gensler (2020), instructors' responsiveness is considered as a teacher and student-centered approach. As Kavanagh et al. (2020) emphasized, instructors' responsiveness leads to negotiation between teachers and students, leading to their equal engagement that develops the process of reshaping new ideas. Instructors' responsiveness leads to create an automated engagement between teachers and students (Aas, 2019). One of the studies conducted by Berkel et al. (2011) suggested that students' responsiveness is unnecessary to involve in this construct. At the same time, LoCasale-Crouch et al. (2016) imply that instructors' responsiveness creates a relation between quality and changes in instructional practices.

H3: Teachers' responsiveness influence and impact their continuance commitment

2.2.4. Educational quality and continuance commitment

Educational quality is explained as providing an authentic learning environment to students by providing them a collaborative learning platform of LMS (Bibi & Ali, 2017). The quality of education is one of the most common factors that directly impact the continuance commitment. This factor directly concerns the interactive capacity of the used LMS. This quality further influences the perspectives of teachers and students in a larger context in terms of its usefulness (Cheng & Gan,

2020). Quality of education emphasizes the professionalism of an individual. According to Erdogan and Cavli (2019), instructors' effective attitudes influence the organization's commitment. Onukwu et al. (2019) stated that educational quality increases students' interests and empowers instructors' commitment. As Agung et al. (2020) proposed, the lack of high educational quality has a high chance that instructors may lose their enthusiasm and dedication. Another researcher highlighted how students also are affected by the quality of education. According to Akar (2018), the loss of dedication of the instructor would directly impact the learning process of students.

H4: Educational Quality influence and impact continuance commitment

2.2.5. Information quality and continuance commitment

Information quality is related to the information and content that teachers generate by using an LMS (McKnight et al., 2017). This exchangeable information must be complete, relevant, up to date, and accurate to make the e-learning process an effective practice (Liu et al., 2016). The quality of information is constituted based on timely learning (Izogo, 2017). This is why students require good material that has to be easily understandable in various formats according to the psychological level of students. After reviewing related literature, Nulhusna et al. (2017) stated that they would consider the information organizers reliable and trustworthy if users can find accurate information. Hence, good quality of information is useful in improving the beliefs towards the online platform. Lee et al. (2017) perceived that higher information quality increases trust towards the system. Xiao et al. (2018) mentioned in their research that the accuracy of information is advantageous for institutions, students, and teachers all at once. Furthermore, this develops interpersonal trust.

H5: Information Quality influence and impact continuance commitment

2.2.6. Service quality and continuance commitment

Service quality is known as technical support any LMS user receives when a technical issue is experienced (Andrew, 2017). In increasing the service quality, the designated LMS individual must resolve the issues related to technology to provide a user-friendly platform that brings out user satisfaction (Sharma et al., 2016). This quality of service is based on the overall evaluation of the services that are being received (Daghan & Akkoyunlu, 2016). According to Jaiswal and Dhar (2016), service quality directly and positively influences the relationship of trust between two individuals or groups. Further proposed by Mou & Cohen (2015) proposed that service quality is a statistically significant antecedent of trust in continuance commitment. It further adds a direct impact on the students using an LMS. Pham et al. (2019) highlighted how institutions, instructors, and students are interconnected with the impacts of service quality.

H6: Service Quality influence and impact continuance commitment

2.2.7. Technical system quality and continuance commitment

The operational success produced by an accurate and efficient platform with which an LMS is reproduced and can deliver the required information is defined as the technical system quality (Valaei & Rezaei, 2016). The technical quality system is an important aspect of online learning (Dağhan & Akkoyunlu, 2016). According to Ramjeawon and Rowley (2017), a good technical system quality has to be reliable, tangible, competent, credible, and trustworthy towards students. Based on the literature proposed by Uddin et al. (2019), higher technical system quality leads to user satisfaction in the case of an LMS. According to Panigrahi et al. (2018), positive outcomes from an online platform positively impact new individuals' enrollment. In another context, low technical system quality leads to issues within the context of continuance commitment (Parvathi, 2019).

H7: Technical system Quality has a significant impact on continuance commitment

2.3 Moderating role of teachers' mental well-Being

This study proposes that teachers' mental well-being can be considered one of the abilities that correlate with the instructor's self-efficacy and system quality. Well-being, in general, entails the harmony between the human mind and body. According to Holmes (2005), the mental well-being of teachers is associated closely with intellectual well-being. Silver and Zinsser (2020) states that mental well-being is a state in which individuals know their abilities, cope with life stresses, operate effectively in society, and contribute to their communities. The idea of the mental well-being of teachers in traditional learning has always been mentioned in multiple kinds of literature.

Furthermore, COVID-19 has made professionals realize the importance of mental well-being on a larger level. During this pandemic, academic instructors, academic staff, and teachers have explicitly suffered on a mental level (Holmes et al., 2020). Bashoff et al. state that workplace stressors such as those faced within the education sector have important consequences for a person's physical and mental well-being. Different physiological mechanisms are triggered in the presence of extreme stress as a compensatory reaction to defend and maintain regular body functions. Bernard and Walton (2011) proposed that the impact of instructors' assurance on continuance commitment affects the mental well-being of teachers. Abeyaratne et al. (2020) proposed that the engagement of older instructors balances the mental well-being of instructors due to their empathy and commitment towards learning.

Moreover, Meyers et al. (2013) professed that empathetic teachers are prone to continuance commitment that highlights their mental well-being. Sheth et al. (2020) identified necessary suitable interventions to minimize the mental health issue arising due to the pandemic. A responsive instructor can continue the commitment that later results in mental well-being (Capone & Petrillo, 2018).

Dimensions within the educational quality and their impact on continuance commitment share a keen relationship with the mental well-being of teachers and academicians. Williams (2017) proposed that educational quality and its execution have a justifiable impact on the teachers' mental well-being. The relationship between educational quality and mental well-being evaluates the necessary actions conducted in institutions (Williams, 2017). Literature that focuses on the impacts within COVID-19 highlights that several teachers felt high rates of stress, and some left the profession due to the unavailability of a proper LMS. Research on mental health contributes to the adaptability of those educators that choose to remain in the profession (Zhang et al., 2020). Furthermore, McLean et al. (2017) conclude that educational quality's impact on continuance commitment directly relates to the teachers' mental well-being. Here, educational quality includes institutional support, response, and transition according to the updated pandemic issues (Holmes et al. 2020).

Thus, in line with the review of the literature, our research proposes the following hypotheses:

- H8: TMW moderates the relationship between teacher's assurance and Continuance Commitment
- H9: TMW moderates the relationship between teacher's empathy and Continuance Commitment
- H10: TMW moderates the relationship between teacher's responsiveness and Continuance Commitment
- H11: TMW moderates the relationship between Educational quality and Continuance Commitment
- H12: TMW moderates the relationship between Information quality and Continuance Commitment
- H13: TMW moderates the relationship between Service quality and Continuance Commitment
- H14: TMW moderates the relationship between Technical system quality and Continuance Commitment

3. Research methodology

3.1. Research model

Figure 1 establishes the research model of this study. The model depicts dimensions of the instructor's self-efficacy and dimensions of system quality on the continuance commitment. Moreover, the teachers' mental well-being is incorporated as a moderator in the study.

3.2. Data Collection and Measurement of Variables

This data is collected through questionnaires. The instrument for data collection was developed using a five-point Likert scale that ranges from strongly disagree to strongly agree. We targeted the employees of the educational industry for the survey. Survey questionnaires were distributed online in Pakistan and Malaysia. The questionnaire was sent to the teachers of higher education that are working in private universities. Hence, sample size includes the responses of 316 and 311 teachers of Pakistan and Malaysia, respectively. The sample size selected for the data was based on the guidelines presented by Raza and Hanif (2013) and Qazi et al. (2020). The sample of 50 is considered poor, 300 as good, 500 as very good, and 1000 was regarded as an excellent sample.

