Investigating Relationship between Digital Payment and Transportation using Panel ARDL

تحليل العلاقة بين سداد المدفوعات الرقمي والنقل

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Abstract

Digitization of payment facilitate easier and faster payment which increase transactions volume in the economy that imply on more shipping of goods. The paper analyzes short and long-run dynamics deploying panel ARDL "Autoregressive Distributed Lag" approach based on specification and model examination. The study estimated three models investigating impact of digital payment on maritime and air freight transport, as well as, investigating main determinants of digital payment for the period from 2000 till 2020 for 16 countries in MENA region "Middle East and North Africa". Main results are positive significance of digital payment, internet, mobile and banking usage on transportation. Main determinants of digital payment found to be income, mobile, internet and transportation which indicate bi directional relationship between transportation and digital payment. The results recommend that digital payment should be considered in policy designing. MENA countries should enhance digital payment, and focus on intensifying access to mobile and Internet.

Keywords: digital payment, ARDL, transport, MENA, income, Internet.

المستخلص

تدرس الورقة العلاقة قصيرة وطويلة المدى باستخدام اسلوب الانحدار الذاتي لفترات الإبطاء الموزع. تم تقدير ثلاثة نماذج لتحليل تأثير السداد الرقمي على نقل الشحن البحري والجوي، فضلاً عن التحقيق في المحددات الرئيسية للدفع الرقمي للفترة من عام 2000 حتى عام 2020 لعدد 16 دولة في منطقة الشرق الأوسط وشمال إفريقيا. وجدت التقديرات معنوية إيجابية للدفع الرقمي والإنترنت والجوال والاستخدامات المصرفية على النقل. كما وجدت المحددات الرئيسية للدفع الرقمي تشمل الدخل، الجوال، الإنترنت والنقل والتي تشير إلى علاقة ثنائية الاتجاه بين النقل والدفع الرقمي. أوصت النتائج بضرورة تعزيز التعاون في مجال السداد الرقمي، والتركيز على تكثيف الوصول إلى الهاتف المحمول والإنترنت بشكل أكثر كفاءة.

الكلمات المفتاحية: النقل، السداد الرقمي، الانترنت، الاجل القصير، الاجل الطويل، الدخل.

1. Introduction

Money as medium of exchange developed with digitization and advancement of commercial activities. Payment with plastic cards and online transactions through

Internet or mobile phones offers customers fast access to their money in handling their daily transactions.

Users of digital tools are increasing, pushing firms to change their way of doing business which is fastening volume of digital payment. Digital payment stimulates economic growth (Thomas & Angus, 2013), encouraged gradual replacement of cash payment with digital transactions all over the world, with different level across countries (Frączek & Urbanek, 2021). There is shortage in literature of digital payment in many economic branches as transportation, which shows the importance of current study.

Main objective of study is to investigate the nexus between digital payment and transportation. Analyzing the impact of digital payment on transportation. Also, determining impact of transportation on digital payment among other factors.

The paper uses deductive approach deriving economic hypotheses. First hypothesis is positive impact of digital payment on transportation. Second hypothesis is significant impact of transportation on digital payment. Testing hypothesis through econometric methods deploying panel ARDL "Autoregressive Distributed Lag" approach. The study will estimate three ARDL models analyzing impact of digital payment on maritime transportation in first model and air freight in second, while third model study the impact of transportation along other factors on digital payment. The analysis includes 16 MENA countries from 2000 to 2020.

The remaining of paper is discussing in second section digital payment globally and in MENA region. Third section discussing theoretical and literature background. The fourth section covers data description and explanation of methodology, followed by results of empirical analysis, then ending with conclusion and policy implications.

2. Digital Payment Review

UNCDF "United Nations Capital Development Fund" **and Better Than Cash Alliance, defined digital payment "**A digital payment, sometimes called an electronic payment, is the transfer of value from one payment account to another using a digital device such as a mobile phone, POS (Point of Sales) or computer, a digital channel communication such as mobile wireless data or SWIFT "Society for Worldwide Interbank Financial Telecommunications" . Includes payments made with bank transfers, mobile money, and payment cards including credit, debit and prepaid cards".

Literature divides digital payment services mainly into; services offered by banks as payments and transfer of funds, using basic or simple accounts through mobile phones, point-of-sale (POS) or payment cards (Löber & Houben, 2018).

According to Thomas & Angus (2013) evolution from cash to cashless economy goes through four stages: First is the Inception stage including countries with cash

transactions higher than 90% by volume. Second is transitioning stage includes countries with cash transactions between 70 to 90%. Third is Tipping Point stage including developed countries that reduced cash transactions to around 50 - 70 % of total consumers' transactions. Fourth is nearly cashless stage includes countries reduced cash transactions to lower than 50%.

Digital evolution added a challenge for developing countries for digitizing their payment system, lead to tremendous growth in digital payment systems around the world. Mobile payment based on Statista (2018) report increased from US$450 billion in 2015 to more than US$4 trillion worldwide and electronic payments market garnered $601.3 billion in 2016 (Goel & Nathb, 2020).

