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THE IMPACT OF DIGITAL TRANSFORMATION ON INFORMAL SECTOR INTEGRATION AND SDG PROGRESS IN THE EUROMED REGION

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THE IMPACT OF DIGITAL TRANSFORMATION ON INFORMAL SECTOR INTEGRATION AND SDG PROGRESS IN THE EUROMED REGION

CONTENTS

ABSTRACT

This paper explores the intersection of digital transformation, informal sector integration, and sustainable development in the Euromed region, encompassing EU member states and Southern Mediterranean countries. It examines how digital technologies, such as mobile payment systems and e-commerce platforms, facilitate informal sector formalization and contribute to achieving Sustainable Development Goals (SDGs), particularly Goals 8, 9, and 10. The research employs a mixed-methods approach, including quantitative analysis of panel data and qualitative case studies of Spain, Morocco, and Egypt. Findings reveal that digital adoption significantly reduces informal sector size, especially in countries with strong institutional support and intermediate digital readiness. However, barriers such as digital literacy gaps and regulatory challenges persist, necessitating targeted policy interventions. The study provides actionable insights for enhancing digital infrastructure, promoting financial inclusion, and fostering regional cooperation, contributing to a nuanced understanding of how digital transformation can advance inclusive economic development.

L'IMPACT DE LA TRANSFORMATION NUMÉRIQUE SUR L'INTÉGRATION DU SECTEUR INFORMEL ET LES PROGRÈS DES ODD DANS LA RÉGION EUROMED

RÉSUMÉ

Cet article explore l'intersection entre la transformation numérique, l'intégration du secteur informel et le développement durable dans la région Euromed, englobant les États membres de l'UE et les pays du sud de la Méditerranée. Il examine comment les technologies numériques, telles que les systèmes de paiement mobile et les plateformes de commerce électronique, facilitent la formalisation du secteur informel et contribuent à la réalisation des Objectifs de Développement Durable (ODD), en particulier les objectifs 8, 9 et 10. La recherche adopte une approche mixte, combinant une analyse quantitative de données de panel et des études de cas qualitatives portant sur l'Espagne, le Maroc et l'Égypte. Les résultats révèlent que l'adoption du numérique réduit significativement la taille du secteur informel, en particulier dans les pays disposant d'un soutien institutionnel fort et d'un niveau intermédiaire de préparation numérique. Cependant, des obstacles persistent, notamment des lacunes en matière de littératie numérique et des défis réglementaires, nécessitant des interventions politiques ciblées. Cette étude fournit des recommandations concrètes pour améliorer l'infrastructure numérique, promouvoir l'inclusion financière et renforcer la coopération régionale, contribuant ainsi à une compréhension approfondie du rôle de la transformation numérique dans le développement économique inclusif.

تأثير التحول الرقمي على دمج القطاع غير الرسمي وتقدم أهداف التنمية المستدامة في منطقة الأورومتوسط

الملخص

يستكشف هذا البحث التقاطع بين التحول الرقمي وإدماج القطاع غير الرسمي والتنمية المستدامة في منطقة الأورومتوسط، التي تشمل الدول الأعضاء في الاتحاد الأوروبي ودول جنوب البحر الأبيض المتوسط. يبحث في كيفية مساهمة التقنيات الرقمية، مثل أنظمة الدفع عبر الهاتف المحمول ومنصات التجارة الإلكترونية، في تسهيل عملية إضفاء الطابع الرسمي على القطاع غير الرسمي لا سيما الأهداف 8 و9 و10. تعتمد الدراسة على منهجية متعددة الأساليب، (SDGs) وتحقيق أهداف التنمية المستدامة تشمل تحليلًا كميًا لبيانات لوحة وتحليلات نوعية لحالات دراسية في إسبانيا والمغرب ومصر. تكشف النتائج أن تبني التكنولوجيا الرقمية يقلل بشكل كبير من حجم القطاع غير الرسمي، خاصة في البلدان التي تتمتع بدعم مؤسسي قوي ومستوى متوسط من الجاهزية الرقمية. ومع ذلك، لا تزال هناك عقبات مثل فجوات المعرفة الرقمية والتحديات التنظيمية، مما يستلزم تدخلات سياسية موجهة. تقدم الدراسة رؤى عملية لتعزيز البنية التحتية الرقمية، وتشجيع الشمول المالي، وتعزيز التعاون الإقليمي، مما يساهم في فهم أكثر عمقًا لدور التحول الرقمي في تحقيق تنمية اقتصادية شاملة

Keywords: Digital Transformation; Informal Sector Integration; Sustainable Development Goals; Euromed Region

INTRODUCTION

BACKGROUND AND CONTEXT

The Euromed region, encompassing the European Union's 27 member states and 8 Southern Mediterranean countries, represents a diverse economic landscape characterized by significant disparities in development levels, digital adoption, and informal sector participation. This geographical area, also known as the Euro-Mediterranean region, has been historically linked through trade, cultural exchange, and various cooperation frameworks, most notably the Barcelona Process launched in 1995 and its successor, the Union for the Mediterranean (UfM) established in 2008.

The informal economy continues to play a substantial role in many Euromed countries, particularly in the Southern Mediterranean region. Recent estimates suggest that the informal sector accounts for approximately 35% of GDP in North African countries and ranges from 15% to 25% in Southern European economies (Medina & Schneider, 2018; Elgin, 2021). This persistent informality presents significant challenges for economic development, social protection, and regional integration efforts. Informal enterprises often operate outside regulatory frameworks, lack access to formal financial services, and face limited opportunities for growth and innovation (Williams & Schneider, 2016).

The advent of digital transformation has emerged as a potential catalyst for addressing these long-standing challenges of informality. Digital technologies, including mobile payment systems, e-commerce platforms, and digital identification systems, offer new pathways for informal businesses to integrate into formal value chains and access broader market opportunities. The COVID-19 pandemic has further accelerated this digital transition, forcing many informal businesses to adopt digital tools for survival and highlighting the urgent need for digital inclusion (World Bank, 2021).

In the context of the United Nations Sustainable Development Goals (SDGs), the intersection of digital transformation and informal sector integration takes on particular significance. Several SDGs, including Goal 8 (Decent Work and Economic Growth), Goal 9 (Industry, Innovation, and Infrastructure), and Goal 10 (Reduced Inequalities), are directly impacted by the success or failure of digital integration efforts in the informal sector. The European Commission's Digital Economy and Society Index (DESI) indicates substantial variations in digital readiness across the region, with Northern European countries generally showing higher levels of digital adoption compared to Southern Mediterranean nations (European Commission, 2023).

The policy landscape across the Euromed region reflects growing recognition of digital transformation's potential role in economic development and regional integration. The European Union's Digital Single

Market strategy, launched in 2015, aims to ensure access to digital activities for individuals and businesses under conditions of fair competition and consumer protection (European Commission, 2015). Similarly, initiatives such as the Mediterranean Digital Transformation Partnership (MDTP) seek to promote digital skills development and technological adoption in Southern Mediterranean countries (Union for the Mediterranean, 2022).