The questionnaire was developed using the items adapted from prior studies. For instance: Teachers' mental well-being questions were adapted from prior studies (Silver and Zinsser (2020)). The items of CC were adapted from (Ahmed et al., 2021). The following studies have been used for the dimensions of the instructor's self-efficacy and dimensions of system quality, i.e. (Rashid et al., 2020); (San-Martín et al., 2020); (Meyer et al., 2019). Lastly, all the involved indirect variables were adapted from Haverback (2020) and Allen et al. (2020). The core variables of the study include instructors' self-efficacy, system quality, and continuance, with the moderating variable of the study, include teachers' mental well-being, respectively.

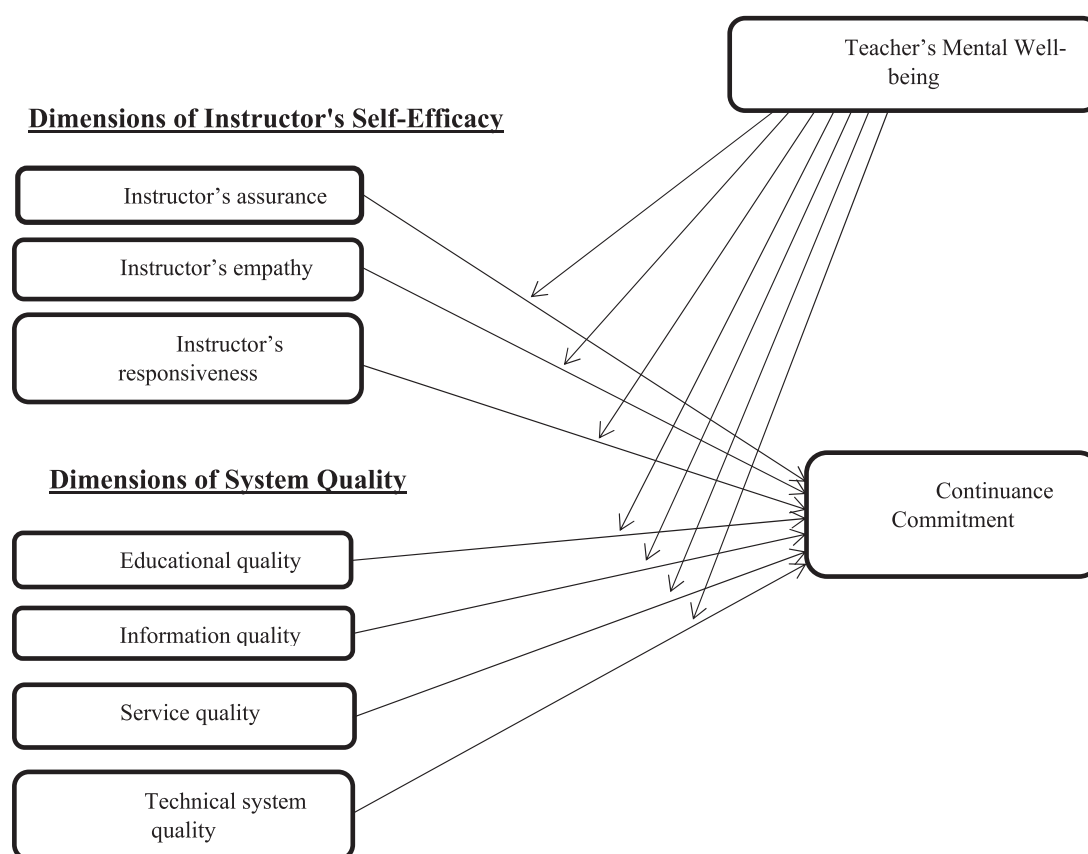


Figure 1. Research Model.

The first section includes the instructor's self-efficacy, a second-order construct consisting of three dimensions: instructor's assurance, instructor's empathy, and instructor's responsiveness. The items for these three dimensions were adopted from the study of San-Martin et al. (2020). Second section refers to system quality that is also a second-order construct and consists of four dimensions. The items for these dimensions were adopted from the study of San-Martin et al. (2020). Third section of the questionnaire includes continuance commitment and teacher's mental well-being, a first-order construct. The items of continuance commitment were adopted from the study of Ahmed, Hussain, and Farid (2018), and the items of teacher's mental well-being were adopted from the Warwick Edinburgh Mental Well-being Scale.

3.3. Demographics

The demographic information is presented in Table 1. According to the demographic characteristics, examining the gender ratio, the percentage of males in Pakistan is 66.5 percent, and Malaysia is 60.5. Compared, the percentage of females in Pakistan is 33.5 percent, and females in Malaysia are 39.5.

In terms of age from Pakistan, 3.8 percent of respondents are between the 25–31 age group, 18.0 percent of respondents are between the 32–38 age group, 34.2 percent are between 39–45, 32.0 of respondents are between the 46–52 age group, and 12.0 percent respondents lie at the age bracket of 53 and above. While from Malaysia, 3.1 percent of respondents are between the 25–31 age group,

Table 1. Respondents details.

Demographics	Frequency	Percent
Pakistan		
Age		
25–31	12	3.8%
32–38	57	18%
39–45	108	34.2%
46–52	101	32%
53 & Above	38	12%
Total	316	100%
Gender		
Male	210	66.5%
Female	106	33.5%
Total	316	100%
Education		
Masters	101	32%
PhD	206	65.2%
Post Doctorate	7	2.2%
Others	2	0.6%
Total	316	100%
Malaysia		
Age		
25–31	4	1.3%
32–38	83	26.7%
39–45	108	34.7%
46–52	73	23.5%
53 & Above	43	13.8%
Total	311	100%
Gender		
Male	188	60.5%
Female	123	39.5%
Total	311	100%
Education		
Masters	114	36.7%
PhD	103	33.1%
Post Doctorate	81	26%
Others	13	4.2%
Total	311	100%

Source: Authors' Estimation.

26.7 percent of respondents are between the 32–38 age group, 34.7 percent are between the age groups of 39–45, 23.5 of respondents are between the 46–52 age group, and 13.8 percent respondents lie at the age bracket of 53 and above.

In terms of education, the data of Pakistan portrays that 32.0 percent of respondents were masters, 65.2 percent were Ph.D., 2.2 percent were Post Doctorate, and 0.6 percent lie at the option of others. While from Malaysia, 36.7 percent of respondents were masters, 33.1 percent were Ph.D., 26.0 percent were Post Doctorate, and 4.2 percent lie at the option of others.

4. Data analysis

Structural Equation Modelling and the support of statistical facts are used for validating the used theory (Ringle et al., 2012). For the Variance-based method, PLS-SEM is used to process the hypothetical model. Additionally, bootstrap resampling is used according to the criteria of Hair et al. (2013) Raza et al. (2021b).

Furthermore, the study compared variance and covariance-based techniques and concluded that the technique has the least restrictions in sample size and residual distributions. Estimations are based on Anderson and Gerbing's (1988) two-step approach; i.e. measurement model and structural model (Prussia et al., 1998).

4.1. Measurement model

Construct reliability, individual item reliability, convergent validity, and discriminant validity are in the measurement model to evaluate the proficiency of the model. To assess the results, Cronbach's Alpha, Composite reliability, Average Variance Extract (AVE) are used with the benchmarks of 0.7, 0.7, and 0.5. The criteria of Straub (1989) are highlighted in the variables of Cronbach's alpha and composite reliability mentioned in Tables 2 and 3 (Churchill, 1979; Ahmed et al., 2021). The criteria of Fornell and Larcker (1981) are used by average variance extracted (AVE) to calculate the convergent validity.

This discriminant validity is also measured using Cross-loading analysis, Fornell and Larcker criterion, and the Heterotrait-Monotrait ratio of correlations (HTMT) to measure the discriminant validity. Tables 4 and 5 signifies the square root of AVE presented diagonally. Also, to explain the discriminant validity of adequacy, Tables 6 and 7 displays loadings and cross-loadings. This follows the criteria of (Gefen & Straub, 2005; Raza et al., 2020). Moreover, the Heterotrait-monotrait ratio of correlations (HTMT) is displayed in Tables 8 and 9.

Therefore, after the above analysis, it is concluded that the measurement model confirmed the convergent validity and discriminant validity. Now it can be used to determine the next model that is a structural model.