At 2021, size of digital payment market globally was $68.61 billion and expected to grow from 2022 to 2030 by 20.5% from 2022 to 2030, due to rising customer preference of real-time payments. E-commerce providers paying efforts to facilitate digital payment services instead of traditional payments methods to raise their competitiveness. POS “point-of-sale” share exceeded 52% of global revenue, used at retail shops for fast transactions processing. Internet banking expected to experience a tremendous growth from 2022 till 2030 as it offers ease of banking (Grand View, 2022).

The pandemic accelerated digital payments, via internet, mobile, and ATMs “Automated Teller Machines” concentrated more among relatively wealthier and younger people. In 2021, almost third of the 18% of adults paid their bills from bank accounts made this transaction for first time after pandemic. In developing countries, 40% of 20% of adults finished digital merchant transaction, made it after the pandemic. In 2021, share of adults making digital payment increased from 35% to 57% from 2014 till 2021. In high income countries, share of adults making digital payment was almost 95%. In developing countries, around 83% of adults made digital payment increased, almost 40% used their account for saving; and 40% for borrowing (Demirgüç-Kunt *et al*., 2022).

Regardless of the advantages of digital payment, consumers volume still low due to lack of trust (Agarwal, 2016). Among main factors of raising trust is reputation of firms offering digital payment services (McKnight, *et al*, 1998; Kim & Prabhakar, 2004). More transactions by customers are attracted towards providers with high reputation in market (Teo & Liu, 2007).

The number of users of digital tools growing rapidly across the world. Globally, around 34% of adults paid their utility bills digitally using mobile phone or Internet, while it's 56% at high-income countries and 29% in developing countries, and only 10% or fewer in countries of South Asia and MENA region. Across developing countries, payment of utility bill varies widely. In Egypt, utility bills paid in cash by

everyone, and in Morocco more than 80% paid in cash while in Turkey, the majority paid directly from account.
In developing countries there is much growth needed in paying directly from bank account using payment cards, mobile phones or internet, due to low rates. In Egypt, around 70% of bank account owners didn't make digital payments using cards, mobile phone or Internet. In 2021 there was a huge shift towards digital payments in e-trade. In MENA countries excluding Iraq, there was 21 % of adults bought something online (Demirgüç-Kunt *et al*., 2022).

3. Literature Review

Digital payment facilitates safe and inexpensive storage and transfer of money across borders. Recently digital payment accelerated across the world through different mechanisms, including wages transfers to bank accounts or debit cards, higher transactions over the internet and mobile phones, and more usage of ATMs "Automated Teller Machines". This shows acceleration of digital payments which require further study of its impact on transportation.
Transport industry has an important role in economic growth, since movement of people and goods on daily basis must take place for the existence of economic activity which needs continuous development and innovation to adapt with advancement of technology and economic activity. The paper main objective is studying the relationship between digital payment and transportation, through two strands of literature.

3.1 Relationship between digital payment and transportation

Joseph Schumpeter (1912) stated "well-functioning banks spur technological innovation by identifying and funding those entrepreneurs with the best chances of successfully implementing innovative products and production processes" (Levine, 1997). Advancement of "Information and Communication Technology" ICT facilitate easier and lower costs money transfer. Also, development of transportation infrastructure led to same effect of faster movement of goods and people (Kuştepeli *et al,* 2012).
Increased digital payment facilitate better access to wider range of financial services and faster methods of payment transactions for investors that promotes manufacturing activities (Wang *et al*., 2022) which raises demand on domestic and international transport. On demand side, digital payment offer consumers financial services that are available from far areas which remove time and travel barriers. Digitization of financial transactions enables people and firms to pay by banking cards, pay online, as well as withdrawal of money from ATMs, and usage of banking mobile applications. This will increase transactions volume from demand and supply

sides, which raise transportation (Ozturk & Ullah, 2022). That easy way of finalizing purchases in far and even from abroad increase demand on products that raise demand on shipping which increase transport. From consumer's perspective, digital payment gives consumer luxury to consume more products (Yao & Tang, 2021). Also, people have easier access to banking services which raise their independence in performing economic activities (Zaidi *et al.*, 2021).

Quinlan & Hamilton (2004) mentioned that developed countries experience higher trade of goods and services led by Internet usage. Tang *et al.*, (2007) state that e-trade improved international trade by speeding up selling of goods raised revenues and brought firms closer to global market. Demirkan and Platt (2009), Kauffman and Badar (2014) state the existence of positive relationship between digital technology and trade among large and nearby economies. This view also, supported by studies of (Clarke, 2002; Liu & Nath, 2013; and Labrousse & Lapointe, 2021" (Mulungula & Nimubona, 2022).

