

Reducing Distance Friction via Digital Taxation -The Piraeus Case

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Abstract. Focusing on the Port of Piraeus as a case of institutional innovation, this study explores how digital taxation reforms can diminish 'distance friction' in maritime trade. By integrating Greek myDATA e-invoicing system with the ICISnet Customs single-window, a pre-clearance process markedly accelerates procedural flows and augments institutional trust in Port of Piraeus. Analytically, the study situates these outcomes within a Technology Organization Environment framework and a theory of institution-to-process-to-efficiency. The findings demonstrate that although initial friction may arise, sustained system stabilization delivers amplified efficiency, especially in transshipment hub contexts like Piraeus. Building on these insights, the paper proposes a cohesive strategy combining system-level enhancements. The strategies include UID pre-clearance benchmarks, frequent performance metrics, and crisis playbooks. This integrated model significantly advances digital Customs integration and offers a scalable road map for countries aiming for resilient and efficient port systems, even if the countries are outside the EU. Finally, several limitations are put forward to be studied in the future.

Keywords: Digital taxation, E-invoicing, Customs modernization, Operational resilience, Port efficiency

1. Introduction

Maritime transport is a pillar of global trade. According to UNCTAD [1], approximately 80% of the total volume of international merchandise trade is transported by sea. One of the most critical links among ocean shipping is the port. Ports serve as pivotal nodes in global maritime logistics, connecting sea routes to inland transportation and facilitating the efficient flow of goods across international supply chains. A port with good performance will help to boost regional economic growth, meaning great significance to the national development strategy. Factors affecting port performance are a lot, from location to facilities, involving both natural and manual. Compared with the enormous amount of work involved in altering the natural environment or constructing facilities, making some changes at the administrative level seems to be a more cost-effective option. Therefore, improving port Customs clearance procedures is an efficacious measure. Such improvements will make ports more attractive to merchant fleets and promote global trade. In this way, Customs reform does more than just improve port efficiency, indeed it reduces the effective friction of distance, making trade routes closer functionally.

Friction of distance is a fundamental concept in geography. It states movement entails some form of cost such as physical effort, energy, time, or the use of other resources. These costs increase in proportion to the distance traveled. Consequently, this friction acts as a resistance to movement. In geographic and spatial analysis, the presence of friction of distance helps to explain why spatial interaction declines over longer distances and underpins models like Tobler's first law, distance decay functions, and cost-distance analysis [2]. The concept above underscores how both spatial and administrative barriers can introduce delays and costs into trade movement. Locating this notion within the broader framework of international shipping and trade flows, it involves the Port Customs clearance process.

In a representative case drawn from Greece, the Piraeus Port illustrates how digital taxation initiatives effectively reduce procedural frictions. This paper integrates the concept of friction of distance with Greece's recent tax reforms, including the myDATA platform, e-invoicing and Integrated Customs Information System (ICISnet), to examine how these changes reduce administrative friction and enhance Customs clearance efficiency. The following sections will outline the theoretical framework, discuss the relevant digital tax initiatives in Greece, present a case study of the Port of Piraeus, and conclude with a discussion of implications and future directions.

2. Literature review

Existing research highlights the role of digital taxation and Customs reform in reducing institutional friction, thereby improving port clearance outcomes. Drawing on Tobler's first law of geography, friction of distance refers to the idea that movement incurs increasing costs, such as time, energy, and procedural complexity. As spatial or institutional separation widens, interaction and trade flows are thereby hindered. In the field of port and trade logistics, evidence from Shubailat et al. demonstrates that digital taxation systems and digital accounting tools, including real-time invoice validation and automated compliance checks, can significantly reduce administrative friction at Customs, effectively improve port clearance efficiency and sustainability [3].

While friction of distance often refers to geographic impedance, Han et al. remind us that even in digital eras interactions remain sensitive to real-world distance [4]. Hence, when evaluating digitization at Piraeus port, we must recognize the institutional friction myDATA reforms address, the spatial friction that remains influential. Previously, Laajaj et al. had studied the computerization reform of Customs clearance for imports in Colombia. Compared with ports that had not undergone reform, ports that implemented electronic Customs clearance saw a significant increase in throughput and tax revenue. In addition, importers also preferred electronic ports [5]. Cabanillas Tacanga shows that government digitalization models can significantly reduce litigation delays through digital identity and system interoperability mechanisms. That model is highly similar to the institutional path of tax digitalisation for Customs process efficiency explored in this study [6].

Building upon these empirical observations, the theoretical framework guiding this study is based on Tobler's First Law, the friction of distance concept, the institutional process then to the efficiency pathway. Theoretical reflection draws upon geographic and institutional principles to explain how procedural innovations translate into measurable performance gains.