4.2. Structural model

In the structural model, hypotheses are tested in which the relationship between proposed constructs is examined. The structural model is determined based on regression. Additionally, the standard significance level is 0.1. Tables 10 and 11 represent the results of Pakistan; whereas, Tables 12 and 13 represent the results of Malaysia. Further, these results are also illustrated by Figure 2(A)-Pakistan and (B)-Malaysia.

4.3. Discussion of the results

Hypothesis 1 shows that the teachers' assurance significantly impacts the continuance commitment both in Pakistan and Malaysia. The SRW readings are ($\beta = 0.474, p < 0.01$) in Pakistani context while in Malaysian context it is ($\beta = 0.550, p < 0.01$). These results are dissimilar from the prior mentioned

Table 2. Measurement Model Results-Pakistan.

	Items	Loadings	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
CC	CC1	0.898	0.887	0.930	0.816
	CC2	0.935			
	CC3	0.876			
EQ	EQ1	0.763	0.858	0.904	0.703
	EQ2	0.839			
	EQ3	0.862			
	EQ4	0.884			
IA	IA1	0.879	0.897	0.934	0.825
	IA2	0.932			
	IA3	0.912			
IE	IE1	0.722	0.789	0.861	0.609
	IE2	0.829			
	IE3	0.767			
	IE4	0.799			
IQ	IQ1	0.738	0.840	0.887	0.610
	IQ2	0.766			
	IQ3	0.783			
	IQ4	0.816			
	IQ5	0.801			
IR	IR1	0.764	0.791	0.856	0.598
	IR2	0.803			
	IR3	0.774			
	IR4	0.751			
SERQ	SERQ1	0.848	0.800	0.869	0.624
	SERQ2	0.746			
	SERQ3	0.762			
	SERQ4	0.800			
TSQ	TSQ1	0.794	0.883	0.914	0.682
	TSQ2	0.823			
	TSQ3	0.839			
	TSQ4	0.882			
	TSQ5	0.787			
TWB	TMWB1	0.826	0.935	0.942	0.618
	TMWB2	0.784			
	TMWB3	0.813			
	TMWB4	0.854			
	TMWB5	0.831			
	TMWB6	0.740			
	TMWB7	0.713			
	TMWB8	0.765			
	TMWB9	0.756			
	TMWB10	0.766			

Notes: CC=Continues Commitment; EQ=Educational Quality; IA=Instructor's Assurance; IE=Instructor's Empathy; IQ=Information Quality; IR= Instructor's Responsiveness; SERQ=Service Quality; TSQ=Technical System Quality; TWB=Teachers' Mental Wellbeing.

literature (San-Martin et al. 2020). This shows that assurance of teachers leads to a positive atmosphere in the classroom. Hence, when students find a friendly atmosphere and a teacher with better understanding so it ultimately satisfies the teachers. Once teachers are satisfied with class environment and students' feedback so it further increases the satisfaction and commitment of teachers towards teaching.

Hypothesis 2 shows that the teachers' empathy has an insignificant impact on the continuance commitment ($\beta = 0.084$) in the Pakistani context. In contrast, in the Malaysian context, it is significant

Table 3. Measurement model results-Malaysia.

	Items	Loadings	Cronbach's Alpha	Composite Reliability	Average Variance Extracted
CC	CC1	0.913	0.837	0.901	0.754
	CC2	0.935			
	CC3	0.746			
EQ	EQ1	0.802	0.884	0.920	0.742
	EQ2	0.880			
	EQ3	0.892			
	EQ4	0.870			
IA	IA1	0.872	0.892	0.932	0.821
	IA2	0.916			
	IA3	0.928			
IE	IE1	0.871	0.773	0.861	0.673
	IE2	0.773			
	IE3	0.854			
IQ	IQ1	0.806	0.834	0.889	0.667
	IQ2	0.836			
	IQ3	0.800			
	IQ4	0.825			
IR	IR1	0.706	0.647	0.730	0.500
	IR2	0.988			
	IR3	0.813			
SERQ	SERQ1	0.927	0.804	0.881	0.712
	SERQ2	0.792			
	SERQ3	0.806			
TSQ	TSQ1	0.897	0.909	0.943	0.847
	TSQ2	0.946			
	TSQ3	0.917			
TWB	TMWB1	0.836	0.933	0.938	0.602
	TMWB2	0.751			
	TMWB3	0.805			
	TMWB4	0.853			
	TMWB5	0.820			
	TMWB6	0.728			
	TMWB7	0.748			
	TMWB8	0.780			
	TMWB9	0.712			
	TMWB10	0.709			

Notes: CC=Continues Commitment; EQ=Educational Quality; IA=Instructor's Assurance; IE=Instructor's Empathy; IQ=Information Quality; IR= Instructor's Responsiveness; SERQ=Service Quality; TSQ=Technical System Quality; TWB=Teachers' Mental Wellbeing

Table 4. Fornell-Larcker criterion-Pakistan.

	CC	EQ	IA	IE	IQ	IR	SERQ	TSQ	TMWB
CC	0.903								
EQ	0.541	0.838							
IA	0.175	0.119	0.908						
IE	0.183	0.161	0.743	0.780					
IQ	0.663	0.823	0.167	0.208	0.781				
IR	0.132	0.110	0.687	0.787	0.144	0.773			
SERQ	0.659	0.576	0.086	0.038	0.725	0.044	0.790		
TSQ	0.494	0.745	0.039	−0.015	0.746	0.017	0.695	0.826	
TMWB	0.266	0.046	−0.051	−0.104	0.175	−0.086	0.222	−0.009	0.786

Notes: "CC=Continues Commitment; EQ=Educational Quality; IA=Instructor's Assurance; IE=Instructor's Empathy; IQ=Information Quality; IR= Instructor's Responsiveness; SERQ=Service Quality; TSQ=Technical System Quality; TWB=Teachers' Mental Wellbeing"

Table 5. Fornell-Larcker criterion-Malaysia

	CC	EQ	IA	IE	IQ	IR	SERQ	TSQ	TWB
CC	0.868								
EQ	0.568	0.862							
IA	0.155	0.144	0.906						
IE	0.182	0.260	0.740	0.821					
IQ	0.637	0.826	0.148	0.246	0.817				
IR	0.214	0.271	0.565	0.686	0.275	0.707			
SERQ	0.345	0.357	−0.041	−0.020	0.446	−0.102	0.844		
TSQ	0.520	0.864	0.110	0.275	0.764	0.271	0.330	0.920	
TWB	0.305	0.061	−0.024	−0.053	0.220	−0.081	0.290	0.052	0.776

Notes: “CC=Continues Commitment; EQ=Educational Quality; IA=Instructor’s Assurance; IE=Instructor’s Empathy; IQ=Information Quality; IR= Instructor’s Responsiveness; SERQ=Service Quality; TSQ=Technical System Quality; TWB=Teachers’ Mental Well-being”