3.2 Determinants of Digital payment

Population excluded from traditional finance can access digital financial services using mobile phones connected to internet (Gomber *et al.*, 2017). Usage of digital tools facilitated by FinTech platforms, allows basic financial transactions as transfer of funds with lower cost. Internationally platforms facilitate easier payment transactions for businesses providing goods and services at lower cost (Demirguc-Kunt *et al*., 2014). Digital finance improves financial system through facilitating redistribution of funds to all people segments (Ozili, 2018).

Economic literature studied factors affecting digital payments in transportation included; Standard of living, using Gross Domestic Product per capita (GDP per capita) (Gong *et al*., 2013), as measure of welfare affecting purchasing behavior and level of consumption, affecting consumer financial independence and buying opportunities, low-income level eliminates consumers purchasing and consumption varieties and allowed available services.

As mentioned by Frączek & Urbanek (2021) the impact of income on level of digital payment changes with time, income considered an important determinant of increased technical capabilities for usage of electronic banking services as it requires acquiring appropriate devices, can be afforded mainly by high income consumers. Currently, ownership of devices supporting financial applications, is acquired by consumers regardless of income level.

Another factor affect digital payment is access and usage of banking services. Owning bank account is a starting point for usage of other financial services (Frączek

& Urbanek, 2021). Bank account stimulates savings and safe quick cashless payments (Rysman & Schuh, 2016).

4. Empirical Methodology

4.1 Data Analysis

The analysis includes annual data from 2000 to 2020 for 16 MENA countries, obtained from World Bank indicators and defined as shown in table (1).

The study investigates impact of digital payment on transport; first model investigates impact on maritime transport using Container port traffic as dependent variable. Second model investigates the impact on Air freight as dependent variable. Third model investigates the impact of air freight and containers among other factors on digital payment.

Dependent variables used in the analysis; ATM as proxy of digital payment following study of (Le *et al.*, 2020; Shen *et al.*, 2021, Ozturk, I. & Ullah, S., 2022) employed ATM and debit and study of Mulungula & Nimubona (2022) used ATM. Following studies of Le *et al.* (2020), Zaidi *et al.* (2021), the analysis used control variables as internet, mobile subscriptions, and following Mulungula & Nimubona (2022) GDP per capita presenting standard of living, and deposits presenting usage of banking services as it facilitates opportunity for saving, and consumption (Han & Melecky, 2013).

Table (1) Variables Definition and Descriptive Statistics

Variable	Mean	Max.	Min.	Definition	Obs.
LNAIRF	5.145	9.718	-1.262	"Air transport, freight (million t-km)"	272
LNATM	2.975	4.892	-2.302	"ATMs per 100,000 adults"	272
LNCONT	14.25	16.87	11.24	"Container port traffic (TEU: 20 foot)"	272
LNDEPOSIT	4.034	5.53	2.005	"Bank deposits as % of GDP"	272
LNGDPC	9.149	11.084	7.042	GDP per capita	272
LNINT	3.442	4.605	-0.126	"Individuals using the Internet as % of pop."	272
LNMOB	16.24	18.44	13.1	"Mobile cellular subscriptions"	272

Source: Estimated by Author - Note: "Ln" stands for logarithm

4.2 Pre- Estimation Tests

- Pesaran (2004) CD_{LM} test and Pesaran (2015) test of cross section dependence CD employed, testing null hypothesis "errors are weakly cross-sectional dependent".
- Bias adjusted LM test of Pesaran *et al.* (2008) employed as its valid if N>T or T>N to test CD.

- Pesaran & Yamagata (2008) slopes homogeneity test testing null hypothesis "slope coefficients are homogenous".
- Identifying order of integration to ensure that studied variables integrated of order zero or one at most to be able to use ARDL model. If CD problem doesn't exist, then first generation unit root test should be employed which don't consider CD problem as IPS "Im, Pesaran, Shin (2003)", which consider heterogeneous autoregressive parameters for each panel. Also, using LLC "Levin, Lin, Chu (2002)" test, and Breitung test. If variables have CD problem second generation unit root test should be employed.
- Testing for long run cointegration among dependent and independent variables using panel co-integration tests as Pedroni (1999, 2004), and Kao (1999). Both tests null hypothesis of no co-integration. If variables are co-integrated then ARDL model can be estimated.

4.3 Model specification

Since used panels has more years than sample units, and variables can be a mixture of $I\sim0$ and $I\sim1$, its proposed to use panel ARDL approach as proposed by Pesaran and Smith (1995) (da Silva et al., 2018). The estimated model has form of an ARDL (p, q, q,..., q) model as (Eq. 1, 3, 5). Reparametrize ARDL- ECM "error correction model" as (Eq, 2, 4, 6).

