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Macroeconomic drivers of digital transformation adoption in the UAE

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ABSTRACT

The article conducts an empirical inquiry into the impact of public sector development, private sector investment, political stability, financial and banking sector development, technical and vocational education and training (TVET) expansion, and quality-of-life improvements on digital transformation (DT) adoption policy in the UAE. It uses macroeconomic time series from 1995 to 2024, covering 30 annual observations. The estimation techniques employed include the Gregory–Hansen test procedure and the ARDL cointegration method, both of which confirm an equilibrium relationship between the selected macroeconomic variables and DT adoption, with a structural break. Based on the findings of the ARDL estimation, public sector development, private sector investment, political stability, financial and banking sector development, TVET expansion, and quality-of-life improvements significantly influence DT adoption. Importantly, the ARDL diagnostic tests confirmed the validity and robustness of the study's model. The findings indicate that UAE digital transformation is propelled by private investment, stable governance, financial sector growth, TVET, and quality-of-life improvements, while excessive or misdirected public sector expansion may inhibit the effective implementation of national DT policies. Policymakers should promote sector-specific digital transformation strategies, particularly in finance, healthcare, and education, to enhance productivity, optimize investment allocation, and support sustainable economic growth in the UAE.

Contribution/Originality: This study offers a novel contribution by integrating multiple macroeconomic sectors into a unified time-series framework to explain digital transformation policy in the UAE. It incorporates structural breaks and reveals the unexpected negative role of public sector expansion, providing new policy-relevant insights into efficient resource allocation for sustainable digital development.

1. INTRODUCTION

Since joining the Gulf Cooperation Council (GCC), the United Arab Emirates (UAE) has shown remarkable economic performance by leveraging its hydrocarbon endowment to achieve rapid infrastructure development and economic growth (Crupi & Schiliro, 2023). However, long-term sustainability concerns, along with increased exposure to oil price volatility, have prompted the country's policymakers to acknowledge the limitations of resource dependence and pursue an ambitious economic diversification agenda, in which tourism development and digital transformation (DT) emerge as central strategic pillars (Antwi-Boateng & Al Jaberi, 2022).

At the global level, the widespread application of advanced digital technologies, including artificial intelligence (AI), blockchain, cloud computing, and platform-based systems, has reshaped production processes and competitive dynamics, all of which have driven traditional industries to enhance their productivity and market efficiency by adopting large-scale digital solutions (Chen & Xing, 2025). In the UAE, these global developments have opened up significant growth opportunities, especially with the support provided by the digitalisation of traditional industries and the creation of new digital industries in the local context. Instead, it represents a system-wide transformation that is embedded in all aspects of national development. With the aim of achieving economy-wide transformation, the UAE's DT adoption strategy has been a coordinated effort across all economic sectors. In recent years, the country has seen developments in private sector investments, public sector performance, sustained political stability, technical and vocational education and training (TVET) development, financial and banking sector expansion and overall improvements in quality of life. Consequently, these developments have jointly created a conducive economic environment in which DT adoption can thrive. In this sense, looking at DT as a simple technological upgrade is a rather limited view of its context and the factors that drive its development and adoption.

Importantly, Agustina and Pramana (2019) suggest that the assessment of the macroeconomic impact of DT adoption can be done with the communication sector as an effective proxy. Indeed, the expansion of digital infrastructure and services has been instrumental in facilitating the UAE's growth (Telecommunications Regulatory Authority, 2011). For instance, the gross domestic product (GDP) contribution of this sector in the UAE rose from 4.1% in 2007 to 9.7% in 2022 (Mohammed, Ines, & Hayet, 2024). Additionally, over the last three decades, the country has demonstrated a strong commitment to accelerating DT initiatives. With these in consideration, it comes as no surprise that the UAE ranked eleventh globally and first within the Middle East and North Africa (MENA) region in the World Digital Competitiveness Report (International Institute for Management Development, 2024).

The UAE's commitment to DT adoption as a growth-enhancing mechanism becomes even clearer when non-oil GDP is considered. This is because digital activities made up about 12% of the non-oil GDP of the country in 2024. Not only this, but the government has declared a target of 20% contribution by 2030 (International Trade Administration, 2024). It is also important to note that the DT trajectory of the country is primarily led by the government through large-scale public digitalization initiatives aimed at reshaping economic structures, service delivery systems, and regulatory frameworks.

Theoretically, governments accelerate DT adoption and long-term growth as a desired consequence, primarily by investing in information and communication technology (ICT) (Alkish, Iyiola, Alzubi, & Aljuhmani, 2025; El Maiss, 2024). According to Alzarooni, Alhashmi, Lataifeh, and Rice (2024), the UAE's public sector is central to the creation of digital infrastructure, expansion of e-government platforms, and the deployment of smart technologies. This means that the sustained growth of the public sector has been critical, as it dictates the scale and speed at which the overall economy transforms digitally. Wardhono et al. (2023) provide additional empirical evidence to support this view, concluding that public investments in ICT enhance the public sector's efficiency and generate macroeconomic spillovers associated with digitalisation. Unsurprisingly, the UAE government prioritises heavy investments in technology and digital infrastructure – a strategy that has enhanced the country's digital readiness, placing it ahead of most economies in the MENA region (El Maiss, 2024).

While the public sector drives DT by providing foundational infrastructure, private investments are also necessary for translating digital strategies into market-based innovation and adoption strategies (Crupi & Schiliro, 2023). This is supported by Maradana et al. (2017), who reported that growth in private investments not only drives technology diffusion and enhances productivity at the firm level but also leads to the development of digital ecosystems. Therefore, for DT outcomes to be fully commercially viable, the participation of the private sector cannot be forgone (Wardhono et al., 2023). At the same time, political stability also drives the adoption of effective DT strategies (Alzaabi, Metawa, & Marks, 2025). This perspective is supported by Samoilikova, Kuryłowicz, Lyeonov, and Vasa (2023) and Yang, Gu, and Albitar (2024), who demonstrated that a stable environment can enhance the effectiveness of digital policy implementation through effective governance, better long-term planning, and reduced policy uncertainties. In contrast, political instability leads to an economy that lacks institutional coordination, which in turn stifles the growth and implementation of digital infrastructure projects (Alzarooni et al., 2024). In the UAE, the government has leveraged its sustained political stability to achieve uninterrupted DT investments, enabling continued policy execution and allowing the country to maximise its DT adoption benefits. For these reasons, there has been increased demand for DT in the form of smart government platforms, digital healthcare, online education, and integrated mobility services, among others. Yet, even though studies have explored the link between DT adoption and quality of life, the focus is typically on the effects of DT on the latter (El Khatib, Al-Nakeeb, Binkhadim, & Shehata, 2024).