3. The case of the Piraeus Port

Located on the Saronic Gulf on the western coasts of the Aegean Sea, Port of Piraeus is the largest port in Greece and fifth largest in Europe [7]. It serves as Greece's and the Eu's marine gateway with nearly 5 MTEU handled annually and a key role in Mediterranean container traffic. As such a

high-volume international gateway, Piraeus represents a special friction-sensitive node, meaning that even minor procedural delays can cascade into critical waiting periods and port-call inefficiencies.

Local authorities have undertaken significant digital reforms in tax administration and Customs procedures. Since 2021, all invoices must be submitted via the myDATA platform, where they are validated in real time and assigned a Unique Invoice Identifier as a unique ID (UID). From 2023 to 2025, B2G and B2B e-invoicing mandates progressively made this system compulsory for public procurement and domestic business transactions. Crucially, the ICISnet Import Subsystem, Greek national Customs single window, now enforces UID based validation, meaning that Customs can only accept an Electronic Import Declaration (EDE) unless it references a validated UID previously. This configuration embeds myDATA and UID enforcement directly into the Customs workflow, converting tax compliance into a pre-clearance structural gate that systematically reduces institutional friction in port clearance processes [8,9].

In 2020, Greece introduced a continuous transaction controls scheme, called myDATA, an e-audit system. MyDATA requires taxpayers to transmit transactional and accounting data to the tax administration, in real-time or periodically, then populates a set of online ledgers maintained on the government portal. Since Oct.1 2021, myDATA scope has extended to include revenue and all taxpayers [10]. Subsequently, the phased mandatory e-invoicing implementation plan for B2G, from 2023 to 2025, provided an institutional path for public procurement, while the domestic B2B mandate, from mid-2025 to 2027, further incorporates business-to-business transactions into the same platform verification mechanism. By mid-2025, Greece's myDATA platform will be operational nationwide as a real-time tax data bus: all companies subject to Greek accounting standards must upload structured invoices and accounting data, the system will verify and assign a UID.

Furthermore, Greek ICISnet Import Subsystem, a module within the national ICISnet, has the functions as a mandatory single-window interface for import clearance. As defined in official guidance, all imports from third countries must be filed electronically through this subsystem, using the EDE form, which includes fields for key supporting documents. The ICISnet Import Subsystem is the mandatory electronic interface for import clearance and supports submission of required supporting documents. In practice, firms reference validated invoice information in clearance workflows, thus placing tax validation within the first procedural gate of Customs clearance.

Building on the status of myDATA as a nationwide real-time tax data bus, this system is used as a clearance-style continuous transaction control mechanism at the Customs interface. Invoices are required to be pre-submitted, validated and assigned UIDs by myDATA before they are accepted in Customs clearance modules. Only invoices issued with a valid UID can trigger release orders, effectively eliminate paper-based controls and dramatically reduce institutional friction in port clearance processes [11]. These institutional reforms lay the groundwork for empirical validation at Greece's largest maritime gateway, the Port of Piraeus.

4. Analysis of the problems

The performance data provides the empirical basis for assessing the mechanisms. In port logistics and supply chain performance analyses, dwell time refers to the period from the arrival of a container at a location, such as a port or inland terminal, to its final departure from that same location [12]. This includes all stages of inactivity at that site. When calculated on a combined basis for both imports and exports, this metric captures the total time spent within the port and any intermediate inland terminals. For imports, from the time of ship unloading through inland transfer, and for exports, from inland aggregation prior to vessel loading.

Although there have been no significant changes in hardware facilities, the paperless together with electronic invoice UID verification mechanism has demonstrated a clear institutional effect. According to S&P Global Market Intelligence, the average dwell time for transshipment berths at the Port of Piraeus decreased by approximately 25% in the fourth quarter of 2024 compared to the beginning of the year, outperforming most major European ports, as many ports have failed to achieve efficiency improvements [13]. The Beacon Global Port Congestion Report indicates that in September 2024, the average container dwell time at the Port of Piraeus was 8.5 days, the highest in Europe, but the monthly increase, around +1.5 days, was far lower than that of other global ports. The report indicates the baseline dwell time was already relatively low and stable [14]. This reduction in dwell time, particularly against the backdrop of a 25% decline in transshipment volumes, serves as a systemic indicator of the dissolution of institutional friction and process compression.

Following the roll out of myDATA validation and mandatory B2B invoicing, Q1 2024 throughput fell below 1 M TEU, whereas Q3 and Q4 recovered to 1,149.2 k TEU and 1,121.2 k TEU respectively. Annual 2024 throughput, around 4,228.5 k TEU, remains slightly below 2023, suggesting initial friction introduced by tax system integration before full system stabilization. Piraeus Container Terminal throughput declined by 7.9% in 2024, mainly due to the security crisis in the southern Red Sea region, such as Houthi attacks causing a shift in shipping routes from the Suez Canal in Egypt to the Cape of Good Hope, resulting in a decrease in traffic at most hub ports in the eastern Mediterranean [15]. The results show that despite the overall decline in volume, the following improvements were observed in the second half of 2024. The dwell time for transshipment containers at Piraeus decreased by approximately 25% in the fourth quarter of 2024 compared to the beginning of the year. This efficiency improvement reflects the effectiveness of institutional mechanisms rather than mere market fluctuations. David Koke indicates that anchorage waiting times also decreased slightly, even as congestion along the entire route intensified, with port internal processes remaining smooth.