First Model: Investigating impact of digital payment among other variables on maritime transport

$$\mathrm{LNCONT}_{it} = \sum_{j=1}^{p} \alpha_{ij}\ LNCONT_{i,t-j} + \sum_{j=0}^{q} \beta'_{ij}\mathrm{X}_{i,t-j} + \mu_i + \varepsilon_{it} \quad \text{(Equ. 1)}$$

Reparametrize the ARDL- ECM turns into:

$$\Delta\ \mathrm{LNCONT}_{it} = \emptyset_i\ (\mathrm{LNCONT}_{i,t-1} - \lambda'_i\ X_{i,t}) + \sum_{j=1}^{p-1} \alpha_{ij}\,\Delta\mathrm{LNCONT}_{i,t-j} + \sum_{j=0}^{q-1} \beta'_{ij}\Delta\mathrm{X}_{i,t-j} + \mu_i + \varepsilon_{it} \quad \text{(Equ.2)}$$

LNCONT is dependent variable, $\emptyset_i$ is "group specific speed of adjustment coefficient", λ'_i is "vector of long run relationships", "error correction term" ECT = $(\mathrm{Y}_{i,t-1} - \lambda'_i\ X_{i,t})$, α_{ij} , β'_{ij} short run dynamic coefficients, *i* represents country and *t* represents time, p lags of dependent variables, while q lags of independent variables. X explanatory variables vector "LNGDPC, LNDEPOSITS, LNINT, LNMOB, LNATM" examining their impact on LNCONT as proxy of maritime transport.

Second Model: Investigating impact of digital payment among other variables on air freight transport using same explamnoty varaibles of first model.

$$\mathrm{LNAIRF}_{it} = \sum_{j=1}^{p} \alpha_{ij}\ LNAIRF_{i,t-j} + \sum_{j=0}^{q} \beta'_{ij}\mathrm{X}_{i,t-j} + \mu_i + \varepsilon_{it} \text{ (Equ. 3)}$$

Reparametrize the ARDL- ECM turns into:

$$\Delta\ \mathrm{LNAIRF}_{it} = \emptyset_i\ (\mathrm{LNAIRF}_{i,t-1} - \lambda'_i\ X_{i,t}) + \sum_{j=1}^{p-1} \alpha_{ij}\ \Delta\mathrm{LNAIRF}_{i,t-j} + \sum_{j=0}^{q-1} \beta'_{ij}\Delta\mathrm{X}_{i,t-j} + \mu_i + \varepsilon_{it} \quad \text{(Equ.4)}$$

Third Model: investigate impact of maritime and air freight transport among other factors on ATM as proxy of digital payment trying to identify its main determinants.

$$\mathrm{LNATM}_{it} = \sum_{j=1}^{p} \alpha_{ij}\ LNATM_{i,t-j} + \sum_{j=0}^{q} \beta'_{ij}\mathrm{X}_{i,t-j} + \mu_i + \varepsilon_{it} \text{ (Equ. 5)}$$

Reparametrize the ARDL- ECM turns into:

$$\Delta\ \mathrm{LNATM}_{it} = \emptyset_i\ (\mathrm{LNATM}_{i,t-1} - \lambda'_i\ X_{i,t}) + \sum_{j=1}^{p-1} \alpha_{ij}\ \Delta\mathrm{LNATM}_{i,t-j} + \sum_{j=0}^{q-1} \beta'_{ij}\Delta\mathrm{X}_{i,t-j} + \mu_i + \varepsilon_{it} \quad \text{(Equ.6)}$$

X is explanatory variables vector “LNGDPC, LNDEPOSITS, LNINT, LNMOB, LNAIRF, LNCONT” examining their impact on LNATM as proxy of digital payment.

Pesaran & Smith (1995) showed that panel ARDL models allow parameters to vary between units. This can be consistently estimated using Mean Group (MG) estimator as suggested by Pesaran *et al*. (1999) to solve bias happen because of heterogeneous slopes in dynamic panels. MG estimates parameters of each country, then average each group.

PMG "Pooled Mean Group" developed by Pesaran *et al*. (1999), estimate non stationary dynamic panels based on averaging of coefficients detects short and long run association among studied variables, with investigating the possibility of heterogonous dynamics across countries (Rafindadi, 2013). PMG allows short run parameters to vary from country to country and forces long run parameters to be homogenous. To read model as an "error correction mechanism" ECM, variables have to be co-integrated (da Silva *et al*., 2018).

5. Estimations Results

5.1 Pre- Estimation Tests Results

Results of Pesaran (2004) CD_{LM} test and (2015) CD test of all three models as shown in table (2) accept null hypothesis showing the no cross section dependence CD between countries. This denotes that if country faced a shock, it will not be transmitted to other countries. Since the literature stressed on the importance of checking for biasness in small time series data, the panels tested for biasness using bias adjusted LM test of Pesaran *et al.* (2008) results as shown in table (2) shows that panels don't have bias estimators.

Slope homogeneity Pesaran and Yamagata (2008) test results reject null hypothesis of slope coefficients homogeneity for all three models which shows the existence of heterogeneity in panel data, coefficients are heterogeneous and their slopes differs across countries which has to be considered by applying heterogeneous panel methods of PMG and MG ARDL.

Based of non-existence of CD among variables first generation co-integration tests Pedroni, and Kao used in all models. As shown from table (2), there is evidence of a long-run cointegration between dependent and explanatory variables for all studied panels. This suggests that an estimation of ARDL models will provide reliable short- and long-run results.