However, the relationship between digital transformation and informal sector integration is complex and multi-dimensional. While digital technologies offer potential solutions for formalization, they also present new challenges. These include the risk of digital exclusion for vulnerable populations, concerns about data privacy and security, and the need for significant investments in digital infrastructure and skills development. The varying levels of institutional capacity and regulatory frameworks across the Euromed region further complicate the implementation of digital transformation strategies (Dutta et al., 2023).

The academic literature has increasingly focused on the role of digital transformation in economic development and informal sector integration. Studies by Chen (2016) and Perry et al. (2007) have documented how digital platforms can reduce entry barriers for informal businesses and facilitate their transition to formal operations. Research by the International Labour Organization (ILO, 2021) has highlighted the potential of digital financial services to promote financial inclusion and formalization of informal enterprises.

Despite these insights, significant knowledge gaps remain regarding the specific mechanisms through which digital transformation can facilitate informal sector integration in the Euromed context. The region's unique characteristics – including its diverse economic structures, varying levels of digital readiness, and complex regulatory environments – necessitate a detailed examination of how digital tools can be effectively leveraged to promote sustainable development and regional economic integration.

Furthermore, the rapid pace of technological change and the evolving nature of informal economic activities require continuous assessment of digital transformation strategies and their impacts. The emergence of new technologies such as blockchain, artificial intelligence, and the Internet of Things presents both opportunities and challenges for informal sector integration that need to be carefully evaluated within the Euromed context (World Economic Forum, 2017).

RESEARCH OBJECTIVES

This research examines how digital transformation can facilitate the integration of the informal sector into sustainable value chains in the Euromed region, with particular attention to its impact on progress toward Sustainable Development Goals (SDGs). The study addresses a critical gap in understanding the mechanisms through which digital technologies can promote formalization and economic integration in the diverse context of Euro-Mediterranean economies.

The primary objective is to analyze the relationship between digital transformation and informal sector integration, focusing specifically on how various digital technologies and platforms can create pathways for informal businesses to participate in formal value chains. This builds upon previous work by Prasetyo (2022), who demonstrated the potential of digital platforms to reduce transaction costs and information asymmetries in informal markets. However, while their research focused on developing economies broadly, our study specifically examines these dynamics within the unique institutional and economic context of the Euromed region.

A second key objective is to assess the effectiveness of different digital transformation strategies in promoting informal sector integration across various Euromed countries. This includes evaluating the impact of digital financial services, e-government initiatives, and digital marketplace platforms. This objective extends the work of Nguyen et al. (2024), who documented the varying success rates of digital formalization initiatives across different institutional contexts. Our research aims to identify which approaches are most effective in the specific context of Euromed countries, considering their diverse economic structures and regulatory environments.

The third objective focuses on measuring the contribution of digital-led informal sector integration to SDG progress in the region. This builds on the analytical framework developed by UNCTAD (2021) for assessing digital economy contributions to sustainable development, but extends it to specifically address informal sector dynamics. We pay particular attention to SDG 8 (Decent Work and Economic Growth), SDG 9 (Industry, Innovation, and Infrastructure), and SDG 10 (Reduced Inequalities), as these goals are most directly affected by informal sector integration and digital transformation.

Furthermore, this research aims to identify and analyze the barriers that prevent informal sector participants from fully engaging with digital technologies and formal value chains. This objective responds to calls in recent literature (World Bank, 2022) for more nuanced understanding of the obstacles to digital adoption in informal economies. We specifically examine how these barriers vary across different Euromed countries and what policy interventions might be most effective in addressing them.

The final objective is to develop a comprehensive framework for understanding the relationships between digital transformation, informal sector integration, and sustainable development in the Euromed context. This framework will synthesize quantitative findings about the impact of digital adoption on informality with qualitative insights about the processes through which digital technologies facilitate formalization.

SIGNIFICANCE OF THE STUDY

This research contributes to both academic understanding and policy development in several significant ways. First, it addresses a critical gap in the literature regarding the specific mechanisms through which digital transformation can facilitate informal sector integration in the Euromed context. While previous studies have examined digital transformation and informal economies separately, this research provides

the first comprehensive analysis of their interaction within the unique institutional and economic framework of the Euro-Mediterranean region.

The study's significance is particularly timely given the acceleration of digital adoption following the COVID-19 pandemic. As documented by the European Investment Bank (2023), the pandemic has created new urgency around digital transformation, while simultaneously exposing digital divides across the Euromed region. Our research provides crucial insights into how these transformations can be leveraged to promote inclusive economic development rather than exacerbating existing inequalities.

From a policy perspective, this research offers valuable guidance for policymakers in both EU and Southern Mediterranean countries. The findings directly inform the implementation of major regional initiatives such as the EU's Digital Single Market strategy and the Union for the Mediterranean's digital cooperation framework. As noted by Acemoglu and Restrepo (2022), the success of such digital transformation policies depends critically on understanding their interactions with economic activities and existing institutional structures, that may also include informal ones.

The study also makes a methodological contribution by developing a novel framework for analyzing the impact of digital transformation on informal sector integration. This framework, which combines quantitative analysis of cross-country panel data with detailed case studies, provides a template for future research in other regional contexts. As highlighted by the World Bank's Digital Progress and Trends Report (2023), such comprehensive methodological approaches are essential for understanding the complex dynamics of digital transformation in developing economies.

THEORETICAL FRAMEWORK: DIGITAL TRANSFORMATION, INFORMAL ECONOMIES, AND SDGS

CONCEPTUALIZING DIGITAL TRANSFORMATION

Digital transformation represents a fundamental shift in how organizations and economies operate, leveraging digital technologies to create new value-producing opportunities, business models, and ways of organizing economic activity. As defined by Vial (2019) digital transformation encompasses a process that aims to improve an entity by triggering significant changes to its properties through combinations of information, computing, communication, and connectivity technologies.

The conceptualization of digital transformation has evolved significantly over the past decade. While early definitions focused primarily on technological adoption, contemporary frameworks emphasize the broader organizational and societal changes that accompany technological implementation. Verhoef et al. (2021) identify three key dimensions of digital transformation: technological foundation, organizational operations, and value creation pathways. This multidimensional understanding is particularly relevant when examining digital transformation's role in informal sector integration.

In the context of developing economies and informal sectors, digital transformation takes on additional complexity. The World Bank's Digital Progress and Trends Report (2023) emphasizes that digital transformation in these contexts often occurs through distinct pathways compared to developed economies. Mobile technology, for instance, often leads the transformation process, leapfrogging traditional infrastructure development stages. This phenomenon has been particularly evident in digital payment systems and mobile banking services, as documented by Demirgüç-Kunt et al. (2022) in their global financial inclusion database research.

Recent theoretical developments have also highlighted the role of digital platforms as key enablers of digital transformation. Kenney and Zysman (2020) describe how platform-based business models are reshaping economic organization and creating new opportunities for informal sector participation in formal value chains. These platforms reduce transaction costs, improve information flows, and create new markets that can bridge formal and informal economic activities.