The role of the financial and banking sector of the UAE has also been critical to the country's DT adoption strategy (Kothari, Grandhi, & Thrassou, 2025; Naouar, 2025). As evidenced by Dwivedi, Alabdooli, and Dwivedi (2021), the modernization of the financial sector is closely linked to advancements in digital technologies. Looking at the story of the UAE's financial sector, the Central Bank of UAE (2020) reports an expansion of total assets from AED 333.2 million in 2001 to AED 3.18 billion in 2020. This financial deepening was accompanied by an increase in the number of transactions and customer demand for digital solutions, as well as more complex service offerings. As a result, the sector was highly incentivised to move towards stronger fintech adoption, wider adoption of digital payment platforms, and regulatory sandboxes (Dwivedi et al., 2021; Srouji, 2020). Amidst all this, the primary focus of existing empirical research has been on the effect of DT adoption on financial performance. Thus, the reverse relationship, where the development of the financial sector shapes national DT adoption policy, has remained underexplored (Naimi-Sadigh, Asgari, & Rabiei, 2022).

Quality of life has similarly emerged as one of the main policy objectives in the UAE, as its importance as a determinant of DT adoption grows (El Khatib et al., 2024). The country currently has full national coverage in terms of internet penetration, and this has been the case since 2022. Interestingly, the internet penetration level was at 66.4% in 2008, a mere fourteen years prior (Federal Competitiveness and Statistics Centre, 2023). Beyond household internet penetration, the development in the quality of life of the UAE population has increased their expectations in areas of service efficiency, accessibility, and convenience. For these reasons, there has been increased demand for DT in the form of smart government platforms, digital healthcare, online education, and integrated mobility services, among others. Yet, even though studies have explored the link between DT adoption and quality of life, the focus is typically on the effects of DT on the latter (El Khatib et al., 2024). Just like in the case of the financial sector, the reverse relationship has been largely neglected. Additionally, macroeconomic indicators suggest that income-based measures alone fail to capture the multidimensional nature of well-being, and this necessitates a broader measure of quality of life in assessing its effect on DT adoption (World Bank, 2023).

Along with the aforementioned sectors, the development of human capital through TVET also helps provide a solid foundation for DT adoption (Aldabbas & Alzoukani, 2025). The labor market, in the wake of digital technology diffusion, has evolved to require more digitally skilled and technologically adaptive workers (Bousrih, Elhaj, & Hassan, 2022; Habibi & Zabardast, 2020). Accordingly, the UAE has enhanced the digital readiness of its workforce and eased the barriers to DT adoption by increasingly investing in TVET institutions and developing industry-oriented skills (Ahmed, Al Amiri, & Abudaqa, 2024; Hamouche, Bani-Melhem, Haj-Salem, Abdalla, & Jamal, 2026). The economic significance of TVET has been duly recognized and empirically explored by researchers like Ali Asadullah (2019) and Asadullah and Zafar Ullah (2018). However, its role as a driver of DT adoption in the UAE remains empirically underexplored.

Even though the literature on DT continues to grow, there has been no empirical inquiry that uses macroeconomic time series to explore how these macroeconomic variables jointly influence DT adoption in the UAE. Some studies have acknowledged the existing links between the variables. However, these are not comprehensive and are often cross-sectional, descriptive, or based on short-term datasets. Therefore, these studies have limitations in that they do not capture dynamic adjustment processes and ever-changing equilibrium relationships. While other studies have employed macroeconomic time series rather than capturing DT adoption in a response role, they often explored DT adoption as an explanatory variable that influences growth (Glinskiy, Serga, Tsurikov, & Plotnikov, 2020; Wang, Shen, & Ling, 2023).

To address the abovementioned gaps, the present study aims to capture the UAE's DT adoption policy as a response variable. In particular, this work uses time series data from 1995 to 2024 to empirically investigate the predictive role of the selected macroeconomic drivers, namely, political stability, private sector investment, public sector development, financial and banking sector development, TVET development and quality-of-life development, on DT adoption in the UAE. This is a novel study that focuses on the drivers of DT adoption rather than its outcomes. It also generates original empirical evidence explaining the mechanisms by which institutional development and macroeconomic conditions drive DT outcomes within the context of the UAE's rapidly developing economy.

Following the current section, the second section of this article presents the literature review. After this, the methodology follows in the third section, which details all the procedures followed in performing the econometric estimations. The fourth section analyses the results and discusses them, whereas the final section presents the conclusion.

2. LITERATURE REVIEW

Following the heightened interest in DT adoption from a macroeconomic perspective in recent times, many studies have investigated its impact on economic growth and other macroeconomic variables, but largely neglected the reverse. Where the focus is on the impact of other macroeconomic variables on DT adoption, this is done in a limited fashion, and critically, there are no such studies in the UAE context. For instance, regarding public sector development, Niftiyev (2022) employed panel least squares, fixed effects, and random effects models in exploring the effect of public development within the expenditure channel on DT adoption in the form of e-government development. The study involved 154 countries and covered the period from 2008 to 2018. The effect was negative, suggesting that the allocation of public expenditure to DT adoption was prone to inefficiencies. This result aligns with the study by Dornean and Țicu (2025), which also applied panel least squares regression with fixed effects, but involved 27 European Union (EU) countries and covered the period between 2003 and 2022. While these studies revealed a negative association, some authors conceptually argue that the relationship should be positive, as the development of expenditures in the form of subsidies and tax incentives is expected to encourage wider DT adoption (Wu, Zeng, & Song, 2025). Granted, these are merely theoretical arguments, but the evidence provided by Dornean and Țicu (2025) and Niftiyev (2022) still has key limitations. Both studies isolate e-government development, which is limited in scope compared to overall DT adoption, as targeted by this study. Additionally, the EU sample used by Dornean and Țicu (2025) has limited applicability to the UAE, considering the differences in governance structures and fiscal priorities.

Furthermore, Cao, Fu, Li, and Wang (2025) focused on how private investments impact DT adoption, applying a multi-period Difference-in-Differences (DID) methodology on a dataset of over 37,000 firm-year observations in China. They focused on the deregulation of private investments in broadband markets and its impact on enterprise DT adoption, revealing that easing private capital restrictions significantly enhanced enterprise DT adoption. This finding is supported by the notion that private investment serves as a catalyst for DT adoption by providing capital and fostering innovation (Balbaa, Abdurashidova, & Nasirkhodjaeva, 2024). Nevertheless, the study only relied on private investments in broadband markets. It also relied on keyword frequencies in annual reports as a proxy for DT adoption, which introduces potential selection bias, as keyword frequency does not capture the true economic value of DT adoption. Firms may simply mention DT initiatives without substantive implementation; thus, this introduces measurement validity concerns.