Based on CD test results first-generation unit root tests are employed to test stationarity as for applying ARDL model integration order of all estimated variables should be either stationary at level or integrated of first order. The study employed IPS, LLC and Breitung for testing variables for stationarity. The results as shown in table (3) shows that LNMOB, LNIT, LNATM and LNCOT are stationary at level, and the other variables are stationary at first difference.

Table (2) Biasness test, CD Test, Cointegration Test

Test	**Model 1**		**Model 2**		**Model 3**	
	Stat.	**P.**	**Stat.**	**P.**	**Stat.**	**P.**
LM_{adj}	-0.239	0.811	2.543	0.111	1.260	0.207
CD_{LM}	-1.056	0.291	0.411	0.680	-0.945	0.343
Pesaran CD	-0.712	0.476	0.681	0.496	-1.012	0.312
Δ	6.509	0.000	8.613	0.000	9.398	0.000
Δ_{adj}	8.946	0.000	10.707	0.000	12.253	0.000
Pedroni test for co-integration						
Modified Phillips-Perron	2.1639	0.015	3.73	0.000	3.418	0.003
Phillips-Perron	-2.526	0.005	-5.08	0.000	-7.023	0.000
Augmented Dickey-Fuller	-2.526	0.005	-5.23	0.000	-8.458	0.000

Kao test for co-integration						
Modified Dickey-Fuller	-2.271	0.011	-2.704	0.003	-2.770	0.028
Dickey-Fuller	-1.990	0.023	-2.583	0.004	-4.706	0.000
Augmented Dickey-Fuller	-1.100	0.135	-1.723	0.042	-3.874	0.002
Unadjusted modified Dickey-Fuller	-2.385	0.085	-3.175	0.000	-2.857	0.002
Unadjusted Dickey-Fuller	-2.043	0.020	-2.783	0.002	-4.739	0.000

Source: Estimated by Author

Table (3) Unit Root Tests Results

Variable	LLC		IPS		Breitung		Result
	level	1st diff	level	1st diff	level	1st diff	
LNMOB	0.000		0.640	0.000	0.135	0.001	$I\sim0$
LNATM	0.042		0.986	0.031	1.000	0.008	$I\sim0$
LNINT	0.000		0.023	0.000	0.999	0.003	$I\sim0$
LNAIRF	0.959	0.009	0.225	0.000	0.989	0.000	$I\sim1$
LNCONT	0.000		0.047		0.999	0.000	$I\sim0$
LNDEPOSIT	0.186	0.000	0.142	0.000	0.979	0.000	$I\sim1$
LNGDPC	0.854	0.000	0.950	0.000	0.999	0.000	$I\sim1$

Note: "Ln" stands for logarithm Source: Estimated by Author

5.2 Models Estimation Results

Since studied panel sample include more years than countries, 16 countries and 20 years, and variables are mixture of $I\sim0$ and $I\sim1$, panel-ARDL model as proposed by Pesaran and Smith (1995) is more appropriate. To ensure that PMG estimator is adequate Hausman test used against MG estimator. Hausman test didn't reject null hypothesis in all models, provides evidence that PMG is consistent, and more efficient, and provide more precise results. long-run coefficients should be considered as PMG forces homogeneity in long-run estimators but not on short-run estimators (da Silva *et al*., 2018).

First Model Estimation results: as shown from table (4) estimation results of short-run dynamic estimates associated with long-run relationship of first model is well fitted at first lag (1,1,1,0,0,0) using PMG as result of Hausman test. ECM model is well fitted as the coefficient of "error correction term" ECT -0.44289 (0.000) is significant at 1% with negative sign as expected which means that disequilibrium from previous periods shock will bounce back to equilibrium. ECT presents speed of adjustment towards long run equilibrium of 44% annual correction rate, deviations from long-run corrected within 2.25 years.

Second Model Estimation results: as shown from table (5) estimation results of short-run dynamic estimates associated with long-run relationship of second model is well fitted at first lag (1,1,1,1,1,1) using PMG as result of Hausman test. ECM model is well fitted as the coefficient ECT -0.86744 (0.004) is statistically significant at 1% level with negative sign as expected which means that disequilibrium from previous periods shock will bounce back to equilibrium at 86.7% annual correction rate, on average correction of shocks is corrected at considerable rate within 1.15 years.