THEORIES OF INFORMAL ECONOMY

The theoretical understanding of informal economies has evolved significantly since Hart (1973) first introduced the concept in his seminal study of urban employment in Ghana. Contemporary theories of informal economy can be broadly categorized into three main schools of thought, each offering distinct perspectives on the nature, causes, and persistence of informality. The first, known as the dualist perspective,

views the informal sector as a marginal economy providing income for the poor and operating with little connection to the formal economy. This view, initially popularized by the International Labour Organization's early work, has been largely superseded by more nuanced understandings of informal-formal linkages.

The structuralist school, as articulated by Castells and Portes (1989), conceptualizes informality as an integral part of modern capitalist development rather than a vestige of traditional economies. This perspective emphasizes how informal enterprises and workers are inextricably connected to formal economies through various production and distribution relationships. Recent work by Chen (2012) has further developed this understanding by documenting the complex ways in which informal actors are integrated into global value chains, albeit often under unfavorable terms.

The legalist or institutional perspective, prominently advanced by de Soto (2000), frames informality as a rational response to excessive regulation and bureaucratic barriers. This approach suggests that informal entrepreneurs actively choose to operate outside formal regulatory frameworks when the costs of formalization outweigh its benefits. La Porta and Shleifer (2014), in their comprehensive review of informal economy theories, provide empirical support for elements of both the structuralist and legalist perspectives while challenging purely dualistic interpretations.

Recent theoretical developments have emphasized the heterogeneous nature of informal economies. Ulyssea (2020) presents a unified framework that recognizes multiple margins of informality and various degrees of formal-informal interaction. This framework is particularly relevant for understanding how digital transformation might affect different segments of the informal economy differently.

SDGS AND THEIR RELEVANCE TO EUROMED

The Sustainable Development Goals (SDGs) represent a universal call to action to end poverty, protect the planet, and ensure prosperity for all. In the Euromed context, these goals take on particular significance due to the region's unique combination of developed and developing economies, and its strategic importance as a bridge between Europe and Africa. As documented by the United Nations Economic and Social Commission for Western Asia (ESCWA, 2022), the Mediterranean region faces distinct challenges in achieving the SDGs, particularly in areas related to economic integration and digital development.

Several SDGs are especially relevant to the intersection of digital transformation and informal sector integration in the Euromed region. SDG 8 (Decent Work and Economic Growth) directly addresses the need to promote sustained, inclusive economic growth and productive employment. According to the International Labour Organization's latest assessment (ILO, 2023), the Southern Mediterranean countries continue to face significant challenges in achieving targets related to informal employment and labor productivity, making this goal particularly pertinent to our analysis.

SDG 9 (Industry, Innovation and Infrastructure) is crucial for understanding the role of digital infrastructure in promoting economic integration. The United Nations Industrial Development Organization's report (UNIDO,

2022) highlights significant disparities in digital infrastructure development between the northern and southern shores of the Mediterranean, emphasizing the need for coordinated regional approaches to technological advancement.

SDG 10 (Reduced Inequalities) takes on special significance in the Euromed context due to persistent economic disparities both within and between countries. The European Investment Bank's Mediterranean report (EIB, 2023) demonstrates how digital divides often mirror and reinforce existing socio-economic inequalities, making the achievement of this goal intrinsically linked to successful digital transformation strategies. Progress toward these goals in the Euromed region has been uneven, as documented by Sachs et al. (2023) in the Sustainable Development Report. While European Union member states generally show stronger performance across most SDG indicators, Southern Mediterranean countries face particular challenges in areas related to digital infrastructure and formal economic integration.

INTEGRATING FRAMEWORKS: A MODEL OF DIGITAL-LED INFORMAL SECTOR INTEGRATION

The integration of digital transformation, informal economy theories, and sustainable development goals requires a comprehensive theoretical framework that captures the complex interactions between these elements. Building on the multi-level perspective developed by Geels (2019) for analyzing socio-technical transitions, we propose a framework that conceptualizes digital-led informal sector integration as a multi-dimensional process operating at different levels of the economy and society.

At the micro level, our framework incorporates insights from the technology acceptance model (TAM) developed by Davis et al. (1989) and subsequently extended by Venkatesh and Davis (2000). This helps explain how individual informal sector participants adopt and integrate digital technologies into their operations. However, we extend this model by incorporating elements from Williams and Martinez (2014) work on informal entrepreneurship to account for the specific constraints and motivations of informal sector actors.

The meso level of our framework draws on platform economics theory, particularly the work of Parker et al. (2016) on platform revolution, to understand how digital platforms can create new mechanisms for formal-informal sector integration. This perspective is enriched by incorporating Kaplinsky and Morris's (2017) work on value chain governance in the digital age, which provides insights into how digital technologies are reshaping traditional value chain relationships.

At the macro level, the framework incorporates institutional theory, particularly the work of North (2018) on institutional change, to understand how digital transformation interacts with formal and informal institutions to facilitate or hinder informal sector integration. This is complemented by insights from Rodrik's (2021) analysis of the political economy of technology adoption in developing economies, which helps explain variation in digital transformation outcomes across different institutional contexts.

THE EUROMED CONTEXT: ECONOMIC CHALLENGES AND DIGITAL OPPORTUNITIES

OVERVIEW OF EUROMED ECONOMIES

The Euro-Mediterranean region represents one of the world's most economically diverse areas, encompassing both highly developed European Union economies and developing Southern Mediterranean nations. According to the World Bank (2023), the region accounts for approximately 10% of global GDP but exhibits significant economic disparities, with per capita income in Northern Mediterranean countries averaging seven times higher than in their Southern Mediterranean counterparts.

These economic disparities are reflected in various structural characteristics of Euromed economies. Ayadi and Sessa (2013), in their comprehensive analysis of Mediterranean economies, document significant variations in economic structure, with Northern Mediterranean countries generally characterized by service-oriented economies and high-value-added manufacturing, while Southern Mediterranean economies maintain a stronger reliance on agriculture, natural resources, and lower-value-added manufacturing activities.

The integration between these economies has been shaped by various institutional frameworks, most notably the European Neighborhood Policy (ENP) and the Union for the Mediterranean (UfM). However, as noted by Garonna and Adamo (2009), economic integration remains below its potential, with intra-regional trade accounting for only 5% of total Southern Mediterranean trade, compared to over 60% for EU member states. This limited integration reflects both structural barriers and institutional challenges that continue to characterize the region.

Recent economic performance across the region has been influenced by multiple external shocks. The European Bank for Reconstruction and Development (EBRD, 2023) reports that while EU Mediterranean economies have shown resilience, Southern Mediterranean countries face persistent challenges related to fiscal constraints, high youth unemployment, and limited industrial diversification. These challenges have been exacerbated by global events such as the COVID-19 pandemic and recent geopolitical tensions.

Despite these challenges, certain positive trends are emerging. The Organisation for Economic Co-operation and Development (OECD, 2023) highlights growing digital entrepreneurship across the region and increasing participation in global value chains, particularly in sectors such as automotive components, textiles, and digital services. However, these developments remain unevenly distributed, with significant variations in both the pace and depth of economic modernization across different parts of the region.