Table 6. Loadings and cross loadings-Pakistan

	CC	EQ	IA	IE	IQ	IR	SERQ	TSQ	TMWB
CC1	0.898	0.498	0.155	0.168	0.590	0.112	0.576	0.404	0.263
CC2	0.935	0.543	0.189	0.218	0.658	0.136	0.613	0.483	0.253
CC3	0.876	0.420	0.127	0.100	0.541	0.106	0.597	0.452	0.203
EQ1	0.452	0.763	0.184	0.203	0.611	0.132	0.377	0.544	0.031
EQ2	0.454	0.839	0.052	0.126	0.678	0.091	0.431	0.559	0.076
EQ3	0.456	0.862	0.058	0.089	0.716	0.055	0.587	0.726	0.008
EQ4	0.451	0.884	0.104	0.122	0.751	0.091	0.532	0.666	0.038
IA1	0.145	0.078	0.879	0.653	0.162	0.595	0.029	0.016	−0.036
IA2	0.198	0.139	0.932	0.682	0.156	0.651	0.122	0.052	−0.050
IA3	0.108	0.092	0.912	0.697	0.130	0.619	0.063	0.031	−0.057
IE1	0.173	0.102	0.368	0.722	0.127	0.642	0.087	0.059	−0.005
IE2	0.103	0.118	0.474	0.829	0.149	0.662	−0.049	−0.074	−0.114
IE3	0.128	0.123	0.387	0.767	0.156	0.517	−0.019	−0.095	−0.092
IE4	0.143	0.159	0.438	0.799	0.214	0.611	0.061	0.022	−0.138
IQ1	0.511	0.519	0.214	0.209	0.738	0.127	0.456	0.541	0.061
IQ2	0.523	0.625	0.203	0.205	0.766	0.156	0.527	0.574	0.125
IQ3	0.522	0.679	0.043	0.139	0.783	0.095	0.551	0.528	0.237
IQ4	0.538	0.724	0.084	0.132	0.816	0.092	0.613	0.605	0.104
IQ5	0.491	0.663	0.109	0.125	0.801	0.091	0.688	0.670	0.157
IR1	0.141	0.180	0.422	0.740	0.186	0.764	0.018	−0.018	−0.054
IR2	0.077	0.113	0.484	0.574	0.140	0.803	0.005	0.042	−0.074
IR3	0.078	−0.001	0.633	0.536	0.046	0.774	0.065	0.025	−0.091
IR4	0.077	−0.030	0.668	0.469	0.009	0.751	0.061	0.028	−0.056
SERQ1	0.617	0.517	0.130	0.050	0.656	0.033	0.848	0.607	0.184
SERQ2	0.421	0.372	0.073	0.081	0.489	0.049	0.746	0.440	0.147
SERQ3	0.544	0.525	0.097	0.074	0.635	0.078	0.762	0.534	0.163
SERQ4	0.464	0.374	−0.051	−0.092	0.477	−0.026	0.800	0.599	0.209
TSQ1	0.402	0.427	0.072	−0.042	0.535	0.003	0.507	0.794	−0.050
TSQ2	0.391	0.522	0.078	−0.018	0.548	0.024	0.541	0.823	−0.018
TSQ3	0.386	0.610	−0.084	−0.103	0.587	−0.057	0.607	0.839	0.075
TSQ4	0.384	0.692	−0.028	−0.072	0.632	−0.013	0.636	0.882	−0.034
TSQ5	0.461	0.792	0.105	0.143	0.748	0.095	0.571	0.787	−0.007
TMWB1	0.248	0.016	−0.035	−0.100	0.137	−0.092	0.227	−0.028	0.826
TMWB2	0.139	0.008	−0.029	−0.059	0.106	−0.023	0.116	0.013	0.784
TMWB3	0.248	0.092	−0.029	−0.070	0.196	−0.046	0.215	0.063	0.813
TMWB4	0.312	0.009	−0.071	−0.088	0.116	−0.088	0.202	−0.055	0.854
TMWB5	0.278	0.063	−0.014	−0.066	0.204	−0.078	0.169	−0.047	0.831
TMWB6	0.105	0.014	−0.049	−0.124	0.083	−0.096	0.110	0.000	0.740
TMWB7	0.104	0.047	−0.065	−0.066	0.104	−0.025	0.148	0.055	0.713
TMWB8	0.103	0.029	−0.040	−0.114	0.146	−0.083	0.132	0.014	0.765
TMWB9	0.147	0.030	−0.034	−0.054	0.113	−0.032	0.182	−0.011	0.756
TMWB10	0.091	0.033	−0.069	−0.140	0.086	−0.107	0.150	0.021	0.766

Notes: “CC=Continues Commitment; EQ=Educational Quality; IA=Instructor’s Assurance; IE=Instructor’s Empathy; IQ=Information Quality; IR= Instructor’s Responsiveness; SERQ=Service Quality; TSQ=Technical System Quality; TWB=Teachers’ Mental Well-being”.

Table 7. Loadings and cross loadings-Malaysia

	CC	EQ	IA	IE	IQ	IR	SERQ	TSQ	TMWB
CC1	0.913	0.538	0.138	0.246	0.615	0.257	0.334	0.552	0.277
CC2	0.935	0.593	0.203	0.195	0.627	0.246	0.237	0.509	0.264
CC3	0.746	0.289	0.026	−0.032	0.369	−0.016	0.368	0.226	0.264
EQ1	0.521	0.802	0.192	0.247	0.722	0.255	0.256	0.576	0.015
EQ2	0.489	0.880	0.034	0.193	0.683	0.189	0.297	0.794	0.129
EQ3	0.472	0.892	0.122	0.226	0.705	0.189	0.338	0.817	0.024
EQ4	0.466	0.870	0.143	0.227	0.732	0.299	0.344	0.801	0.042
IA1	0.114	0.101	0.872	0.596	0.156	0.481	−0.016	0.074	−0.047
IA2	0.163	0.123	0.916	0.675	0.102	0.458	−0.047	0.104	−0.016
IA3	0.136	0.165	0.928	0.732	0.157	0.607	−0.042	0.117	−0.008
IE1	0.155	0.176	0.832	0.871	0.187	0.512	−0.022	0.157	−0.015
IE2	0.075	0.209	0.522	0.773	0.247	0.523	0.102	0.244	−0.061
IE3	0.179	0.255	0.431	0.854	0.203	0.641	−0.061	0.284	−0.063
IQ1	0.541	0.655	0.195	0.218	0.806	0.263	0.285	0.483	0.092
IQ2	0.534	0.624	0.174	0.285	0.836	0.266	0.312	0.559	0.182
IQ3	0.470	0.644	−0.021	0.084	0.800	0.128	0.455	0.679	0.296
IQ4	0.530	0.775	0.119	0.205	0.825	0.231	0.419	0.784	0.164
IR1	0.019	−0.019	0.267	0.379	0.022	0.706	−0.005	−0.018	−0.120
IR2	0.229	0.308	0.518	0.672	0.313	0.988	−0.107	0.310	−0.070
IR3	0.036	−0.042	0.555	0.366	−0.065	0.813	−0.032	−0.056	−0.065
SERQ1	0.386	0.359	−0.009	−0.003	0.445	−0.111	0.927	0.328	0.259
SERQ2	0.212	0.208	−0.080	−0.061	0.259	−0.105	0.792	0.172	0.256
SERQ3	0.222	0.311	−0.036	0.001	0.396	−0.030	0.806	0.310	0.227
TSQ1	0.460	0.758	0.065	0.220	0.707	0.252	0.290	0.897	0.119
TSQ2	0.497	0.838	0.116	0.235	0.732	0.266	0.306	0.946	0.000
TSQ3	0.477	0.788	0.122	0.303	0.669	0.230	0.313	0.917	0.029
TMWB1	0.295	0.018	−0.004	−0.063	0.140	−0.043	0.207	−0.001	0.836
TMWB2	0.134	0.018	−0.002	−0.012	0.148	−0.024	0.149	0.032	0.751
TMWB3	0.275	0.134	0.004	0.000	0.249	−0.077	0.303	0.138	0.805
TMWB4	0.327	−0.011	−0.076	−0.088	0.128	−0.095	0.251	−0.022	0.853
TMWB5	0.344	0.077	−0.009	−0.014	0.260	−0.069	0.312	0.039	0.820
TMWB6	0.124	0.068	−0.005	−0.030	0.137	−0.038	0.181	0.091	0.728
TMWB7	0.132	0.062	0.003	−0.020	0.169	−0.039	0.193	0.068	0.748
TMWB8	0.150	0.062	0.022	−0.007	0.192	−0.057	0.186	0.099	0.780
TMWB9	0.119	0.002	−0.044	−0.075	0.109	−0.068	0.161	−0.015	0.712
TMWB10	0.106	0.034	−0.078	−0.143	0.078	−0.109	0.135	0.020	0.709

Notes: “CC=Continues Commitment; EQ=Educational Quality; IA=Instructor’s Assurance; IE=Instructor’s Empathy; IQ=Information Quality; IR= Instructor’s Responsiveness; SERQ=Service Quality; TSQ=Technical System Quality; TWB=Teachers’ Mental Well-being”.

Table 8. Heterotrait-Monotrait Ratio (HTMT)-Pakistan.