Table (4) ARDL First Model Estimation Results

Variable	PMG		MG	
	Coef.	Prob.	Coef.	Prob.
Long Run				
LNDEPOSIT	0.08297	0.021	3.22021	0.101
LNGDPC	0.24844	0.000	2.23647	0.116
LNATM	0.10280	0.000	2.34441	0.241
LNINT	0.30381	0.000	-1.97333	0.079
LNMOB	0.46075	0.000	-1.64893	0.544
Short run				
ECT	-0.44289	0.000	-0.28477	0.659
$LNcont_{t-1}$	0.26511	0.003	0.29937	0.321
LNDEPOSIT	-0.64513	0.237	-5.44010	0.222
LNGDPC	-0.05239	0.948	-1.74259	0.370
LNATM	. 502123	0.264	-2.72609	0.066
LNINT	. 077782	0.676	0.715782	0.745
LNMOB	. 072977	0.606	2.895538	0.170
C	-7.18156	0.000	-418.9368	0.182

Source: Estimated by Author

***First and Second models long run estimation*:** Both first and second models investigate the impact of digital payment and supporting variables on transportation using container as proxy of maritime transport as dependent variable of first model and air freight as dependent variable of second model.

At long run, all investigated variables in both models are positively statistically significant to transport at 1% confidence level. Positive significant impact of ATM as proxy of digital banking, as well as, internet and mobile on transport goes with Kuştepeli *et al.,* (2012) stated that ICT facilitate development of transportation and faster movement of goods and people. Also goes with Quinlan & Hamilton (2004) that mentioned that internet raise trade of goods and services. Also, going with findings of (Clarke, 2002; Tang *et al.,* 2007; Demirkan and Platt, 2009; Liu & Nath,

2013; Kauffman and Badar, 2014; Labrousse & Lapointe, 2021) found positive relation between digital technology and trade as e-trade speed up sale of goods which increase transport.

Positive significant impact of ATM as proxy of digital payment on transport goes with findings of Wang *et al*., (2022) faster methods of payment raise demand on goods which raise transport. Also, goes with Ozturk & Ullah, (2022) mentioned that digitization of financial transactions increases transactions volume in economy from demand side and supply side, which raise transportation. Goes with findings of (Yao & Tang, 2021; and Zaidi *et al.*, 2021) mentioned that digital payment gives consumer luxury to consume more products, through easier access to financial services.

Table (5) ARDL Second Model Estimation Results

Variable	PMG		MG	
	Coef.	Prob.	Coef.	Prob.
Long Run				
LNDEPOSIT	1.66305	0.000	-2.69406	0.832
LNGDPC	2.18354	0.000	57.3089	0.095
LNATM	1.12239	0.000	5.99627	0.623
LNINT	0.82308	0.000	16.9806	0.174
LNMOB	0.26335	0.000	-3.35987	0.144
Short Run				
ECT	-0.86744	0.004	-1.28545	0.041
$LNairf_{t-1}$	0.753847	0.056	0.364375	0.365
LNDEPOSIT	0.961917	0.166	0.158416	0.917
LNGDPC	1.00666	0.615	-4.61972	0.206
LNATM	-1.393861	0.211	-0.21238	0.926
LNINT	-0.53962	0.501	-1.96508	0.043
LNMOB	-0.42707	0.371	0.172604	0.678
C	5.10052	0.001	-252.921	0.498

Source: Estimated by Author

Third Model Estimation results: as shown from table (6) estimation results of short-run dynamic associated with long-run relationship of third model is well fitted at first lag (1,0,0,0,0,0,0) using PMG as result of Hausman test. ECM model is well fitted as the coefficient of ECT is -0.26107 (0.008) statistically significant at 1% level with negative sign which means that disequilibrium from previous periods shock will bounce back to equilibrium in 26% annual correction rate, correction of shocks from long-run is corrected within 3.83 years.

Results shows positive significant impact of maritime and air freight transport on digital payment which shows that higher trade needs more advanced fast processing payment methods, which shows that the relationship between transportation and digital payment is a bi-directional relationship.

Results shows positive significant impact of GDP per capita as proxy of income and standard of living on digital payment which goes with findings of (Gong *et al*., 2013; Frączek & Urbanek, 2021) mentioned that higher income level raise purchasing behavior, level of consumption, and buying opportunities which raise usage of digital payment.

Results shows positive impact of deposits as proxy of banking usage goes with Joseph Schumpeter (1912) stated that well-functioning banks enhance successful implementation of innovative products. Also goes with findings of (Rysman & Schuh, 2016; Frączek & Urbanek, 2021) mentioned that owning bank account is a starting point for usage of other financial services. The account enables saving of funds ,as well as, allowing for safe and quick cashless payment processing.

Also, results show positive significant impact of internet and mobile on ATM as proxy of digital payment which goes with findings of Kuştepeli *et al.*, (2012) stated that ICT facilitate easier and lower costs of money transfer.