Moreover, Li and Xie (2025) investigated how the financial sector influences DT adoption. Similar to Cao et al. (2025) and Li and Xie (2025), who only conducted a segmented study, focusing on digital finance development and corporate DT adoption. Upon application of fixed-effects and instrumental variable regressions on data from 4,344 Chinese A-share listed firms between 2015 and 2022. The study showed that developments in digital finance boosted DT adoption by broadening financing channels and eliminating traditional financing constraints. Indeed, other researchers argue that as the financial sector develops, the accompanying modernization spills over to other areas of commerce and economic activities, promoting DT adoption (Yoganandham, 2024). However, Li and Xie (2025) also rely on text analysis of annual reports as a proxy for DT adoption. The study also focuses on A-share listed firms, a small segment of the economy, which limits the ability to draw economy-wide implications from the results.

Shifting the focus onto quality of life and its impact on DT adoption, there is a severe dearth of empirical evidence. Nonetheless, the study by Kubatko et al. (2022) comes closest to the scope of this study. They applied generalized least squares regression with random effects to data from 33 European economies between 2016 and 2018 to investigate how DT adoption impacts life satisfaction. While this study primarily focuses on the DT-quality of life effect, they indicate, in their empirical modelling, that income, reduced debt, and human capital development in science and technology "lead to technological progress" (Kubatko et al., 2022). However, understandably, the deficiencies of this study are glaring, considering that it makes an inference based on a model that originally tests how DT adoption impacts quality of life, and not the other way round. Furthermore, although the variables employed reflect certain aspects of quality of life, they constitute only a partial measure of the construct. It should be noted, though, that the potential for quality-of-life development to enhance DT adoption through human capital development is conceptually supported by Kryzhanovskij, Baburina, and Ljovkina (2021) and Ma and Ma (2025), emphasizing the need for a more direct and rigorous empirical test.

For political stability, Asongu and Biekpe (2017) provide one of the few empirical studies that examine how political stability influences DT adoption. They investigated how political stability, as a part of governance quality, influences DT adoption (measured as ICT penetration) in Sub-Saharan Africa. Using Generalised Method of Moments (GMM) on panel data from 49 countries between 2000 and 2012, they revealed that political stability, in the short run, exerts a positive effect. Notably, results show that this effect becomes negative in the long run. In particular, this study's findings suggest that while political stability initially promotes DT adoption, if resulting policies become rigid and cannot adapt easily, then the long-run effects of DT adoption may be restrictive. Nonetheless, the study's findings are specific to the region of Sub-Saharan Africa, thus limiting its generalisability to other contexts, such as the UAE. The study also utilises a different set of ICT penetration indicators, namely, internet penetration, mobile phone penetration, and telephone penetration, thus neglecting other DT-enabled economic activities, such as e-commerce and fintech, within the economy.

Meanwhile, using a balanced panel of 30 Chinese provinces over the period 2013–2023, Wang and Xia (2025) employed panel threshold regression, two-way fixed effects, and instrumental variable techniques to examine the association between the quality of economic development (QED) and TVET development. Given the limited number of studies that have investigated the effect of TVET on DT adoption, Wang and Xia (2025) study is relevant because it incorporates the level of digitalisation as a QED indicator. Their findings revealed a positive effect, suggesting that TVET helps minimise skill mismatches during the process of digital production. However, the study treated digitalisation as a mere component of the broader QED framework rather examined it as a distinct dependent variable. Hence, the study provides only limited evidence regarding the direct impact of TVET on DT adoption.

The abovementioned review of the existing literature reveals that despite the widespread research interest in DT adoption, few studies have considered investigating it beyond an explanatory role. Thus, to address the gap and the scarcity of empirical evidence on the topic, the present study aims to contribute to the literature by explicitly examining how selected macroeconomic variables affected DT adoption in the UAE during the period 1995–2024. Additionally, where DT adoption has been considered a dependent variable, many studies exhibited deficiencies in how it was measured. Hence, the present study targets this gap and ensures robustness by capturing DT adoption through the ICT sector's GDP contribution to the UAE's economy. Thus, the study builds a model that jointly assesses the effect of the selected macroeconomic variables, thereby capturing their individual influences with high statistical rigour. In doing so, it departs from prior work and provides a more comprehensive and contextually relevant assessment of how macroeconomic factors influence DT adoption in the UAE.

3. METHODOLOGY AND DATA

3.1. Model Specification and Theoretical Framework

To examine the influence of macroeconomic sectors on the DT in the UAE, the study's actual model borrows its functionality based the origin from the Technological Growth Model of Romer (1990) within the DT with some modifications that consider the macroeconomic conditions of the UAE economy. Modelling the DT adoption policy as a technology improvement's proxy as the dependent variable, can be expressed in its linear form as:

$$ln\, DT_t = \alpha + \beta_1\, ln\, PEX_t + \beta_2\, ln\, PRS_t + \beta_3 BS_t + \beta_4 QL_t + \beta_5 PS_t + \beta_6\, ln\, TVET_t + e_t \quad (1)$$

Where *DT* denotes DT adoption policy at time *t*, is measured as the ICT sector's contribution to GDP. *PEX* denotes public sector development measured by its growing expenditures in the country at time t, *PRS* denotes private sector investment at time *t*, proxied by gross fixed capital formation. *BS* denotes banking and financial sector development at time *t*, proxied by domestic credit to the private sector, expressed as a percentage of GDP. *QL* denotes the quality of life of the UAE's population at time *t*, proxied by the Human Development Index (HDI), which ranges from 0 to 1. *PS* denotes political stability at time *t*, proxied by the political stability and absence of violence/terrorism indicator, ranging from 0 to 100. TVET denotes technical and vocational education and training at time *t*, measured as the TVET sector's contribution to GDP. e is the stochastic error term, subscript t denotes the study time period, βi denotes the vector of slope coefficients of the variables, where i=1,….,6, α denotes the intercept, and *ln* is the natural logarithm converter. This study model argues that when adopting this model for DT adoption policy, the presence of economic processes within the economy contributes to causing DT development to grow, and in turn, influences economic growth. The DT adoption policy model integrates the selected macroeconomic sectors that affect its profile in the economy of the UAE, as presented in Equation 1.

As shown in Equation 1, the coefficients of the explanatory variables, which serve as proxies of selected macroeconomic sectors of interest, are expected to have the signs $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5,$ *and* $\beta_6 > 0$, respectively. This is to say that positive shocks in public sector development, private sector investment, political stability, financial and banking sector development, and TVET education are expected to raise the level of DT adoption strategy in the UAE.

3.2. Estimation Techniques

In this study, the Gregory and Hansen (1996) technique, along with the Autoregressive Distributed Lag (ARDL) model, as introduced by Pesaran, Shin, and Smith (2001), is utilised to confirm the equilibrium relationship between the UAE's DT adoption policy and its potential drivers. However, the Gregory-Hansen cointegration test is used to identify the specific point in the equilibrium relationship where there is a structural change (Atatreh, Gamal, Hussin, Jalil, & Abd Hadi, 2025; Maashani, Gamal, Shaarani, Rambeli, & Zulkifli, 2026).