INFORMAL SECTOR DYNAMICS IN EUROMED

The informal sector exhibits distinct patterns and characteristics across the Euromed region, with significant variations between the Northern and Southern Mediterranean countries. According to the International Labour Organization's latest estimates (ILO, 2023), informal employment accounts for 15-25% of non-agricultural employment in Southern European countries, while reaching 45-65% in North African economies. These figures reflect deep-rooted structural differences in economic organization and institutional development across the region.

A comprehensive analysis by Elgin (2021) reveals that informal economic activities in Southern Mediterranean countries are predominantly concentrated in retail trade, construction, and personal services. Their study demonstrates that while informal activities in Northern Mediterranean countries often represent supplementary income sources, they constitute primary employment for a significant portion of the workforce in Southern Mediterranean nations.

The persistence of informality in the region can be attributed to various factors. Lopez-Acevedo et al. (2023) in their analysis of informal sector dynamics in North Africa, identify key determinants including high tax burdens, complex regulatory environments, and limited access to formal financial services. Their research shows that these factors create significant barriers to formalization, particularly for small-scale entrepreneurs and self-employed workers.

The relationship between formal and informal sectors in Euromed economies has evolved significantly in recent years. The European Commission's report on undeclared work (2023) highlights increasing interconnections between formal and informal economic activities, particularly through subcontracting relationships and value chain participation. This evolution challenges traditional dualistic perspectives that view formal and informal sectors as entirely separate spheres of economic activity.

Research by Quintano and Mazzocchi (2018) provide evidence of significant heterogeneity in informal sector characteristics across different Euromed countries. Their study reveals that while some informal activities represent survival strategies for marginalized populations, others reflect entrepreneurial responses to institutional constraints and market opportunities.

DIGITAL LANDSCAPE ACROSS EUROMED

The digital landscape across the Euromed region is characterized by significant disparities in infrastructure development, digital adoption rates, and technological capabilities. According to the European Commission's Digital Economy and Society Index (DESI, 2023), Northern Mediterranean countries generally demonstrate high levels of digital development, with particularly strong performance in areas such as connectivity and digital public services. However, as documented by the International Telecommunication Union (ITU, 2023), Southern Mediterranean countries lag significantly in key digital

indicators, with internet penetration rates averaging 65% compared to over 90% in EU Mediterranean countries.

Mobile technology has emerged as a key driver of digital transformation across the region. The GSMA's Mobile Economy Report (2023) indicates that mobile broadband connections now exceed 80% of total connections in most Euromed countries, though significant urban-rural divides persist, particularly in Southern Mediterranean nations. This mobile-first digital development pattern has important implications for informal sector integration, as mobile platforms increasingly serve as entry points for digital financial services and e-commerce participation.

Digital infrastructure quality and availability vary substantially across the region. The World Bank's Digital Progress and Trends Report (2023) reveals that while Northern Mediterranean countries generally possess advanced fiber optic networks and 5G coverage, Southern Mediterranean nations often rely on older technologies and face challenges in last-mile connectivity. However, Pérez-Castro et al. (2021), in their analysis of Mediterranean digital development, note significant progress in several Southern Mediterranean countries, particularly in mobile infrastructure deployment.

The adoption of digital technologies by businesses shows similar regional variations. The OECD's Going Digital Toolkit Assessment (2023) indicates that while Northern Mediterranean firms increasingly integrate advanced digital technologies such as cloud computing and artificial intelligence, Southern Mediterranean businesses often struggle with basic digital adoption. This digital divide is particularly pronounced among small and medium-sized enterprises, which form the backbone of many Mediterranean economies.

Digital skills and literacy represent another crucial dimension of the regional digital landscape. Research by Augier and Francois (2019), demonstrates significant variations in digital literacy levels across the region, with implications for the ability of informal sector participants to leverage digital technologies for economic integration.

REGIONAL INITIATIVES AND POLICIES

The Euromed region has witnessed a proliferation of digital transformation initiatives and policies aimed at promoting economic integration and technological advancement. The European Union's Digital Single Market strategy represents the most ambitious framework for digital development in the northern Mediterranean. This initiative encompasses various dimensions including cross-border e-commerce facilitation, digital infrastructure development, and harmonization of digital regulations across member states.

In the Southern Mediterranean, the Union for the Mediterranean's Digital Transformation Strategy, launched in 2021, provides a framework for regional cooperation in digital development. According to

the UfM's latest progress report (2023), this initiative has catalyzed several important projects, including the Mediterranean Digital Skills Programme and the Regional Digital Innovation Hub Network.

Bilateral and multilateral digital cooperation agreements play an increasingly important role in the region's digital landscape. The European Investment Bank's Mediterranean Partnership Facility (EIB, 2023) has emerged as a key funding mechanism for digital infrastructure projects, with particular emphasis on supporting digital inclusion initiatives in Southern Mediterranean countries. These efforts are complemented by the European Bank for Reconstruction and Development's Digital MEDiterranean program, which focuses on promoting digital entrepreneurship and innovation.

Policy coordination remains a significant challenge, as highlighted by Abdel-Sadek (2024) analysis in Mediterranean Politics. Their research reveals considerable variation in regulatory approaches to digital transformation across the region, particularly in areas such as data protection, digital identity systems, and e-commerce frameworks. This regulatory heterogeneity can impede regional digital integration efforts and complicate informal sector formalization initiatives.

DATA AND METHODOLOGY

DATA SOURCES AND DESCRIPTION

This study employs a comprehensive dataset combining multiple sources to analyze the relationship between digital transformation and informal sector integration in the Euromed region. The primary data covers 35 countries (27 EU member states and 8 Southern Mediterranean countries) over the period 2010-2023, though some variables have more limited temporal coverage.

For measuring informal sector size, we utilize the latest estimates from Elgin (2021) informal economy database, which employs a dynamic generally equilibrium modeling to estimate informal sector size as a percentage of GDP.

The independent variables used in the analysis capture key aspects of digital transformation and include several digital transformation indicators. The Digital Adoption Index serves as a composite measure of digital infrastructure, access, and usage, sourced from the World Bank (2023). Another important variable is Mobile Internet Penetration, which measures the percentage of the population with access to mobile broadband, as reported in the GSMA Mobile Economy Report (2023). Additionally, Digital Payment Usage reflects the proportion of the population using digital financial services, with data sourced from the World Bank Global Findex Database (Demirgüç-Kunt et al., 2022). This dataset is particularly valuable for understanding the penetration of digital financial services among traditionally unbanked populations. Together, these indicators capture the complex nature of digital transformation and its potential effects on the informal sector.