	CC	EQ	IA	IE	IQ	IR	SERQ	TSQ	TMWB
CC									
EQ	0.618								
IA	0.183	0.129							
IE	0.205	0.195	0.831						
IQ	0.764	0.806	0.190	0.253					
IR	0.142	0.135	0.831	0.065	0.165				
SERQ	0.769	0.682	0.128	0.125	0.871	0.088			
TSQ	0.554	0.847	0.102	0.160	0.859	0.086	0.819		
TMWB	0.244	0.060	0.063	0.146	0.187	0.104	0.241	0.070	

Notes: “CC=Continues Commitment; EQ=Educational Quality; IA=Instructor’s Assurance; IE=Instructor’s Empathy; IQ=Information Quality; IR= Instructor’s Responsiveness; SERQ=Service Quality; TSQ=Technical System Quality; TWB=Teachers’ Mental Well-being”.

($\beta = 0.384$, $p < 0.01$). These results are dissimilar from the prior mentioned literature (Allen et al., 2020). The results depict that in Pakistan, teachers’ empathetic nature does not increase their commitment level. Teachers are continuously struggling to educate students in this pandemic but do not

Table 9. Heterotrait-Monotrait Ratio (HTMT)-Malaysia.

	CC	EQ	IA	IE	IQ	IR	SERQ	TSQ	TWB
CC									
EQ	0.632								
IA	0.160	0.163							
IE	0.226	0.310	0.879						
IQ	0.738	0.660	0.184	0.314					
IR	0.170	0.220	0.766	0.867	0.236				
SERQ	0.412	0.411	0.060	0.106	0.534	0.095			
TSQ	0.566	0.710	0.120	0.329	0.881	0.220	0.373		
TWB	0.292	0.085	0.044	0.080	0.237	0.137	0.308	0.093	

Notes: "CC=Continues Commitment; EQ=Educational Quality; IA=Instructor's Assurance; IE=Instructor's Empathy; IQ=Information Quality; IR= Instructor's Responsiveness; SERQ=Service Quality; TSQ=Technical System Quality; TWB=Teachers' Mental Well-being".

Table 10. Results of path analysis-Pakistan.

Hypothesis	Regression Path	Effect type	SRW	Remarks
H1	IA -> CC	Direct Effect	0.474***	Supported
H2	IE -> CC	Direct Effect	0.084	Not Supported
H3	IR -> CC	Direct Effect	0.315**	Supported
H4	EQ -> CC	Direct Effect	0.140***	Supported
H5	IQ -> CC	Direct Effect	0.249**	Supported
H6	SERQ-> CC	Direct Effect	0.366***	Supported
H7	TSQ -> CC	Direct Effect	0.425	Not Supported

Notes: "CC=Continues Commitment; EQ=Educational Quality; IA=Instructor's Assurance; IE=Instructor's Empathy; IQ=Information Quality; IR= Instructor's Responsiveness; SERQ=Service Quality; TSQ=Technical System Quality; TWB=Teachers' Mental Well-being".

Table 11. Moderating effect of teacher's mental well-being-Pakistan.

Hypothesis	Regression Path	Effect type	SRW	Remarks
H8	IA -> CC	Indirect Effect	0.088	Not Supported
H9	IE -> CC	Indirect Effect	0.568***	Supported
H10	IR -> CC	Indirect Effect	0.450*	Supported
H11	EQ -> CC	Indirect Effect	0.022	Not Supported
H12	IQ -> CC	Indirect Effect	0.293**	Supported
H13	SERQ-> CC	Indirect Effect	0.146***	Supported
H14	TSQ -> CC	Indirect Effect	0.158**	Supported

Notes: "CC=Continues Commitment; EQ=Educational Quality; IA=Instructor's Assurance; IE=Instructor's Empathy; IQ=Information Quality; IR= Instructor's Responsiveness; SERQ=Service Quality; TSQ=Technical System Quality; TWB=Teachers' Mental Well-being".

Table 12. Results of path analysis-Malaysia.

Hypothesis	Regression Path	Effect type	SRW	Remarks
H1	IA -> CC	Direct Effect	0.550***	Supported
H2	IE -> CC	Direct Effect	0.384***	Supported
H3	IR -> CC	Direct Effect	0.031	Not Supported
H4	EQ -> CC	Direct Effect	0.236**	Supported
H5	IQ -> CC	Direct Effect	0.227*	Supported
H6	SERQ-> CC	Direct Effect	0.607***	Supported
H7	TSQ -> CC	Direct Effect	0.690*	Supported

Notes: "CC=Continues Commitment; EQ=Educational Quality; IA=Instructor's Assurance; IE=Instructor's Empathy; IQ=Information Quality; IR= Instructor's Responsiveness; SERQ=Service Quality; TSQ=Technical System Quality; TWB=Teachers' Mental Well-being".

get the same recognition in return. An empathic factor is based on an individual's personality; hence, empathy does not have any association with commitment because they might switch the platform in upcoming times. In contrast, in Malaysia, when teachers show empathy so it motivates them to show continuous commitment because their surrounding is motivating them.

Table 13. Moderating effect of teacher's mental well-being-Malaysia.

Hypothesis	Regression Path	Effect type	SRW	Remarks
H8	IA -> CC	Indirect Effect	0.629**	Supported
H9	IE -> CC	Indirect Effect	0.295***	Supported
H10	IR -> CC	Indirect Effect	0.256	Not Supported
H11	EQ -> CC	Indirect Effect	0.238**	Supported
H12	IQ -> CC	Indirect Effect	0.501	Not Supported
H13	SERQ-> CC	Indirect Effect	0.138***	Supported
H14	TSQ -> CC	Indirect Effect	0.503***	Supported

Notes: "CC=Continues Commitment; EQ=Educational Quality; IA=Instructor's Assurance; IE=Instructor's Empathy; IQ=Information Quality; IR= Instructor's Responsiveness; SERQ=Service Quality; TSQ=Technical System Quality; TWB=Teachers' Mental Well-being"

Hypothesis 3 shows that the teachers' responsiveness has a significant impact on the continuance commitment ($\beta = 0.315$, $p < 0.05$) in the Pakistani context. In contrast, in the Malaysian context, it is insignificant ($\beta = 0.031$). These results are dissimilar from the prior mentioned literature (Kolluri et al., 2020). The results confirm that in Pakistan, when teachers perceived that they are quick in resolving their students' problems so this feeling increases their commitment. However, in Malaysian context, we see contrasting results. It means that teachers of Malaysia do not find responsiveness as a crucial factor that might boost commitment.

Results from hypothesis 4 show that the educational quality has a significant impact on the continuance commitment ($\beta = 0.140$, $p < 0.01$) in the Pakistani context and in the Malaysian context as well ($\beta = 0.236$, $p < 0.05$). These results are dissimilar from the prior mentioned literature (Cheng & Gan, 2020). The results confirm that teachers of both countries prefer educational quality the most crucial factor that can increase their continuance commitment. The teachers of both countries want LMS to be effective in the field of education so that students and teachers can have a smooth learning process. So, when teachers find that LMS is capable enough to provide education quality then it ultimately increases the commitment to use LMS.

Hypothesis 5 shows that the information quality significantly impacts the continuance commitment in both Pakistan and Malaysia. The SRW readings are ($\beta = 0.249$, $p < 0.05$) in Pakistan while in Malaysia it is ($\beta = 0.227$, $p < 0.1$). These results are dissimilar from the prior mentioned literature (McKnight et al., 2017). The results confirm that teachers of both countries do not compromise on the information quality aspect of LMS. The function of LMS is to make education more advance and useful. In the era of technology, it is mandatory to have effective platform that can make learning possible in the pandemic as well. Hence, if teachers find that LMS provide information and can be useful so definitely they would continue to use LMS.

Hypothesis 6 shows that service quality has a significant impact on the continuance commitment in both Pakistan and Malaysia. The SRW readings are ($\beta = 0.366$, $p < 0.01$) in Pakistan while in Malaysia it is ($\beta = 0.607$, $p < 0.01$). These results are dissimilar from the prior mentioned literature (Daghan & Akkoyunlu, 2016). Based on the findings, it is concluded that service quality factors are important for the teachers of both countries. It does not matter that a country is poor or rich because people pay for quality services. Therefore, teachers understand the importance of quality in the field of education. If students do not get quality education just because of poor services, then it will be alarming for the future of nation. Therefore, if institutions want their teachers to continue the use of LMS even after pandemic then they should provide best service quality LMS. It will foster continuous commitment among teachers of both countries.