The Gregory-Hansen procedure specified three models to identify the precise structural break, two of which are implemented in this study, as shown in Equation 2 and Equation 3.

Model 1 – The model incorporates a single structural break in the intercept at an estimated time-point T_b (C).

$$ln\, DT_t = \mu_1 + \mu_2 DU_{tk} + \alpha_1\, ln\, PEX_t + \alpha_2\, ln\, PRS_t + \alpha_3 BS_t + \alpha_4 QL_t + \alpha_5 PS_t + \alpha_6\, ln\, TVET_t + e_t \quad (2)$$

Model 2 – The model incorporates a structural break in the intercept and slope of the trend function at an estimated time-point T_b (C/T).

$$ln\,DT_t = \mu_1 + \mu_2 DU_{tk} + \mu_3 t + \alpha_1 \,ln\,PEX_t + \alpha_2\,ln\,PRS_t + \alpha_3 BS_t + \alpha_4 QL_t + \alpha_5 PS_t + \alpha_6\,ln\,TVET_t + e_t \quad (3)$$

As presented in Equation 2 and Equation 3, μ_1 represents the constant before the level shift, μ_2 represents the change in the intercept at the shift, α represents the slope coefficient before the regime shift, and e represents the error term. The identified structural break is then included in the ARDL procedure to stand for the structural break effect. This mutual technique simplifies the accurate estimation of the ARDL model and helps to better understand the equilibrium dynamics of the relationship between DT and its drivers.

Based on the DT adoption model, the unrestricted error-correction representation of the ARDL model is expressed as:

$$\Delta \ln DT_t = \alpha_1 + \sum_{j=1}^{p} \delta_j \Delta DT_{t-j} + \sum_{i=1}^{K}\sum_{j=0}^{q} \beta_{ij}\Delta Z_{i,t-j} + \sigma_1 D_t + \lambda_1 DT_{t-1} + \lambda_2 Z_{t-1} + e_{1t} \quad (4)$$

As presented in Equation 4, the difference operator is denoted by Δ, the dummy variable for the structural break identified in the Gregory-Hansen cointegration procedure is denoted by D_t, the intercept is denoted by α, the dynamic parameters are denoted by δ and β, the long-run coefficients are denoted by λ_1 and λ_2, and the vector of selected macroeconomic variables entering the DT adoption policy model in Equation 1 is denoted by Z.

Within this framework, the null hypothesis of no cointegration, denoted by ($H_0\colon \lambda_1 = \lambda_2 = 0$), is compared to the alternative hypothesis of cointegration, denoted by ($H_1\colon \lambda_1 \neq 0, \lambda_2 \neq 0$), to determine the existence of equilibrium relationships among the series.

To reliably determine that there is cointegration among the series, the F-statistic, which is estimated from the ARDL bounds test, is compared with Narayan (2005) lower and upper critical bound thresholds. The comparison looks at whether the estimated F-statistic is larger than the upper bound or smaller than the lower bound. If it is larger than the upper bound, the cointegration relationship is reliably confirmed. However, if it is smaller than the lower bound, the null hypothesis cannot be rejected, and it can be reliably confirmed that there is no cointegration relationship. Importantly, in the event that the estimated F-statistic is neither larger than the upper bound nor smaller than the lower bound, a cointegration relationship can neither be reliably confirmed nor denied, leading to inconclusive results (Maashani et al., 2026).

Upon confirming that there is a cointegration relationship, the estimation of the long-run relationship is derived by normalizing the coefficients of the lagged explanatory variables (λ_2) by the coefficient of the lagged dependent variable (λ_1), that is, the long-run coefficient equals $-(\lambda_2/\lambda_1)$. In the same way, for the short-run estimation, a dynamic error-correction (ECM) based ARDL model is used, as shown in Equation 5.

$$\Delta y_t = \alpha + \sum_{i=1}^{p-1} \zeta_i' \Delta y_{t-i} + \sum_{i=1}^{p-1} \xi_i' \Delta x_{t-i} + \sum_{j=1}^{r} \chi_j' DU_{t,j} + \phi \mu_{t-1} + \varepsilon_t \quad (5)$$

As presented in Equation 5, the slope of the error correction term lagged by one period (μ_{t-1}) is denoted by ϕ. This shows how quickly short-term deviations converge back to the equilibrium state.

Finally, a series of robustness tests is conducted to determine that the ARDL model is valid for estimating the DT adoption model. These include the heteroscedasticity test, the autocorrelation test, the normality test, and the misspecification bias test. It must also be ensured that the model is stable for the purpose of the DT adoption model, and this is done by conducting the tests for the Cumulative Sum of Recursive Residuals (CUSUM) and the Cumulative Sum of Squares of Recursive Residuals (CUSUMSQ).

3.3. Data

The study relies on time series for the period from 1995 to 2024. With 30 annual observations, all variables are obtained from the UAE's Federal Competitiveness and Statistics Centre (FCSC), except for the quality-of-life variable, which is sourced from the United Nations Development Programme (UNDP). The political stability variable is then obtained from the World Bank database.

4. RESULTS AND DISCUSSION

4.1. Descriptive and Correlation Analyses

The descriptive statistics of the study's variables for the 30-year period from 1995 to 2024 are presented in Table 1. With a total of 30 observations, all the sectors exhibit significant variation. In terms of which specific macroeconomic variables to include in the study, it considers how prior research has explored how several factors, including quality of life, political stability, private investments, public sector development, banking and financial sector development and TVET shape aspects of DT adoption, these studies remain fragmented and often rely on narrow proxies, such as ICT penetration, e-government indices or keyword frequencies in firm reports. Hence, they lack the methodological rigour required to generate reliable macroeconomic evidence. Furthermore, because these variables are region-specific and cannot be reliably generalised to the UAE context, they are constrained in terms of scope. This is particularly pronounced in the aspects of TVET expansion and public sector development, both of which demonstrate that the UAE economy has progressed rapidly over the 30-year period. The variables are suitable for subsequent econometric estimation as they are generally within acceptable ranges, especially when the focus is on the skewness and kurtosis values.

Table 1. Descriptive Statistics.

Statistics	PEX	PRS	BS	PS	QL	TVET	DT
Mean	7.7299E+11	62522.73	56.66	91.52	0.84	30301920.15	30929.84
Maximum	1.81341E+12	158561.94	87.92	100	0.94	49010886.72	55656.65
Minimum	60756	16537.20	29.22	76.19	0.76	6180754.25	10481
Std. Dev.	5.07964E+11	38736.55	19.01	6.62	0.06	10730641.36	13868.88
Skewness	-0.10	0.65	-0.09	-0.69	0.42	-0.69	0.11
Kurtosis	2.22	2.87	1.57	2.48	1.95	2.81	1.73
Observations	30	30	30	30	30	30	30

Before proceeding to subsequent analyses, it should be noted that though originally measured in their absolute values, the natural logarithmic transformations of DT, PEX, PRS, and TVET are used. BS, PS, and QL are used in their original measured forms. Specifically, BS is expressed as a percentage, QL is measured as an index ranging from 0 to 1, and PS is measured as an index ranging from 0 to 100.