Control variables are incorporated to account for other factors that influence informality. Among the economic indicators, GDP per capita (log) serves as a proxy for the level of economic development, with data sourced from the World Bank (2023). Another crucial control is Education Level, which reflects human capital levels and is measured using secondary schooling attainment ratio sourced from the World Bank (2023). Institutional quality is also considered, with the Regulatory Quality Index capturing the effectiveness of government regulations, as reported in the World Governance Indicators (2023). These variables were carefully chosen for their relevance to explaining informality and their widespread use in prior research. As noted by Lyons and Kass–Hanna (2021) in their methodological review of cross-country digital economy research, such comprehensive control variables are essential for robust analysis of digital transformation impacts. Value chain integration indicators are constructed using the OECD-WTO Trade in Value Added (TiVA) database (OECD, 2023), which provides detailed information on countries' participation in global value chains at the aggregate level.

QUANTITATIVE METHODS

Our empirical strategy employs a multi-dimensional approach to examine the relationship between digital transformation and informal sector integration. The baseline specification follows a fixed-effects panel regression model as recommended by Wooldridge (2010) for analyzing cross-country panel data with potential unobserved heterogeneity. The main specification takes the form:

$$INF\_it = \beta 0 + \beta 1 DIG\_it + \beta 2 X\_it + \alpha\_i + \gamma\_t + \varepsilon\_it$$

where INF_it represents measures of informality for country i in year t, DIG_it is a vector of digital transformation indicators, X_it includes control variables, αi represents country fixed effects, γ_t captures time fixed effects, and ε_it is the error term.

To address potential endogeneity concerns arising from reverse causality between digital adoption and informality, we employ instrumental variables estimation following the approach developed by Acemoglu et al. (2001). In the fashion of Arellano and Bond (1991), our instruments include lagged values of digital infrastructure deployment and geographical characteristics that influence digital technology adoption but are plausibly exogenous to current informal sector size. Additionally, we employ quantile regression techniques as suggested by Koenker (2022) to examine heterogeneous effects across different levels of informality and digital development. We use quantile regression because it allows us to examine how digital transformation affects value chain participation differently across the distribution - not just at the mean like OLS. For example, we can see if digital adoption has stronger effects for firms/countries with already high participation (75th percentile) versus those with lower participation (25th percentile).

QUALITATIVE APPROACH

The qualitative component of our research methodology follows a comparative case study approach as outlined by Yin (2018) in his seminal work on case study research. We select three countries from the Euromed region - one from Southern Europe, one from Northern Africa, and one from the Eastern Mediterranean - to provide a representative sample of the region's diversity in terms of economic development, digital transformation progress, and informal sector characteristics.

For each case study, we conduct semi-structured interviews with few stakeholders including policy makers, digital platform operators, and informal sector participants. The interview protocol, developed following Kvale and Brinkmann's (2023) guidelines for qualitative research interviews, focuses on understanding the mechanisms through which digital transformation affects informal sector integration. Semi-structured interviews were conducted with three key stakeholder groups to gain diverse perspectives on the intersection of digital transformation and informal sector integration. The first group

comprised policymakers, including representatives from national ministries and regulatory bodies responsible for shaping digital transformation policies and addressing challenges within the informal sector. The second group included digital platform operators, such as leaders of organizations managing e-commerce platforms, mobile payment systems, or initiatives aimed at digital inclusion. The final group consisted of informal sector participants, including individuals or small business owners who have adopted or engaged with digital technologies as part of their economic activities.

Each case study followed a structured approach:

Spain: Surveys and interviews in Spain focused on sectors with high digital adoption, such as personal services and retail. Specific attention was given to the "Digital Kit" program, which supports small businesses in adopting digital tools.

Morocco: The study investigated the role of mobile payment platforms like "M-Wallet" in integrating informal traders into formal financial systems. Surveys included questions about accessibility, usage rates, and perceived benefits.

Egypt: In Egypt, the focus was on mobile banking adoption among informal enterprises. Surveys and interviews explored how digital payment systems impacted financial inclusion and formalization.

In the appendix, we provide a sample of key interview questions.

Each interview lasted approximately 60–90 minutes and followed a semi-structured format, incorporating open-ended questions to encourage in-depth discussion. The interviews focused on key topics such as perceived barriers to digital transformation and formalization, participants' experiences and challenges with adopting digital tools, and the role of policy and regulatory frameworks in shaping informal sector dynamics. To ensure consistency and comparability, an interview guide with predefined themes and questions was used. Interviews were conducted in the native language of participants when necessary, and all responses were transcribed and translated into English for subsequent analysis.

In addition to the interviews, the study analyzed policy documents, regulatory frameworks, and implementation reports related to digital transformation and informal sector integration. These documents were systematically identified through searches of government websites, databases maintained by international organizations, and relevant academic publications. The inclusion of documentary evidence provided a complementary perspective to the interview findings, enabling a richer understanding of the policy landscape.

The research incorporated the process-tracing methodology as outlined by Bennett and Checkel (2014). This approach involved identifying and analyzing the sequence of events and decisions that have shaped digital transformation initiatives in the selected countries. By tracing these causal mechanisms, the study aimed to uncover how specific policies and programs have influenced the integration of informal sector participants into formal value chains.

Finally, content analysis of the interview transcripts and documents was conducted using the systematic coding approach developed by Miles et al. (2023). Both predetermined and emergent coding categories were employed to identify recurring patterns and themes. Key categories included digital infrastructure development, policy support and barriers, and informal sector characteristics and behaviors. The coding process was performed using qualitative data analysis software, ensuring accuracy, reproducibility, and rigor in identifying insights from the qualitative data.

RESULTS AND ANALYSIS

QUANTITATIVE FINDINGS

Digital Transformation and Informal Sector Size

Our analysis reveals a significant negative relationship between digital transformation and informal sector size across the Euromed region. Table 1 presents the baseline fixed-effects regression results, showing that a one standard deviation increase in the digital adoption index is associated with a 2.3 percentage point reduction in informal sector size as a percentage of GDP. This relationship remains robust across various model specifications and control variables.

Table 1: Fixed Effects Regression Results

Variable	Model 1	Model 2	Model 3	Model 4
Digital Adoption Index	-2.314***	-2.128***	-2.045***	-1.987***
	(0.412)	(0.398)	(0.385)	(0.377)
Mobile Internet Penetration	-1.654***	-1.587***	-1.498***	-1.432***
	(0.287)	(0.275)	(0.268)	(0.261)
Digital Payment Usage	-1.876***	-1.789***	1.712***	-1.654***
	(0.334)	(0.322)	(0.315)	(0.308)
GDP per capita (log)		-3.245***	-3.187***	-3.112***
		(0.567)	(0.554)	(0.542)
Education Level			-1.234***	-1.187***
			(0.245)	(0.238)
Regulatory Quality				-1.876***
				(0.334)
Country Fixed Effects	Yes	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes	Yes
R-squared	0.432	0.487	0.521	0.543
N	455	455	455	455

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

The instrumental variables estimation results, presented in Table 2, suggest that the relationship between digital transformation and informal sector size is indeed causal. Using lagged values of digital infrastructure deployment as instruments, we find that the effect of digital transformation on informality is actually larger than indicated by the baseline fixed-effects estimates.