Hypothesis 7 shows that the technical system quality has an insignificant impact on the continuance commitment ($\beta = 0.425$) in the Pakistani context. In contrast, in Malaysian context, it is significant ($\beta = 0.690$, $p < 0.01$). These results are dissimilar from the prior mentioned literature (Parvathi, 2019). The findings portray that technical system quality is important for both states but Pakistani teachers does not have association with this factor but Malaysian do pay great attention towards technical system quality as well.

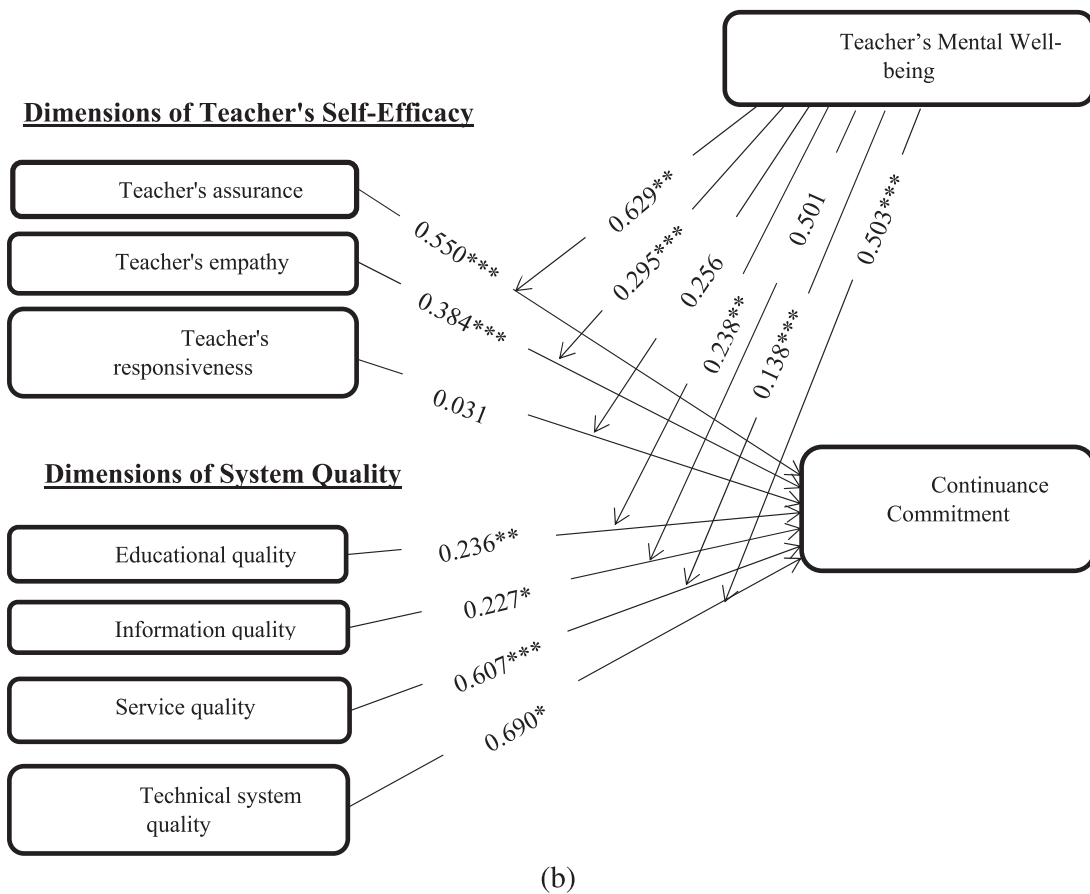
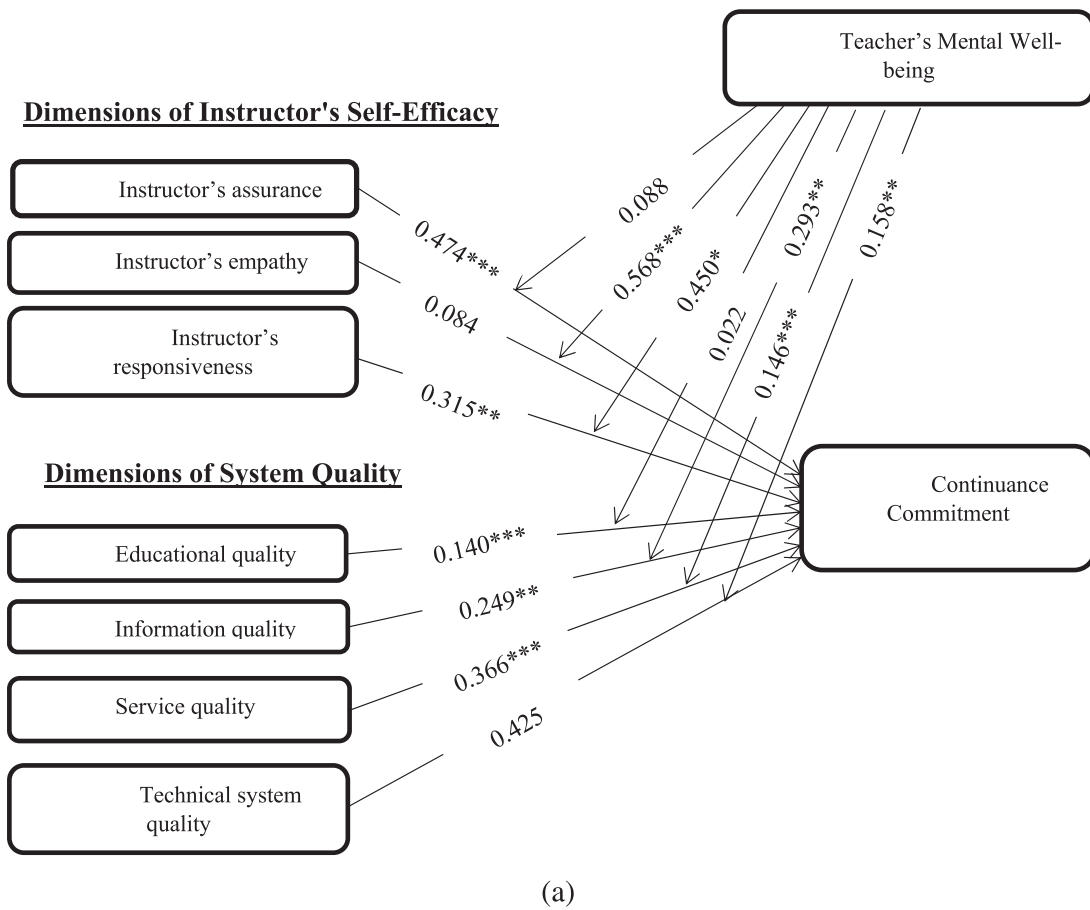


Figure 2. (A) Results of Path Analysis-Pakistan. (B) Results of Path Analysis-Malaysia

The moderating role of teacher's mental well-being

Tables 11 & 13 show the results of moderation analysis. It depicts that TMW moderates the association between the generated hypotheses. The results in table 11 are all indirect in effect and have a positive perception. In Pakistani context H8 is insignificant ($\beta = 0.088$), H9 is significant ($\beta = 0.568$, $p < 0.01$), H10 is significant ($\beta = 0.450$, $p < 0.1$), H11 is insignificant ($\beta = 0.022$), H12 is significant ($\beta = 0.293$, $p < 0.05$), H13 is significant ($\beta = 0.146$, $p < 0.01$), and H14 is significant ($\beta = 0.158$, $p < 0.05$). On the other, in Malaysian context H8 is significant ($\beta = 0.629$, $p < 0.05$), H9 is significant ($\beta = 0.295$, $p < 0.01$), H10 is insignificant ($\beta = 0.256$), H11 is significant ($\beta = 0.238$, $p < 0.05$), H12 is insignificant ($\beta = 0.501$), H13 is significant ($\beta = 0.138$, $p < 0.01$), and H14 is significant ($\beta = 0.503$, $p < 0.01$).