As presented in Table 2, the correlation statistics of the study's variables reveal that all of the explanatory variables are significantly correlated with DT adoption. With the exception of public sector development, which is significant at the 5% threshold, all other variables are significant at the 1% threshold. Notably, private investment (0.88) and financial and banking sector development (0.84) share the strongest correlations with DT adoption. All variables except political stability (-0.77) share a positive correlation with DT adoption. Considering some explanatory variables share a high correlation (for example, public sector development and TVET development, with a statistic of 0.91), the use of ARDL is justified, as it allows for stringent robustness checks.

Table 2. Correlation Matrix.

Variables	lnDT	lnPEX	lnPRS	BS	QL	PS
lnPEX	0.45^{**}					
lnPRS	0.88^{***}	0.79^{***}				
BS	0.84^{***}	0.73^{***}	0.89^{***}			
QL	0.83^{***}	0.70^{***}	0.88^{***}	0.79^{***}		
PS	-0.77^{***}	-0.56^{***}	-0.74^{***}	-0.81^{***}	-0.81^{***}	
lnTVET	0.61^{***}	0.91^{***}	0.85^{***}	0.76^{***}	0.79^{***}	-0.64^{***}

Note: Asterisk, ** represents significance at 5% threshold and *** represents significance at 1% threshold.

4.2. Preliminary Analysis of Unit Root, Structural Break and Cointegration Test

Before exploring the relationship between the DT adoption and its selected macroeconomic drivers in the UAE, it is imperative to ensure that all the series included in the study's model are integrated of order I(1) or below. The augmented Dickey and Fuller (1979) and Zivot and Andrews (2002) unit root tests, as reported in Table 3, are used for this purpose.

Table 3. Results of unit root tests of ADF and ZA.

Test/Variables		lnDT	lnPEX	lnPRS	BS	QL	PS	lnTVET
ADF	Level	-0.82**	-1.97**	-0.58**	-1.43**	-0.48**	-1.78**	-8.47***
	1st Diff.	-5.26***	-5.25***	-3.38**	-4.48***	-3.14**	-5.25***	-
ZA	Level	-4.23**	-36.99***	-3.31**	-4.69**	-4.65**	-8.52***	-10.03***
	T_b	2001	2001	2005	2007	2014	2017	2009
	1st Diff.	-5.98**	–	-4.58*	-5.12**	–	-6.86***	–
	T_b	2003	–	2009	2010	–	2018	–

Note: For the ADF test (No intercept and trend, in this case), the null hypothesis of a non-stationary process is tested against the alternative hypothesis of a stationary process. For the ZA test, the null hypothesis of a non-stationary process is tested against the alternative hypothesis of a trend stationary process. The applied ZA also accounts for a structural break in the intercept (Model A) at an unknown time, and the determined date is denoted by T_b, as shown in the ZA results. With a maximum lag length of 3, the Schwarz Information Criteria (SIC) of Schwarz (1978) was used to choose the optimal lag length for both tests. Importantly, the critical values provided by MacKinnon (1996) for the ADF test are -2.6471 for the 1% threshold, -1.9529 for the 5% threshold, and -1.6100 for the 10% threshold. For Model A of the ZA test, the critical values are -5.34 for the 1% threshold, -4.93 for the 5% threshold, and -4.58 for the 10% threshold. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

Both results of ADF and Zivot-Andrews unit root tests confirmed that all the tested variables are integrated either of order I(0) or I(1), indicating that none of the tested variables is dealing with I(2) order. Upon confirmation that the series includes no I(2) (or above) processes, the Gregory-Hansen (GH) procedure was implemented, as shown in Table 4. The GH procedure confirmed the presence of cointegration with a t-statistic of -5.47, significant at the 10 percent level, based on the level dummy shift with the intercept model presented in Equation 2. The results indicate that the model identifies 2010 as the structural break year. This breakpoint corresponds to the post-global financial crisis recovery period, during which the UAE accelerated its economic diversification strategy by initiating major smart city programs and increasing its investments in education, innovation ecosystems and digital infrastructure (Sharafi, 2022).

Table 4. Results of the Gregory-Hansen cointegration test.

Model	ADF*	T_b	t-critical	Decision
GH-1 (Level shift)	-5.47*	2010	-5.31	Reject the null hypothesis
GH-2 (Level shift with trend)	-6.29	2006	-6.36	Accept the null hypothesis

Note: The determined break date is denoted by T_b, and the significance threshold of 10% is denoted by the asterisk*. Gregory and Hansen (1996), Table 1 provides the critical values for m=4.

The ARDL bounds test for cointegration was applied with the 2010 structural break dummy, following the confirmation of the stationarity properties and the determination of a structural break date. According to the results, which are displayed in Table 5, the F-statistic is larger than the upper critical bound of 4.15 at the 5% significance threshold, signalling that the null hypothesis can be rejected. The output shows that an equilibrium relationship exists between DT adoption and the selected macroeconomic variables in the UAE.

Table 5. Results of ARDL test.

Lag Length	F-statistic	k	n	Bounds	10%	5%	1%
				I(0)	2.33	2.79	3.98
2,1,2,2,2,2,0	5.44**	6	30	I(1)	3.52	4.15	5.69

Note: The number of explanatory variables is denoted by k, and the asterisks, **, signify significance at the 5% threshold. Narayan (2005) provides the critical values. While the maximum lag length was set to 2, the AIC guided the optimal lag length selection.

4.3. Digital Transformation and Its Macroeconomic Drivers: Long- and Short-Run Relationships

After establishing cointegration while accounting for the structural break, the ARDL approach was applied to the digital transformation model. Based on the optimal lag structure (2,1,2,2,2,2,0) selected using the AIC criterion, the estimation results are presented in Table 6. The corresponding long-run and short-run coefficients are reported in Panels A and B of Table 6, respectively.

Table 6. Estimation results of the ARDL model.