This analysis clarifies how institutional reforms may influence port clearance performance, setting the empirical and theoretical ground for the research design that follows. Embedding e-invoicing and real-time compliance checks via myDATA accelerates procedural flows, signals, institutional trust, encourages smoother cooperation in Customs clearance. This aligns with empirical findings that electronic invoicing improves audit efficiency and reduces VAT fraud incidents. From a Technology–Organization–Environment perspective, improvements at Piraeus stem from technological infrastructure, organizational readiness and supportive regulatory frameworks. Similar efficiencies have been documented in other e-invoicing contexts. Beyond steady state efficiency gains, these institutional arrangements also offer strategic value in maintaining performance during periods of exogenous disruption.

In a volatile shipping environment, such as disruptions in the Red Sea region, Piraeus experienced only modest increases in dwell time, indicating enhanced operational resilience. Robust digital tax–Customs mechanisms helped mitigate external shocks, preserving port performance and demonstrating that efficiency gains extend beyond speed to include system stability. These empirical results reinforce the coherence of the institutional-to-process-to-efficiency framework in explaining performance improvements under regulatory innovation.

From a global market perspective, the e-invoicing sector is expanding rapidly. By 2024, an estimated 560 billion invoices were expected to be processed annually, 125 billion of which were e-invoices. The market value is predicted to increase from \$8.9 billion to \$23.7 billion by 2028.

Greece's experience through myDATA contributes a valuable case study to this global trajectory of automation-driven efficiency.

5. Suggestions

To address the limitations and maximize policy and academic impact, several interconnected strategies are proposed. First, system functionality should be optimized. Accompanying this, routine publication of high-frequency metrics would foster transparency and create a dynamic feedback mechanism that supports continuous improvement. Finally, robust interface testing and real-time dash boarding across Customs, port authorities are essential for ensuring the reliability and interoperability of the myDATA and ICISnet platforms. Boarding and capacity-building programs targeted at SMEs would mitigate short-term compliance burdens and enhance inclusion.

Simultaneously, institutional preparedness should incorporate crisis-oriented protocols, including simulation-based stress testing of port workflows, to safeguard operational continuity under volatility. Cross-national comparative analyses would test the external validity of findings and reveal institutional boundary conditions. Additionally, the development of agent-based and system-dynamics models to trace friction pathways from paper to UID gated Customs workflows would enable quantification of error rates, processing delays, and reliability impacts. Finally, longitudinal cost-benefit studies evaluating time saved, compliance cost reductions, and retained trade volume would demonstrate reform value and support strategic decisions. Together, these operational and analytical pathways build a unified, forward-looking program that advances both practice and research in digital Customs integration.

6. Conclusion

The myDATA digital invoicing platform, real-time UID validation, and its linkage to the ICISnet single-window system, successfully demonstrated that even without large-scale infrastructure upgrades, administrative innovations alone can compress procedural barriers and improve port clearance performance. The coherence of this pathway also suggests a similar reform to ports with similar transshipment profiles and digital-tax architectures. Though overall throughput of Piraeus Port declined by 7.9% in 2024, the decline largely attributed to macro factors, dwell time fell by 25% within Q4 alone, the anchor waiting times remained competitive in comparison to peer ports. This affirms the potency of institution-to-process-to-efficiency of our theoretical model. In policy terms, this research echoes broader international recommendations. Both OECD and UNCTAD evidence affirm that digital connectivity and automated tax - Customs interfaces can significantly reduce trade costs and procedural frictions, benefit both governments by improving compliance and Customs offices by streamlining clearance dynamics. This study contributes a transferable model, by institutionalising pre-clearance validation and integration into Customs workflows. Therefore, jurisdictions can foster more resilient and time efficient trade corridors, even amid global volatility. Accordingly, countries even outside the EU can adapt similar clearance frameworks to reform Customs logistics systems.

However, this study remains inherently constrained by its single-case design, focusing exclusively on Piraeus as a qualitative demonstration of the institution-to-process-to-efficiency pathway induced by Greece's myDATA and e-invoicing reforms. Several limitations need to be studied carefully in the future: the absence of a control port restricts causal inference; reliance on secondary data may capture broader trade dynamics beyond institutional impact; and the simultaneous rollout of myDATA and ICISnet complicates attribution. Future research could address

these constraints by employing comparative multi-port designs or introducing quantitative methods, such as difference-in-differences or interrupted time series, to isolate institutional effects. Expanding the scope geographically and methodologically would enhance the generalizability and explanatory power of the policy proposed here.

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