These moderating hypotheses show that Teachers' mental well-being has a strong relationship with the generated hypothesis. After incorporating the teacher's mental well-being as a moderating variable, it has been discovered that teachers' mental well-being in this perspective is not discussed before. The approach used in this paper extends and offers a deeper understanding of the key drivers related to the teachers' mental well-being. Prior researches in the traditional literature have focused on a few determiners of the moderator. Moreover, the previously designed models have worked on the continuance commitment related to online learning, such as the usefulness of the involved variables. In this case, the involved moderator shows the value of its relationship with the instructors' self-efficacy and system quality. These moderating results clearly show that the relationship has an indirect effect.

5. Conclusion & recommendations

5.1. Conclusion

The teaching approach has been changed in terms of new educational technologies. Due to the pandemic, e-learning systems have developed and making a rapid change in this sector. In this study, an extended version of the research model focuses on mental well-being with continuance commitment in the global pandemic (Daniel, 2020). As the contributions in literature and using the content from teachers' perspective, the e-learning system quality and instructors' self-efficacy are revealed as a key factor in making the teachers willing to continue their online practices. A wider sample of university teachers from Pakistan and Malaysia is collected for the study.

5.2. Theoretical and practical implications

There are several implications designed for the policymakers of educational institutions. In the educational sector, the researchers have established that the collaborated approaches involved with the educational personnel and employers are essential to increase the satisfaction of teachers by understanding their mental well-being. This satisfaction of the teachers is pivotal as it has a positive influence. Current studies show that a positive correlation is generated within this manner as it highlights the impacts of the variables with continuance commitment. Thus, a positive environment is produced in the organization (educational institution) with establishing this relationship. So, establishing this relationship achieves goodwill behavior between students, teachers, and employers.

Shortages in the educational sector are common worldwide, and understanding them is a necessary factor for policymakers. Focusing on teachers' mental being is linked to the teachers' effectiveness and student performance. Professional factors in the educational sector such as workload, support from the organization, connectivity from the institution, satisfaction with updated professional learning opportunities, and personal experiences can contribute to the mental wellness of the teacher. To implement new strategies for improving teachers' well-being, it is advised to be aware of the professional experiences, knowing their issues, and relevancy within the classroom.

Policymakers can create a positive educational environment that could improve the academic achievement of teachers and students.

Thus to focus on the mental well-being of teachers, there are some factors to be taken into consideration. Such as; an evidence-based program that is conducted on an institutional level to take professional protective measures, and teachers must be provided with a well-maintained system and active drivers that are important for self-efficacy. According to the theoretical implications, the educational institution should establish training programs to explain the value of e-learning and its beneficial influence. The instructors' dedication is reinforced when the educational institution has a well-established LMS since it clarifies their standing and responsibility within the organization. It also secures their standing as online educators and may encourage offline educators to check out the digital system. The educational institution is also responsible for making sure that teachers utilize the e-learning system effectively. Promote its use by growing the e-learning service, and offer it to students. They are also responsible for checking data transfer speeds and network resources. To enhance the present system, it is also advised that users provide regular feedback to understand better teachers' concerns about using the LMS and demonstrate the educational institutions' massive support for teachers.

5.3. Limitations and future recommendations

This research has some limitations and recommendations. First, the research focused on the quantitative data. Hence, it is recommended to conduct interview sessions with teachers of both states and conduct qualitative analysis as well. Secondly, Pakistan can be compare with its neighboring countries as well. For instance, India and Bangladesh. Thirdly, in present research two countries are the target so any other countries can be added for better understanding. For future researches factor-related structural model is recommended. Lastly, more studies in the context of shifting from traditional studies to online studies for students could be considered for future researchers.

Note

1. <https://moderndiplomacy.eu/2019/04/01/new-era-of-pakistan-malaysia-relations/>

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Appendix

Survey Questionnaire

S.NO	Teacher Mental Wellbeing	Strongly Disagree (1)	Disagree (2)	Neutral (3)	Agree (4)	Strongly Agree (5)
1	I have been feeling optimistic about the future.	1	2	3	4	5
2	I have been feeling useful.					
3	I have been feeling relaxed.					
4	I have been dealing with problems well.					
5	I have been thinking clearly					
6	I have been feeling good about myself					
7	I have been feeling close to my students					
8	I have been feeling confident					
9	I have been able to make up my own mind about things					
10	I have been interested in new things					

S.NO	Teacher's assurance	1	2	3	4	5
1	I consider myself fair and impartial in grading.					
2	I try to answer all the questions thoroughly.					
3	I am sure that I have an expert understanding of the material.					
S.NO	Teacher's empathy	1	2	3	4	5
1	I am genuinely concerned about the students.					
2	I understand the individual needs of students.					
3	I have the students' best long-term interests in mind.					
4	I try to encourage and motivate students to do their best.					
S.NO	Teacher's responsiveness	1	2	3	4	5
1	I respond quickly and efficiently to students' needs.					
2	I welcome students' questions and comments.					
3	I respond to students' questions positively.					
4	I resolve students' confusion.					
S.NO	Educational quality	1	2	3	4	5
1	E-learning provides encouragements to the student.					
2	E-learning provides collaborative learning.					
3	E-learning provides required facilities such as chat and forum.					
4	E-learning provides possibility of learning evaluation.					
S.NO	Information quality	1	2	3	4	5
1	E-learning provides information that is relevant to students' needs.					
2	E-learning provides complete information.					
3	E-learning provides the information the students' want.					
4	E-learning provides organized content and information.					
5	E-learning provides required content and information.					
S.NO	Service Quality	1	2	3	4	5
1	E-learning provides a proper online assistance and explanation.					
2	E-learning department staff responds cooperatively.					
3	E-learning provides the opportunity of reflecting views.					
4	E-learning provides good management for the courses.					
S.NO	Technical system quality	1	2	3	4	5
1	The e-learning platform is aesthetically satisfying.					
2	The e-learning platform optimizes response time.					
3	The e-learning platform is user friendly.					
4	The e-learning platform provides interactive features between users and the system.					
5	The e-learning platform has flexible features.					
6	The e-learning platform has attractive features.					

S.NO	Continuance commitment	1	2	3	4	5
1	I would like to continue being an online teacher.					
2	I intend to continue being an online teacher.					
3	I prefer being an online teacher rather than being an offline teacher.					

可选成果 复印件*

填写说明详见《南京审计大学专业技术职务评聘工作实施办法（修订）》（南审校发〔2025〕13号）中附件1《南京审计大学教师专业技术资格条件》的附表4可选成果条目。

满足可选成果第 1-（5）、4 项。

表1 申报 教学科研并重 类型 副教授 职称业绩成果要求--可选成果材料目录

选择序号	材料名称	备注
附表4-1-（5）	作为第一指导老师指导的学生获得B类以上学生竞赛、省级二等奖以上	3项
附表4-4	获得国家授权发明专利且成果转化金额10万元以上	代表性成果

说明：1.申报类型处需选择“教学为主型”、“教学科研并重型”、“科研为主型”、“社会服务型”其中一项；职称处需选择“副教授”、“教授”其中一项。

2.思想政治理论课教师、体育学科教师、艺术学科教师需在备注中填写该学科名称（思想政治理论、体育、艺术）。

附表4-1-（5）：

5. 作为第一指导老师指导的学生获得B类以上学生竞赛、省级二等奖以上

指导学生获得A类竞赛一等奖2项、A类竞赛三等奖1项

* 若拟评职务中无须提供此材料，可删除此项

附表 4-4:

4. 获得国家授权发明专利且成果转化金额 10 万元以上

国家发明专利《基于图像识别的报销单据自动化识别校验系统》（专利号：202411565539）于 2024 年 10 月 22 日获得授权，本发明专利于 2026 年 1 月以 100800 元的价格转让给勤业科创服务（江苏）有限公司。