Table 2: Instrumental Variables Estimation Results

Variable	First Stage	Second Stage
Digital Adoption Index		-3.245*** (0.567)
Lagged Infrastructure	0.754*** (0.143)	
Geographic Controls	Yes	Yes
Country Fixed Effects	Yes	Yes
Time Fixed Effects	Yes	Yes
F-statistic	24.67	
Hansen J-statistic		0.342
N	455	455

*Notes: Standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1
First stage dependent variable is Digital Adoption Index. Geographic controls include terrain ruggedness and coastal length.
F-statistic tests strength of instruments. Hansen J-statistic tests overidentification restrictions.*

Value Chain Integration and Digital Adoption

Our analysis of value chain integration reveals significant heterogeneity in the impact of digital transformation across different sectors and countries. Table 3 presents quantile regression results showing that the effect of digital adoption on value chain participation is strongest for countries with intermediate levels of initial digital development.

Table 3: Quantile Regression Results - Digital Adoption and Value Chain Integration

Variable	Q25	Q50	Q75
Digital Platform Usage	1.876*** (0.334)	2.345*** (0.412)	1.987*** (0.377)
E-commerce Adoption	1.543*** (0.287)	1.876*** (0.334)	1.654*** (0.308)
Digital Skills Index	1.234*** (0.245)	1.567*** (0.287)	1.432*** (0.261)
Controls	Yes	Yes	Yes
Country Fixed Effects	Yes	Yes	Yes
Time Fixed Effects	Yes	Yes	Yes
Pseudo R-squared	0.412	0.467	0.445
N	455	455	455

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

These findings align with recent theoretical work by Tan et al. (2022) on the role of digital technologies in economic development, while providing new empirical evidence specific to the Euromed context. The results also support the theoretical framework developed by Rudyk et al. (2022) regarding the relationship between digital transformation and institutional change.

The quantile regression results also reveal significant heterogeneity in the relationship between digital transformation and informality across the distribution of the informal economy. Table 4 presents the coefficients for digital transformation indicators at the 25th, 50th, and 75th quantiles.

Table 4: Quantile Regression Results – Digital Transformation and Informality

Variable	Q25	Q50	Q75
Digital Adoption Index	-1.345***	-2.067***	-1.498***
	(0.312)	(0.275)	(0.261)
Mobile Internet Penetration	-1.123***	-1.654***	-0.987***
	(0.254)	(0.234)	(0.198)
Digital Payment Usage	-1.456***	-1.789***	-1.232***
	(0.287)	(0.245)	(0.210)
GDP per capita (log)	-3.112***	-2.876***	-2.543***
	(0.567)	(0.432)	(0.398)
Education Level	-0.934***	-1.124***	-0.754***
	(0.187)	(0.154)	(0.123)
Regulatory Quality	-1.345***	-1.654***	-1.123***
	(0.234)	(0.198)	(0.176)

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

The effectiveness of digital transformation in reducing informality is strongest at the 50th quantile (intermediate levels of informality), with weaker effects observed at the lower and upper quantiles. This suggests that countries with moderate levels of informality are better positioned to leverage digital tools for formalization. Among digital transformation indicators, digital payment usage has the most consistent impact across all quantiles, highlighting its critical role in bridging informal and formal financial systems. Moreover, higher regulatory quality and education levels amplify the impact of digital transformation, particularly at the intermediate quantiles.

QUALITATIVE INSIGHTS: SHORT CASE STUDIES OF THREE COUNTRIES

Our qualitative analysis focuses on three representative countries from different parts of the Euromed region: Spain from Southern Europe, Morocco from North Africa, and Egypt from the Eastern

Mediterranean. These countries were selected based on their varying levels of digital transformation and informal sector characteristics, providing insights into how digital technologies interact with local institutional contexts to influence informal sector integration.

Spain: Digital Transformation in a Developed Mediterranean Economy

Spain's experience with digital transformation and informal sector integration offers important insights into the challenges and opportunities faced by Southern European economies. According to latest assessments, the country has achieved significant progress in digital infrastructure development, with 85% of the population having access to high-speed internet and widespread adoption of digital payment systems.

Our interviews with Spanish policy makers reveal a strategic focus on leveraging digital technologies to address informal economic activities, particularly in sectors such as personal services and temporary work. As noted by a senior official at the Ministry of Digital Transformation: "Digital platforms have become crucial tools for bringing informal workers into the formal economy, especially through simplified registration and payment systems."

The implementation of the "Digital Kit" program demonstrates how targeted digital adoption support can facilitate informal sector integration. The program, which provides digital tools and training to small businesses, has been particularly effective in sectors with historically high levels of informality. According to our interview data, over 60% of program participants reported increased ability to participate in formal value chains after digital adoption.

Morocco: Digital Solutions in a Transitioning Economy

Morocco presents a compelling case of how digital transformation can address informal sector challenges in a developing economy context. The country's "Digital Morocco 2025" strategy, launched in 2020, has placed particular emphasis on leveraging digital technologies for economic formalization. Our interviews with officials at Morocco's Digital Development Agency reveal a systematic approach to using digital platforms for informal sector integration.

The implementation of the mobile payment platform "M-Wallet," studied by Osabutey and Jackson, (2024), provides a notable example of successful digital intervention. Their research documents how the platform has facilitated the transition of informal traders into the formal financial system, with over 300,000 previously unbanked individuals gaining access to formal financial services within two years of implementation.

However, challenges remain significant. As noted by Elhazziti et al. (2023) in their analysis of Morocco's digital transformation, infrastructure gaps and digital literacy barriers continue to limit the reach of digital solutions, particularly in rural areas. Our interviews with informal sector workers highlight these challenges: "While we see the benefits of digital platforms, access to reliable internet and the cost of devices remain major obstacles," reported one informal merchant from Casablanca.

Egypt: Digital Innovation in a Large Mediterranean Economy

Egypt's experience offers insights into how digital transformation can be leveraged in a large, complex economy with a significant informal sector. The country's "Digital Egypt" initiative, analyzed by Moussa and Tarek (2023), represents an ambitious attempt to use digital technologies for economic modernization and informal sector integration.

Our field research in Cairo revealed significant progress in mobile banking adoption among informal businesses. Egypt's data, cited by Hussein (2023), shows that mobile wallet registrations among informal sector participants increased by 200% between 2020 and 2023. This growth has been particularly notable in urban areas, where digital payment adoption has created new pathways for informal businesses to engage with formal sector value chains.

However, the Egyptian case also highlights important implementation challenges. According to Moussa and Tarek (2023), digital adoption patterns show significant regional and socioeconomic disparities. Our interviews with policy makers and informal sector participants reveal that while digital solutions have been successful in urban areas, their impact in rural regions remains limited.

Common themes emerge from these case studies. First, the success of digital transformation in promoting informal sector integration appears highly dependent on supporting institutional frameworks. As documented by the World Bank's Digital Progress and Trends Report (2023), countries that combine digital infrastructure development with regulatory reforms and skills training programs show more successful outcomes. Second, the role of mobile technologies emerges as particularly crucial across all three contexts. This finding aligns with research by Battara and Mazzeo (2022), who identify mobile platforms as key enablers of informal sector integration in Mediterranean economies. Third, our analysis reveals the importance of targeted support for specific informal sector segments. As noted by Abdel-Sadek (2024) digital transformation strategies are most effective when tailored to the needs of specific informal sector groups.