Table (6) ARDL Third Model Estimation Results

Variable	PMG		MG	
	Coef.	Prob.	Coef.	Prob.
Long Run				
LNCONT	0.307524	0.000	-0.61135	0.115
LNAIRF	0.094804	0.000	0.35112	0.563
LNDEPOSIT	0.251417	0.000	1.32103	0.080
LNGDPC	2.264809	0.000	0.49442	0.678
LNINT	0.173717	0.000	-0.71936	0.128
LNMOB	0.10085	0.000	-0.28805	0.678
Short run				
ECT	-0.26107	0.008	-0.37533	0.309
$LNATM_{t-1}$	-0.03368	0.781	-0.14142	0.589
LNCONT	0.085914	0.189	-0.66677	0.195
LNAIRF	0.008875	0.795	-0.26643	0.358
LNDEPOSIT	0.082872	0.193	-0.05292	0.82
LNGDPC	-0.02319	0.94	0.131782	0.947
LNINT	-0.07247	0.206	0.207859	0.254
LNMOB	-0.12237	0.216	0.030761	0.893
C	-4.08714	0.019	12.81389	0.106

Source: Estimated by Author

Conclusion and Policy Implication

Since studied panel include more years than countries, and variables of different orders stationary at different orders, and no CD problem or biasness, existence of slope heterogeneity, and there is evidence of a long-run relationship between dependent and explanatory variables for all studied panels, then panel-ARDL approach is appropriate. Long-run coefficients are considered as PMG forces homogeneity in long-run estimators but not on short-run.

ECM is well fitted at all models which means that disequilibrium from previous periods shocks will bounce back to equilibrium at considerable rate in all models within 1.15 to 3.83 years. Both first and second models investigate the impact of digital payment and supporting variables on transportation using container as proxy of maritime transport as dependent variable of first model and air freight as dependent variable of second model.

The analysis found positive significant impact of ATM as proxy of digital payment on transport which shows that digital payment as faster and easier payment methods raise transportation. Also, there is positive impact of internet and mobile on transport showing that ICT facilitate faster movement of goods and people. Internet facilitate e-trade which raise trade of goods and services and speed up sales of goods which increase demand of transport for shipping purchased goods.

Third model, shows positive impact of transportation on digital payment using container and air freights indicators as proxy of transportation shows bidirectional relationship between transportation and digital payment. Digital payment facilitates and raise consumption and demand of goods and services which raise shipping and transportation of goods. In other direction higher transportation require easier and faster way of doing business stimulate digital payment to easier finalization of transactions.

Also, results show positive impact of GDP per capita as proxy of income and standard of living on digital payment shows that higher income level raise purchasing behavior and level of consumption, which raise consumer financial independence and buying opportunities. Also, shows positive impact of deposits as proxy of banking usage as owning bank account is a starting point for usage of other financial services. The account enables saving of funds as well as allowing for safe and quick cashless payment processing.

Based on above conclusion showing the importance of digital payment on transportation, digital payment should be considered seriously in policy designing as follows:

First, MENA countries should enhance improvement of digital payment required systems.

Second, MENA countries should focus on improving access to mobile and internet more efficiently.

Third, policy reforms in financial sector should be designed to facilitate expansion of digital payment services utilization.

Fourth, expand usage of digitalizing merchant payments and help business owners to be more competitive

Fifth, regardless of the advantages of digital payment, its volume still low in MENA countries due to lack of trust. Financial literacy should be addressed by financial systems and governments towards raising trust in digital financial transactions and raising people's trust that their money is safe and secure.

References

Agarwal, S. (2016). Initial euphoria of prepaid wallets dies down. The Economic Times.

da Silva,P., Cerqueira, A., & Ogbe, W. (2018). Determinants of renewable energy growth in Sub-Saharan Africa: Evidence from panel ARDL. Energy Volume 156, 1 August 2018, Pages 45-54.

Dahmani, M., Mabrouki, M., & Youssef, A. (2021). The ICT, Financial Development, Energy Consumption and Economic Growth Nexus in MENA Countries: Panel CS-ARDL Evidence. GREDEG Working Paper No. 2021-46

Demirguc-Kunt, A., Klapper, L., & Singer, D. (2014). The Global Findex Database , 2015.

Demirgüç-Kunt, A., Klapper, L., Singer, D. & Ansar, A. (2022). Global Findex Database 2021: Financial Inclusion, Digital Payments, and Resilience in the Age of COVID-19. Washington, DC: World Bank.

Demirkan, S., & Platt, H. (2009). Financial Status, Corporate Governance Quality, and the Likelihood of Managers Using Discretionary Accruals. Accounting Research Journal, 22, 93-117.

Frączek, B. & Urbanek, A. (2021). Financial inclusion as an important factor influencing digital payments in passenger transport: A case study of EU countries. Research in Transportation Business & Management 41 (2021) 100691.

Goel, N. & Nathb, V. (2020). An Exploratory Study on Digital Payment Systems and its Impact on Trust and Continuance Intention in Newly Remonetized and Digitized Era.3rd International Conference on Innovative Computing and Communication (Icicc-2020).

Gomber, P., Koche, J, & Siering, M. (2017). Digital Finance and FinTech: current research and future research directions. Journal of Business Economics. July 2017.

Gong, W., Stump, R. L., & Maddox, L. M. (2013). Factors influencing consumers' online shopping in China. Journal of Asia Business Studies, 7(3), 214–230.