代表性成果

证书号第7462318号



专利公告信息

发明专利证书

发明名称：基于图像识别的报销单据自动化识别校验系统

专利权人：南京审计大学

地址：211899 江苏省南京市浦口区江浦街道雨山西路86号

发明人：孙国岩;马杰;何太明

专利号：ZL 2024 1 1056553.9

授权公告号：CN 118570825 B

专利申请日：2024年08月02日

授权公告日：2024年10月22日

申请日时申请人：南京审计大学

申请日时发明人：孙国岩;马杰;何太明

国家知识产权局依照中华人民共和国专利法进行审查，决定授予专利权，并予以公告。
专利权自授权公告之日起生效。专利权有效性及专利权人变更等法律信息以专利登记簿记载为准。

局长
申长雨

申长雨



第1页(共1页)



合同编号：

技术转让（专利权）合同

项目名称：基于图像识别的报销单据自动化识别校验系统
发明专利专利权转让

受让方（甲方）：勤业科创服务（江苏）有限公司

让与方（乙方）：南京审计大学

签订时间：2025 年 9 月 30 日

签订地点：南京市

有效期限：自合同签订之日起有效

中华人民共和国科学技术部印制

技术转让（专利权）合同

受让方（甲方）：勤业科创服务（江苏）有限公司

住所地：常州西太湖科技产业园禾香路 123 号 6 号楼

法定代表人：王雨花

项目联系人：王雨花

联系方式：025-58395179

通讯地址：常州市西太湖科技产业园禾香路 123 号 6 号楼

电话：025-58395179

电子信箱：cmaen@qq.com

让与方（乙方）：南京审计大学

住所地：南京市浦口区江浦街道雨山西路 86 号

法定代表人：陆华良

项目联系人：孙国岩、马杰

联系方式：13814009245、13505180938

通讯地址：南京市雨山西路 86 号南京审计大学

电话：13505180938 传真：无

电子信箱：270007@nau.edu.cn

本合同乙方将其基于图像识别的报销单据自动化识别校验系统的专利权转让甲方，甲方受让并支付相应的转让价款。双方经过平等协商，在真实、充分地表达各自意愿的基础上，根据《中华人民共和国民法典》的规定，达成如下协议，并由双方共同恪守。

第一条 本合同转让的专利权：

1. 为 发明（发明、实用新型、外观设计）专利。

让费且专利公示 15 日无异议后 20 日内，让与方向受让方交付合同第五条所述的全部资料；

2. 提交地点：全部资料的交付地点为受让方所在地或双方约定的地点；

3. 提交方式：让与方将上述全部资料以面交方式递交给受让方，并将资料清单以面交方式递交给受让方。

第七条 本合同签署后，由乙方负责在 / 内办理专利权转让登记事宜。

第八条 为保证甲方有效拥有本项专利，乙方向甲方转让与实施本项专利权有关的技术秘密：

1. 技术秘密的内容：以专利证书为准。
2. 技术秘密的实施要求：以专利证书为准。
3. 技术秘密的保密范围和期限：以专利证书为准。

第九条 乙方应当保证其专利权转让不侵犯任何第三人的合法权益。

第十条 乙方对本合同生效后专利权被宣告无效，不承担法律责任。

第十一条 甲方向乙方支付该项专利权转让的价款及支付方式如下：

1. 专利权的转让价款总额为：100800 元（大写：拾万零捌佰元整）；

2. 专利权的转让价款由甲方一次（一次、分期或提成）支付乙方。

具体支付方式和时间如下：

（1）汇款

（2）2026 年 3 月 30 日之前

乙方开户银行名称、地址和账号为：

开户银行：南京市工商银行大行宫支行

开户名称：南京审计大学

地址：南京市秦淮区太平南路 2 号

银行账号：4301016609100115921

第十二条 双方确定，在本合同履行中，任何一方不得限制另一方的技术竞争和技术发展。

第十三条 双方确定：

1. 甲方有权利用乙方转让专利权涉及的发明创造进行后续改进由此产生的具有实质性或创造性技术进步特征的新的技术成果，归甲方所有。

2. 乙方有权在已交付甲方该项专利权后，对该项专利权涉及的发明创造进行后续改进。由此产生的具有实质性或创造性技术进步特征的新的技术成果，归 乙方 所有。

第十四条 双方确定，按以下约定承担各自的违约责任：

1. 乙方违反本合同第 六 条约定，应当 退还甲方支付的全部专利权使用费。

2. 甲方违反本合同第 十一 条约定，应当 双方协商解决。

第十五条 双方确定，在本合同有效期内，甲方指定 王雨花 为甲方项目联系人，乙方指定 孙国岩、马杰 为乙方项目联系人。项目联系人承担以下责任：

1. 项目的联系与协调；

2. 资料的转接与保存。

一方变更项目联系人的，应当及时以书面形式通知另一方。未及时通知并影响本合同履行或造成损失的，应承担相应的责任

第十六条 双方确定，出现下列情形，致使本合同的履行成为不必要或不可能的，可以解除本合同：

1. 因发生不可抗力;

2. 无_____。

第十七条 双方因履行本合同而发生的争议,应协商、调解解决。

协商、调解不成的,确定按以下第1种方式处理:

1. 提交南京仲裁委员会仲裁;

2. 依法向人民法院起诉

第十八条 双方确定:本合同及相关附件中所涉及的有关名词和技术术语,其定义和解释如下:

1. 无_____;

2. 无_____。

第十九条 与履行本合同有关的下列技术文件,经双方确认后为本合同的组成部分:

1.技术背景资料: 无_____;

2.可行性论证报告: 无_____;

3.技术评价报告: 无_____;

4.技术标准和规范: 无_____;

5.原始设计和工艺文件: 无_____;

6.其他: 无_____。

第二十条: 双方约定本合同其他相关事项为: 无。

第二十一条: 本合同一式 陆 份,具有同等法律效力。

第二十二条: 本合同自国家专利行政主管部门登记之日起生效。

甲方：_____（盖章）



法定代表人 / 委托代理人：_____（签名）

2026 年 1 月 16 日

乙方：_____（盖章）



法定代表人 / 委托代理人：_____（签名）

2026 年 1 月 16 日

印花税票粘贴处：



电子发票(普通发票)



发票号码: 26322000001850475946

开票日期: 2026年03月11日

购买方信息				销售方信息			
名称：勤业科创服务（江苏）有限公司				名称：南京审计大学			
统一社会信用代码/纳税人识别号：91320412MA213E76X7				统一社会信用代码/纳税人识别号：1232000046600736XP			
项目名称	规格型号	单位	数量	单价	金额	税率/征收率	税额
*无形资产*专利技术转让							
					97864.08	3%	2935.92
合 计					¥ 97864.08		¥ 2935.92
价税合计（大写）					⊗ 壹拾万零捌佰圆整		
价税合计（小写）					¥ 100800.00		
备 注							

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开票人: 刘宇

到款凭证

财务内部核算专用，对外无效

(无需盖财务章)

到款日期	2026-02-05
凭证号	2026 2S 84
核销代码	2602 S84-4
摘要	收勤业科创服务（江苏）有限公司转来合同款
金额	¥ 100000.00
大写	壹拾万圆整

打印人工号：270007 打印人姓名：马杰

到款凭证

财务内部核算专用，对外无效

(无需盖财务章)

到款日期	2026-02-05
凭证号	2026 2S 84
核销代码	2602 S84-6
摘要	收勤业科创服务（江苏）有限公司转来合同款
金额	¥ 800.00
大写	捌佰圆整

打印人工号：270007 打印人姓名：马杰

其他材料 复印件*

表 1 申报 教学科研并重 类型 副教授 职称其他材料目录

序号	材料名称	备注
1	基于融资视角的科技型中小企业研发投入策略研究	代表性成果
2	实验（实践）课程《财务决策模拟实验》项目优秀	代表性成果

说明：1.申报类型处需选择“教学为主型”、“教学科研并重型”、“科研为主型”、“社会服务型”其中一项；职称处需选择“副教授”、“教授”其中一项。

2.思想政治理论课教师、体育学科教师、艺术学科教师需在备注中填写该学科名称（思想政治理论、体育、艺术）。

1. 基于融资视角的科技型中小企业研发投入策略研究



2. 实验（实践）课程《财务决策模拟实验》项目优秀