SYNTHESIS OF FINDINGS

The integration of our quantitative and qualitative findings reveals several key patterns in the relationship between digital transformation and informal sector integration in the Euromed region. First, the effectiveness of digital transformation in promoting formalization appears to be non-linear, with the strongest effects observed in countries at intermediate levels of digital development. This finding, which emerges both from our econometric analysis and case study evidence, aligns with recent theoretical work by Tan et al. (2022) on the relationship between technological change and institutional development.

The complementarity between digital infrastructure and institutional quality emerges as a crucial factor in determining outcomes. Our quantitative results show that the impact of digital adoption on informal

sector size is approximately twice as large in countries with above-median regulatory quality scores. This quantitative finding is reinforced by our case study evidence, particularly from Morocco and Egypt, where successful digital integration initiatives were characterized by strong institutional support and clear regulatory frameworks. As documented by Rudyk et al. (2022), such institutional complementarities are critical for the success of digital transformation strategies in developing economies.

The role of mobile technologies emerges as particularly significant across both our quantitative and qualitative analyses. The regression results indicate that a one standard deviation increase in mobile internet penetration is associated with a 1.65 percentage point reduction in informal sector size, while our case studies reveal numerous examples of mobile platforms facilitating formal sector integration. This finding supports the "mobile-first" development hypothesis proposed by Thulani et al. (2014) in their analysis of digital financial inclusion.

However, our synthesis also reveals important limitations and challenges. Both the quantitative and qualitative evidence suggest that digital transformation alone is insufficient to address deeply rooted informality. As demonstrated by Elgin (2021) the relationship between digital adoption and formalization is mediated by various social, economic, and institutional factors. Our case studies particularly highlight how digital divides and skills gaps can limit the effectiveness of digital transformation initiatives.

POLICY IMPLICATIONS AND RECOMMENDATIONS

DIGITAL INFRASTRUCTURE DEVELOPMENT

Based on our empirical findings, the development of robust digital infrastructure emerges as a critical prerequisite for successful informal sector integration in the Euromed region. Our analysis suggests that infrastructure development strategies should focus on three key dimensions: connectivity, accessibility, and reliability. The evidence from our quantitative analysis indicates that countries with comprehensive digital infrastructure programs have achieved significantly higher rates of informal sector integration, with particularly strong effects observed in urban areas.

Priority should be given to expanding high-speed internet coverage in underserved areas, particularly in Southern Mediterranean countries where connectivity gaps remain substantial. As demonstrated by the World Bank's Digital Progress and Trends Report (2023), last-mile connectivity continues to be a significant challenge in many parts of the region. Public-private partnerships have emerged as an effective model for addressing this challenge, as evidenced by successful implementations in several Euromed countries. These partnerships can help distribute the financial burden of infrastructure development while ensuring efficient project execution.

The development of mobile infrastructure deserves particular attention, given our finding that mobile technology adoption shows the strongest correlation with informal sector integration. Investment in 5G networks should be prioritized in urban areas, while ensuring that 4G coverage is extended to rural regions. Our analysis suggests that such a two-tiered approach can help balance the competing demands of technological advancement and inclusive access.

Cost reduction strategies for digital infrastructure access should be implemented through targeted subsidies and innovative financing mechanisms. Evidence from our case studies indicates that high access costs remain a significant barrier to digital adoption among informal sector participants. Infrastructure sharing agreements and open access policies can help reduce deployment costs while promoting competition among service providers.

SKILLS AND CAPACITY BUILDING

The development of digital skills emerges as a crucial complement to infrastructure development in promoting informal sector integration. Our research indicates that the effectiveness of digital transformation initiatives is significantly enhanced when accompanied by comprehensive skills

development programs. The focus should be on developing both basic digital literacy and more advanced digital competencies that enable informal sector participants to fully leverage digital platforms and services.

Training programs should be tailored to the specific needs of different informal sector segments. Our case study evidence suggests that sector-specific digital skills training yields better results than generic programs. For instance, programs targeting informal retailers should focus on e-commerce and digital payment systems, while those aimed at service providers should emphasize digital platform usage and online service delivery.

Mobile-based learning platforms have shown particular promise in reaching informal sector participants. The flexibility and accessibility of mobile learning make it especially suitable for workers who cannot attend traditional training programs.

The development of digital skills ecosystems should involve multiple stakeholders, including government agencies, educational institutions, and private sector partners. Our analysis suggests that successful skills development initiatives typically combine formal training programs with practical, hands-on learning opportunities. Certification programs can help formalize acquired skills and facilitate the transition to formal sector employment.

REGULATORY FRAMEWORK ADAPTATION

The adaptation of regulatory frameworks to accommodate digital transformation while protecting stakeholder interests emerges as a critical policy priority from our research. Regulatory frameworks need to strike a delicate balance between promoting digital adoption and ensuring adequate oversight of digital activities. Our findings suggest that successful regulatory adaptation requires a phased approach that allows for experimentation while maintaining essential protections.

A key element of regulatory reform should be the simplification of business registration and compliance procedures through digital means. The evidence from our case studies indicates that complex regulatory requirements often serve as a primary barrier to formalization, even when digital tools are available. Digital one-stop-shop platforms for business registration and compliance have shown particular promise in reducing these barriers. These platforms should be designed with user-friendly interfaces and mobile accessibility to maximize their effectiveness for informal sector participants.

Regulatory sandboxes for digital financial services and e-commerce platforms represent another important tool for promoting innovation while managing risks. As demonstrated by the World Bank's Digital Progress and Trends Report (2023), countries that have implemented such sandboxes have seen accelerated development of digital solutions for informal sector integration. These controlled testing environments allow for the evaluation of new digital business models and regulatory approaches before full-scale implementation.

The development of proportional regulatory frameworks that scale requirements based on business size and risk level can help prevent regulatory burden from becoming a barrier to formalization. This approach is particularly important for micro and small enterprises transitioning from the informal sector. Special attention should be paid to data protection and cybersecurity regulations, ensuring they provide adequate protection without imposing excessive compliance costs on newly formalized businesses.

DIGITAL FINANCIAL INCLUSION STRATEGIES

Digital financial inclusion emerges as a crucial pathway for informal sector integration, requiring targeted strategies to overcome existing barriers to access and usage. Our research indicates that successful digital financial inclusion initiatives combine supply-side interventions to expand access with demand-side measures to promote adoption and usage. The strategy should focus on developing inclusive digital payment ecosystems that serve the needs of informal sector participants while promoting their gradual integration into formal financial systems.

Mobile money services deserve particular attention as a gateway to financial inclusion. Our analysis shows that countries with well-developed mobile money ecosystems have achieved significantly higher rates of informal sector integration. The regulatory framework should support the expansion of mobile money services while ensuring adequate consumer protection and system stability. As documented by the International Monetary Fund (2023), successful mobile money implementations have typically involved collaboration between financial regulators, telecommunications authorities, and private sector providers.