Grand View (2022). Digital Payment Market Share, Size, Trends, Industry Analysis Report, By End-Use (BFSI, Healthcare, IT & Telecom, Media & Entertainment, Retail & E-commerce, Transportation, Others); By Solution; By Mode of Payment; By Deployment; By Enterprise Size; By Region; Segment Forecast, 2022 - 2030. published by Grand View Research.

Han, R., & Melecký, M. (2013). Financial Inclusion for Financial stability: Access to Bank Deposits and the Growth of Deposits in the Global Financial Crisis (No. 6577). The World Bank.

Kauffman, J. & Badar, J. (2014). How We Might Make Special Education for Students with Emotional or Behavioral Disorders Less Stigmatizing. SAGE Journals. Volume 39, Issue 1. P 16-27

Kim, K.K., & Prabhakar, B. (2004). Initial trust and the adoption of B2C e-commerce: The case of internet banking. *ACM SIGMIS Database* Adv. Inf. Syst. 35, 50–64.

Kuştepeli, Y., Akgũngōr,S. & Gũlcan, Y. (2014). The Impact of Road Network on External Trade. Historical Methods: A Journal of Quantitative and Interdisciplinary History 47:4, pages 190-198

Le, T.H., Le, H.C., & Taghizadeh-Hesary, F., (2020). Does financial inclusion impact CO2 emissions? Evidence from Asia. Finance Res. Lett. 34, 101451.

Levine, R. (1997). Financial Development and Economic Growth: Views and Agenda. Journal of Economic Literature, 35(2), 688–726.

Löber, K., & Houben, A. (2018). Committee on Payments and Market Infrastructures Markets Committee .

McKnight, D. H., Cummings, L. L., & Chervany, N. L. (1998). Initial trust formation in new organizational relationships. Academy of Management Review, 23(3), 473–490. https://doi.org/10.5465/AMR.1998.926622

Mulungula, A. M., & Nimubona, F. (2022). Digital Financial Inclusion and Trade Openness in Africa. Open Journal of Business and Management, 10, 744-777.

Ozili, P. K. (2018). Impact of Digital Finance on Financial Inclusion and Stability. Borsa Istanbul Review, 18, 329-340.

Ozturk, I. & Ullah, S. (2022). Does digital financial inclusion matter for economic growth and environmental sustainability in OBRI economies? An empirical analysis. Resources, Conservation & Recycling 185 (2022) 106489.

Pesaran M. H. (2015). Testing Weak Cross-Sectional Dependence in Large Panels. Econometric Reviews, 34(6-10), 1089-1117.

Pesaran, M. H., & Smith, R. P (1995). Estimating Long-Run Relationships from Dynamic Heterogeneous Panels. Journal of Econometrics, Volume 68, Issue 1, 1995,Pages 79-113.

Pesaran, M. H., Shin, Y., & Smith, R. P. (1999). Pooled Mean Group Estimation of Dynamic Heterogeneous panels. Journal of the American Statistical Association, 94(446), 621-634.

Quinlan, J. P., & Hamilton, D. S. (2004). Drift or Rapprochement? The Pre-Eminence of the Transatlantic Economy . Robert Schuman Foundation.

Rafindadi, A. (2013), an Application of Panel ARDL in Analyzing the Dynamics of Financial Development and Economic Growth in 38 Sub-Saharan African Continents. Proceeding - Kuala Lumpur International Business, Economics and Law Conference Vol. 2. December 2 - 3, 2013. Hotel Putra, Kuala Lumpur, Malaysia

Rysman, M. & Schuh,S. (2016), New Innovations in Payments, No. 22358, NBER Working Papers, National Bureau of Economic Research, Inc.

Shen, Y., Hu, W., & Hueng, C.J., (2021). Digital financial inclusion and economic growth: a cross-country study. Procedia Comput. Sci 187, 218–223.

Tang, Y.-Y., Ma, Y., Wang, J., Fan, Y., Feng, S., Lu, Q., Yu, Q., Sui, D., Rothbart, M. K.,v Fan, M., & Posner, M. I. (2007). Short-Term Meditation Training Improves Attention and Self-Regulation. Proceedings of the National Academy of Sciences, 104, 17152-17156.

Teo, T.S.H. and Liu, J. (2007) Consumer Trust in E-Commerce in the United States, Singapore and China. Omega, 35, 22-38.

Thomas, H., Jain, A., & Angus, M. (2013). MasterCard Advisors ' Cashless Journey the Global Journey from Cash to Cashless. White Paper, (Sep.), 1–15.

Wang, L., Wang, Y., Sun, Y., Han, K., & Chen, Y., (2022). Financial inclusion and green economic efficiency: evidence from China. J. Environ. Plann. Manag. 65 (2), 240–271.

Yao, X., & Tang, X., (2021). Does financial structure affect CO2 emissions? Evidence from G20 countries. Finance Res. Lett. 41, 101791

Zaidi, S.A.H., Hussain, M., & Zaman, Q.U., (2021). Dynamic linkages between financial inclusion and carbon emissions: evidence from selected OECD countries. Resour. Environ. Sustain. 4, 100022.