Panel A: ARDL(2,1,2,2,2,2,0) Long-run coefficient estimates–Dependent variable: DT						
Cons	**lnPEX**	**lnPRS**	**BS**	**QL**	**PS**	**lnTVET**
-3.44	-0.08 (-3.52)**	0.24 (2.17) **	0.40 (1.69) *	1.44 (1.81)*	0.03 (3.64)**	0.31 (2.72)**

Panel B: ARDL(2,1,2,2,2,2,0) Short-run coefficient estimates – Dependent variable: ΔlnDT		
Regressors	Lag order	
	0	1
ΔlnDT	-	-0.08 (-2.52)**
ΔlnPEX	-0.16(-31.40)***	-
ΔlnPRS	0.69(12.89)***	0.33 (5.05)***
ΔBS	0.03(0.30)	0.40 (3.57)***
ΔQL	12.15(10.77)***	9.40 (5.16)***
ΔPS	0.40 (1.79)*	-0.02 (-5.75)***
ΔlnTVET	-	-
DU_2010	0.18 (6.21)***	-

Note: The AIC guided the selection of the optimal lag length, though the maximum lag was set to 2. The t-ratios are placed in parenthesis (.), whereas the first difference operator is denoted by Δ, and the 1% significance threshold, 5% significance threshold, and 1% significance threshold are denoted by the asterisks, ***, ** and *, respectively.

The long-run estimates reported in Panel A of Table 6 show that public sector development has a statistically significant negative effect on the DT adoption policy at the 5 percent level. Specifically, a 1 percent increase in public sector development reduces DT adoption by approximately 0.08 percent. This unexpected result, as it contradicts the widely held view that continuous public sector development in digital infrastructure, e-government services, and regulatory frameworks enhances DT adoption capacity, as documented in previous UAE-based studies (Sharafi, 2022). The negative long-run relationship suggests that the expansion of public sector development in the UAE may have generated resource misallocation and crowding-out effects, whereby increased government spending is directed toward administrative expansion and non-digital infrastructure rather than productivity-enhancing digital investments, thereby constraining the pace of digital transformation adoption. Another possible explanation is that public sector expansion may be accompanied by added regulatory requirements that simply discourage private firms or delay them from adopting digital technologies. By contrast, the results show that the coefficient (0.24) of private sector investment demonstrates a positive and significant long-run relationship with DT adoption at the 5 percent level. This indicates that a 1% increase in private sector investment increases about a 0.24 percent in DT adoption. This "moderate elasticity" indicates that the effect shows measurable gains in DT adoption competitiveness, thus demonstrating its economically meaningful impact. For instance, DT adoption increased by roughly 2.4% in response to a 10% increase in private investment. As Mızrak (2023) demonstrates, this relationship indicates that digital progress is enhanced considerably when private sector engagement is effective and sustained.

For the results on the effect of the financial and banking sector, a coefficient of 0.40, marginally significant at the 10% level, indicates that an increase of 1% in financial and banking sector development corresponds to an increase in DT adoption by 0.40 percent in the long run. It can then be inferred that as the financial and banking sector grows, it plays a significant role in driving broader DT adoption across the economy. In support of this dynamic, empirical evidence from the UAE shows that the adoption of fintech and other digital innovations by the banking sector enhances economic competitiveness and performance. Dwivedi et al. (2021), for instance, show that banks in the UAE become significantly more competitive and efficient in areas of service delivery following their adoption of innovative fintech technologies. The UAE's financial and banking sector enjoys significant investments in digital banking and fintech solutions, especially in core banking operations, as banks continue to move towards mobile and digital financial services. It comes as no surprise that the modernization of the financial sector in the UAE is considered a catalyst for DT adoption across the economy (Aloulou, Grati, Al-Qudah, & Al-Okaily, 2024). Even though the positive effect derived in this study is consistent with a larger section of the existing literature, there are some slightly contrasting views. Mushtaq and Haider (2025), for instance, hold the view that at the firm level, structural and regulatory challenges can sometimes limit the ability of the financial and banking sector to boost DT adoption. Nonetheless, they agree that digital integration in financial planning and governance at this level improves organizational agility and decision-making, thereby boosting competitiveness. In line with this view, Alsuwaidi, Sharif, and Alshami (2025) emphasize that the benefits of banking sector growth in driving DT adoption can be realized only when it is accompanied by organizational culture, workforce skills, and regulatory readiness. Thus, while the financial and banking sector is a proven driver of DT adoption, the strength of the impact depends on complementary factors such as governance, regulatory frameworks, and human capital.

Quality of life then reported a coefficient of 1.44, which is marginally significant at the 10% threshold. This indicates that it has a positive and statistically significant long-run effect on DT adoption, and a 0.1-unit improvement in quality of life is associated with an approximately 14.4 percent increase in DT adoption. It should be noted that this large elasticity of quality of life is interpreted within the UAE context, as the country's advanced digital infrastructure and strong government-driven digitalization initiatives may amplify the responsiveness of DT adoption to improvements in quality of life. This finding aligns with evidence from Nouria (2024), which shows that social well-being, access to infrastructure, and inclusive development contribute to the development of DT adoption. To explain this, improvements in living standards enhance digital readiness as the population gains increased access to education, healthcare services, and digital connectivity. This then strengthens the capacity of individuals and institutions to adopt and utilize digital technologies effectively. The relationship is especially evident in the UAE, as national development strategies explicitly integrate quality-of-life enhancement with digital modernization goals. Focusing on the UAE context, the abovementioned result supports the view that private capital formation in areas like automation, ICT, and innovation significantly drives digital competitiveness (Salman, Mansor, & Alshami, 2025). For example, strategic leadership initiatives that aim to boost smart infrastructure, advanced healthcare systems, and education reform are strongly associated with broader DT objectives (Ahmed et al., 2024). Further evidence provided by Al-Hajri, Abdella, Al-Yafei, Aseel, and Hamouda (2024) reveals that DT adoption initiatives in the Gulf region, especially in the UAE, are most effective when implemented within comprehensive socioeconomic development frameworks.

Furthermore, the ARDL estimation revealed that political stability has a positive and statistically significant effect on DT adoption in the long run. Its coefficient of 0.03 is significant at the 5% threshold, implying that a 1-point increase in political stability is associated with a 3% rise in DT adoption. This finding underscores the important role played by governance effectiveness, policy predictability, and institutional continuity in facilitating digital initiatives. Within the UAE context, evidence suggests that long-term national strategies, such as the UAE Digital Government Strategy and Smart Dubai initiatives, which are brought about by stable leadership, have led to sustained investments in innovation ecosystems and digital infrastructure. One such piece of evidence is provided by Mosteanu and Alghaddaf (2019a), who concluded that political and regulatory stability in the UAE significantly improves the implementation of digital business models and e-government services.

Another example is the study by Al-Hajri et al. (2024), which reports that stable political environments and governance frameworks boost digital readiness and technology diffusion in emerging economies, including Gulf countries. However, given that political stability on its own may not suffice in facilitating DT adoption, there is a need for strong institutional and structural conditions to be in place (Privara & Caplanova, 2025). Indeed, some scholars have argued that there should also be flexibility along with political stability, as rigid regulatory environments tend to slow down innovation efforts. Pelkmans and Renda (2014) demonstrated this notion by showing how digital entrepreneurship and innovation performance are hindered by regulatory rigidity in stable political systems. Furthermore, even though political stability reduces uncertainties, inclusive institutional reforms and market openness can only be achieved with technological progress (Allard, Martinez, & Williams, 2012). Overall, the abovementioned views, along with the results of the estimation, imply that although political stability in the UAE provides a strong foundation that supports DT adoption, its effectiveness still depends on private sector participation, complementary regulatory reforms, and continuous institutional modernisation (Alfaqaei, Awad, & Alzaatreh, 2024).