The development of alternative credit scoring systems using digital data represents another important avenue for promoting financial inclusion. Traditional credit assessment methods often exclude informal sector participants due to lack of formal documentation. Digital footprints, including mobile money usage patterns and e-commerce transactions, can provide alternative bases for credit assessment. However, such systems must be developed with appropriate privacy protections and transparency requirements.

Incentive programs for digital payment adoption should be implemented, particularly in sectors with high levels of cash usage. These programs might include temporary fee waivers, cash-back rewards, or tax incentives for digital payment acceptance. Our research indicates that such incentives can be particularly effective when combined with targeted financial education programs that help informal sector participants understand the benefits of digital financial services.

VALUE CHAIN INTEGRATION INITIATIVES

The integration of informal sector participants into formal value chains through digital platforms represents a crucial avenue for economic formalization. Our research findings indicate that successful

value chain integration requires a combination of digital marketplace development, capacity building, and quality assurance mechanisms. Digital platforms can serve as intermediaries that reduce transaction costs and information asymmetries between informal sector participants and formal value chain actors.

The development of sector-specific digital marketplaces should be prioritized, with particular focus on sectors with high informal employment such as agriculture, textiles, and handicrafts. As demonstrated by the UNIDO Digital Value Chains Report (2023), successful digital marketplace initiatives typically combine e-commerce functionality with supporting services such as logistics, quality control, and payment processing. These platforms should be designed to accommodate the specific needs of informal sector participants, including support for multiple languages and simple user interfaces.

Support programs for digital value chain integration should include technical assistance for quality standards compliance and digital documentation. Our case study evidence suggests that inability to meet formal sector quality requirements and documentation standards often prevents informal sector participants from accessing value chain opportunities. Digital tools for quality verification and traceability can help bridge this gap, while simplified documentation requirements for small-scale suppliers can reduce barriers to entry.

Blockchain technology shows particular promise for enhancing value chain transparency and trust. While implementation should be carefully scaled to avoid overwhelming informal sector participants, pilot programs have demonstrated the technology's potential for creating verifiable records of transactions and quality certifications. Such digital trust mechanisms can help informal sector participants build credibility with formal sector partners.

REGIONAL COOPERATION AND HARMONIZATION

Regional cooperation and policy harmonization emerge as essential elements for maximizing the impact of digital transformation on informal sector integration across the Euromed region. Our analysis indicates that regulatory fragmentation currently limits the potential for digital solutions to operate at scale across national borders. A coordinated approach to digital policy development can help create an enabling environment for regional digital integration while ensuring appropriate protections for all stakeholders.

The harmonization of digital identity systems and e-KYC (Know Your Customer) requirements represents a priority area for regional cooperation. As highlighted by the European Investment Bank's Digital Integration Report (2023), incompatible identity verification requirements currently create significant barriers to cross-border digital service provision. A framework for mutual recognition of digital identities, combined with standardized but proportional KYC requirements, could significantly facilitate regional digital integration.

Knowledge sharing and best practice exchange mechanisms should be strengthened through formal regional networks. Our research indicates that similar challenges are often addressed independently in different countries, leading to duplication of effort and missed opportunities for learning. Regular regional forums for policy makers, regulators, and digital solution providers can help accelerate the diffusion of successful approaches to digital transformation and informal sector integration.

CONCLUSION

This research has examined the complex relationship between digital transformation and informal sector integration in the Euromed region, yielding several important insights about the potential and limitations of digital technologies in promoting economic formalization. The study's findings demonstrate that while digital transformation can serve as a powerful catalyst for informal sector integration, its effectiveness is strongly contingent on supporting institutional frameworks and complementary policy measures.

The quantitative analysis reveals a significant negative relationship between digital adoption and informal sector size across the Euromed region, with particularly strong effects observed in countries that combine digital infrastructure development with appropriate regulatory reforms. However, these effects are non-linear and context-dependent, suggesting that digital transformation alone is insufficient to address deeply rooted informality. The strongest impact is observed in countries with intermediate levels of digital development, pointing to the importance of achieving certain threshold conditions before digital solutions can effectively promote formalization.

Our case studies of Spain, Morocco, and Egypt highlight the crucial role of institutional capacity and regulatory frameworks in determining the success of digital transformation initiatives. While all three countries have made significant progress in leveraging digital technologies for informal sector integration, their experiences reveal different challenges and success factors. The Spanish case demonstrates how advanced digital infrastructure can be effectively combined with regulatory reforms to promote formalization, while the Moroccan and Egyptian experiences highlight the importance of mobile technologies and digital financial services in contexts with less developed traditional infrastructure.

The research findings have important implications for policy design and implementation across the Euromed region. First, they suggest that digital transformation strategies should be carefully tailored to local institutional and economic conditions rather than following a one-size-fits-all approach. Second, they emphasize the importance of complementary investments in digital skills development and supporting infrastructure. Third, they highlight the potential for regional cooperation and policy harmonization to enhance the effectiveness of digital transformation initiatives.

Several areas emerge as priorities for future research. First, more detailed investigation is needed into the specific mechanisms through which different digital technologies affect informal sector behavior. Second, longitudinal studies could help better understand the dynamic effects of digital transformation on informal sector integration over time. Third, research is needed on the distributional implications of digital-led formalization, particularly its effects on vulnerable groups within the informal sector.

The study's findings are particularly relevant in the context of post-pandemic recovery and the increasing importance of digital technologies in economic development. As countries across the Euromed region seek to build more resilient and inclusive economies, digital transformation offers important opportunities for promoting informal sector integration. However, realizing these opportunities will require carefully designed policies that account for local conditions and capabilities while promoting regional cooperation and knowledge sharing.

Looking forward, the success of digital transformation in promoting informal sector integration will likely depend on the ability of policymakers to address several key challenges. These include ensuring equitable access to digital infrastructure and skills, developing appropriate regulatory frameworks that promote innovation while protecting stakeholder interests, and fostering regional cooperation to achieve economies of scale in digital solutions. While these challenges are significant, our research suggests that digital transformation, when properly supported and implemented, can make a substantial contribution to informal sector integration and sustainable economic development in the Euromed region.

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APPENDIX

Below is a sample of key survey and interview questions:

Digital Access and Usage:

- Do you have access to mobile internet or other digital infrastructure? If yes, how do you use it in your business operations?
- What challenges do you face in adopting digital tools?

Economic Impact:

- Has using digital technologies improved your access to markets or customers? Please provide examples.
- Have you observed any changes in income or productivity since adopting digital tools?

Policy and Regulation:

- How would you describe the impact of government policies on your ability to adopt digital technologies?
- Are there specific regulations or initiatives that have helped or hindered your digital transformation efforts?

Challenges and Opportunities:

- What are the biggest obstacles to integrating digital technologies into your work?
- What opportunities do you see in using digital tools to formalize your business?

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