Meanwhile, TVET development reported a coefficient of 0.31, which is significant at the 5% threshold. This means that TVET expansion contributes considerably to DT adoption in the UAE. Specifically, a 1% increase in TVET development leads to a 0.31% increase in DT adoption, suggesting the essential role played by skilled human capital to help the economy effectively apply and spread large-scale DT use. Studies in the UAE present similar findings, as investments in digital skills programmes, vocational training, and applied technical education have been shown to strengthen workforce readiness for advanced technologies. For instance, Abdalla Alfaki and Ahmed (2013) showed how technological adaptability due to the UAE government's TVET reforms has led to enhanced labour productivity in the country. Sibanda, Bakhouche, Chaita, and Kehal (2020) add that initiatives in Gulf economies that focus on skill development tend to promote innovation capacity and technology adoption. More recently, evidence provided by Ateeq, Almuraqab, and Ateeq (2025) and Alsuwaidi et al. (2025) shows that workforce upskilling and digital competency programs are critical to achieving the UAE's national digital economy and smart government objectives. Thus, the findings of this study, as well as the supporting evidence from the literature, support the importance of TVET to the UAE's DT adoption. Despite this, some suggest that the positive effect of political stability requires ideal conditions, including training programs that are carefully aligned with the digital competency needs of the labour market. Oliveira and de Souza (2022), for instance, argue that the effectiveness of TVET to boost DT adoption can be stifled by skill mismatches and outdated curricula. Also, according to Akour and Alenezi (2022), organizational readiness and digital infrastructure are two of the key conditions needed for the DT adoption benefits of TVET to be maximised. Thus, the evidence generated by this study and other studies strongly supports the role of TVET as a driver for DT adoption in the UAE, provided the aforementioned conditions are present.

Focusing on the short-run dynamics shown in Panel B of Table 6, the coefficient for changes in public sector development was -0.16 and significant at the 1% threshold. This indicates that changes in public sector development exert a contemporaneous significant negative effect on DT adoption in the short run. This result means that an increase in public sector development by 1 percent corresponds to a 0.16 percent decrease in DT adoption in the short run. Thus, in line with the pattern described in studies on fiscal-driven digital transitions (Rivero del Paso, Pattanayak, Uña, & Tourpe, 2023), short-term developments in the public sector may initially be directed toward non-digital priorities, causing its positive effects to be delayed.

Contrastingly, private investment reported coefficients of 0.69 and 0.33 for the current and lagged periods, respectively, both of which are significant at the 1% threshold. This means that an increase in private investment by 1 percent corresponds to increases in DT adoption in the current and first lagged periods by 0.69 percent and 0.33 percent, respectively. This matches the expectation in the literature, as private capital formation in ICT, automation, and innovation ecosystems facilitates digital competitiveness (Mızrak, 2023). It should also be noted that the lagged effect of private investment is positive, which means that the effect on DT adoption persists in the short run. Overall, this result confirms that private capital formation generates immediate and sustained benefits in advancing DT adoption.

Next, the one-period lag of financial and banking sector development has a coefficient of 0.40, which is significant at the 1 percent threshold. This means that while the banking sector influences DT adoption in the short run, its influence is delayed by one period. Such a dynamic may be an indication of the ideal time required to introduce financial innovations, digital banking services, and institutional reforms so that they can spread to other parts of the economy. Shan and Liu (2023) support this idea, arguing that strengthened financial stability can help improve access to digital financial services, strengthen payment infrastructure, and support technology-driven investments, which in turn enhance DT adoption.

The short-run results for quality of life also show that it has current and one-period lagged coefficients of 12.15 and 9.40, respectively, both of which are significant at the 1% threshold. This indicates that an increase in quality of life by 0.1-units corresponds to increases in DT adoption by 121.50 percent and 94.01 percent for the current and lagged periods, respectively. The magnitude of these effects suggests that as human development and living standards go through enhancements, the demand for digital services surges (Alhassan & Adam, 2021). Additionally, the strength of the effects suggests that DT adoption rapidly responds to changes in quality of life, with both current and prior gains in quality of life exerting substantial influence.

Political stability then has short-run coefficients of 0.40 and −0.02, representing the current and lagged periods, respectively. The effect in the current period is positive and significant at the 10% threshold, whereas the effect in the lagged period is negative and significant at the 1% threshold. This means a one-point increase in current political stability increases DT adoption by 0.40 percent, whereas a one-point increase in political stability in the previous period reduces DT adoption by 0.02 percent. The short run reveals contrasting results when compared to the long run, showing that while political stability provides a conducive environment for DT adoption in the long run, its short-run effects may reflect adjustment dynamics in policy implementation or investment flows (Mosteanu & Alghaddaf, 2019b). Additionally, the different signs of the coefficients for the current and lagged periods may be due to the complex nature of short-run political and institutional interactions; whereas immediate developments in political stability may drive DT adoption, the delayed effects signal potential rigidities (where stability stifles development potentially due to policy inertia) or temporary reallocation of resources. However, based on the short-run results and the optimal ARDL (2,1,2,2,2,2,0) specification, the current values of the TVET variable do not appear in the short-run dynamics, indicating that its effects on DT adoption are not immediate but gradually materialize over the long run.

Finally, the 2010 structural break dummy has a coefficient of 0.18, which is significant at the 1% threshold. This breakpoint corresponds to the post-global financial crisis period, with results indicating that DT adoption in the UAE accelerated significantly after this phase. The result also suggests that the country improved its digital readiness by increasing its digital investments and implementing relevant reforms during this period. It also shows that the UAE shifted its policy focus toward innovation-led growth and smart government initiatives that, in turn, led to DT adoption playing a more central role in the economy's recovery and subsequent long-term growth (Sharafi, 2022). Additionally, given the significant effect of the dummy variable, it can be inferred that both external shocks and structural reforms have persistent impacts on the UAE's DT adoption policy.

The short- and long-run results both confirm the relevance of the study's investigation. In particular, the application of the ARDL technique in conducting a time series analysis of the DT adoption model played a critical role in understanding the selected macroeconomic drivers' short- and long-term effects on the UAE's DT adoption. This is because the ARDL technique effectively captures both the immediate and lasting effects of the selected variables, namely, quality of life, political stability, private investments, public sector development, TVET and financial and banking sector development. The findings of the short- and long-run estimations not only help policymakers and businesses design targeted interventions but also inform decisions to balance urgent actions on the one hand and strategic planning for sustainable DT adoption on the other.

4.4. Diagnostic and Model Stability Tests Results

Robustness checks are also required for time series analyses, such as the ARDL estimation, because they help validate the model and confirm the reliability of its results. In the present study, the specific checks performed include autocorrelation, the error correction term, heteroskedasticity, misspecification bias, normality and model stability. Results of diagnostic test statistics are reported in Table 7.

Table 7. Results of Diagnostic test statistics.

ECT_{t-1}	$\chi^2_{SC}(2)$	χ^2_{HET}	$\chi^2_{FF}(1)$	χ^2_{J-B}	Adj. R^2
-0.44 (-8.81)***	3.65 [0.08]	16.86 [0.53]	0.92 [0.36]	2.77 [0.25]	0.98

Note: The AIC guided the selection of the optimal lag length, though the maximum lag was set to 2. The t-ratios are placed in parenthesis (.), whereas the probability values are placed in square parenthesis [.]. The 1% significance threshold is denoted by the asterisk ***. The Breusch-Godfrey autocorrelation, Breusch-Pagan-Godfrey heteroscedasticity, Ramsey RESET's misspecification bias, and Jarque-Bera normality test statistics are denoted by χ^2_{SC}, χ^2_{HET}, χ^2_{FF}, and χ^2_{J-B}, respectively.

The results in Table 7 show that the −0.44 coefficient of the error-correction term, significant at the 1% threshold, indicates that about 44% of short-run shocks are corrected within a year. Furthermore, the adjusted R2 value of 0.98 indicates that approximately 98% of the changes in DT adoption can be explained by the selected macroeconomic variables examined in this study. The diagnostic checks then produced the statistics, 3.65, 16.86, 0.92, and 2.77, representing the Breusch–Godfrey LM, Breusch–Pagan–Godfrey heteroskedasticity, Ramsey RESET, and Jarque–Bera normality tests, respectively. The respective probability values of the test statistics were 0.08, 0.53, 0.36, and 0.25, signalling that they all exceeded the 5% threshold and indicating failure to reject their respective null hypotheses. As shown in Figure 1, the CUSUM and CUSUMSQ tests were performed to confirm parameter stability, and the graphs indicate that the DT adoption model for the UAE is stable over the sample period.

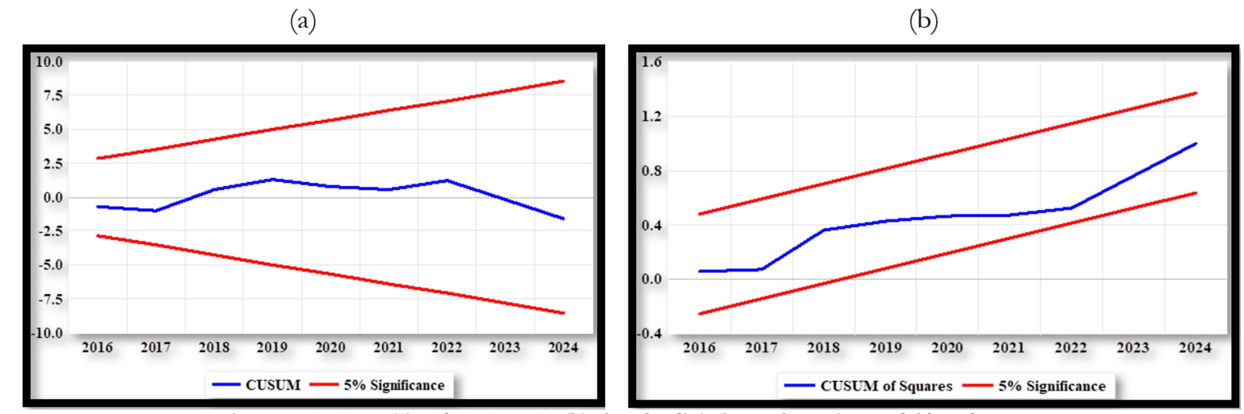

Figure 1. CUSUM (a) and CUSUMSQ (b) plots for digital transformation model based ARDL.

5. CONCLUSION AND POLICY IMPLICATIONS

To understand the response of the UAE's DT adoption policy to public sector development, private sector investment, political stability, financial and banking sector development, quality of life improvements, and TVET expansion, the study employs a time series for the 1995-2024 period. Using the Gregory–Hansen and ARDL estimation techniques, the study analyses a DT adoption model built on Romer's endogenous technological growth framework with a linear modification to align with the characteristics of the UAE economy. Furthermore, the findings reveal that DT adoption in the UAE is negatively influenced by public sector development. This negative long-run relationship indicates that the public sector's expansion may have generated crowding-out effects and resource misallocation, whereas increased government spending is allocated to non-digital infrastructure and administrative expansion rather than productivity-enhancing digital investments, which tend to constrain the pace of digital transformation adoption. The ARDL results further indicate that improved quality of life, political stability, private sector investments, financial and banking sector development and TVET expansion all exert significant positive effects on DT adoption, albeit with varying magnitudes.

At the same time, the negative effect of public sector development on DT adoption suggests the presence of inefficiencies or crowding-out effects. Thus, the UAE government is recommended to streamline its administrative processes related to public expenditure allocation. Doing so would help eliminate inefficiencies and reduce administrative delays linked to delayed investments in DT adoption within the public sector. Moreover, when implementing DT adoption strategies, the UAE government should also pay equal attention to other sectors, as lopsided investments in DT adoption can lead to an imbalance. For example, directing the majority of resources to the public sector, which stifles DT adoption initiatives in other sectors due to limited resource allocation, could lead to a crowding-out effect. A possible solution is to balance DT adoption expenditures so that digital infrastructure development is at the same pace as digital service delivery across other sectors. In this way, the economy can maximize the benefits of existing digital infrastructure before further investments follow.

While the current study ensures the robust application of econometric techniques, it is subject to a few limitations. First, the study used a small sample size of 30 annual observations. Although it is considered sufficient for ARDL estimation, the sample size is notably constrained by the historical availability of DT data. Second, the study's emphasis on the UAE context limits the generalisability of its findings regarding other developing economies. Finally, considering the potential existence of bidirectional relationships between the study's variables, potential endogeneity issues cannot be entirely ruled out, despite the fact that the study used ARDL and Gregory-Hansen techniques to mitigate bias.

A recommendation for future research is to thoroughly examine the sector-specific effects of DT adoption on the UAE's economic growth. For example, future research could focus on how DT adoption in key sectors, such as healthcare, finance and education, influences productivity and overall economic growth. Analyses exploring this research direction could prove valuable to policymakers as they seek optimised sectoral investments intended for the advancement of the digital economy in the UAE. Furthermore, given that the study demonstrates how DT can be feasibly operationalised for macroeconomic analyses, the stage is set for similar empirical enquiries in the future, especially those focused on other economies in the GCC and elsewhere.

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