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# Effects of digital capability on digital export: international evidence

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**Abstract**
This paper uncovers the nexus between digital capability and digital exports using newly cross-country data from the World Bank Enterprises Survey. Digital export reflects the export of goods directly through electronic means and shipped by mail parcel or courier service. Using the Entropy Balance approach to fix the endogeneity problem, we find that digital capability enhances the probability of digital exports. Moreover, financially constrained firms or SMEs suffer a liability to engage with digital export.

*Keywords*: digital capability, digital export, export, international trade, entrepreneurship
*JEL Classification Codes*: F13, F14, F68, L86

## 1. Introduction

The Industry Revolution 4.0 has resulted in founding new digital business models, which creates pressure for firms to adapt to technology development to achieve and maintain sustained competitive advantage. This is especially true for companies that are planning to broaden their global footprint by engaging international markets through e-commerce. However, many companies face difficulties with inadequate resources that hinder their capacity to capitalize on digital export opportunities (Gregory et al., 2019). The existing literature on the positive relationship between digital export and digital capabilities across different sizes of firms is mixed (Cassetta et al., 2020; Spiezia, 2013). On the one hand, digital capabilities enhance business performance compared to competitors, making digital transformation implementation more effective (Luu, 2023). These also encourage organizations to utilize data

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mining effectively in regional and global market data sources, facilitating firms' entry into the global market (Pereira et al., 2022). Moreover, small and medium enterprises (SMEs) demonstrate a robust inclination to participate in digital export activities, even in the face of resource limitations (Elia et al., 2021). On the other hand, digital transformation requires structural reforms that involve modernizing policies, procedures, and managing relationships between various stakeholders, including suppliers and employees, which demands a suitable international business strategy (Bharadwaj et al., 2013). SMEs encounter challenges when venturing into digital export, primarily due to their constrained resources and reduced adaptability in modifying business models (Hånell et al., 2019).

The controversy surrounding this issue may stem from the proxies of digital capabilities employed in different studies. Digital capabilities encompass a set of competencies that bolster an organization's ability to create, deploy, and efficiently utilize its organizational resources and processes by harnessing digital technologies to attain a competitive advantage. Rana et al. (2024) categorize different elements of digital capabilities, including internal factors (innovation, culture), external factors (infrastructure, stakeholder's technologies), enabler factors (mobile technology, cloud computing, data analytics), and new capabilities (managers expertise, employee knowledge). While recent studies on digital capabilities have put much emphasis on the internal factors (innovation) (Luu, 2023), new capabilities (manager leadership) (Elia et al., 2021; Luu, 2023) that enhance digital export, research on external factors has been scarce. Digital infrastructure serves as the foundation of digital transformation (Zhou et al., 2022). The Internet is widely acknowledged for its capacity to facilitate e-commerce and cross-border e-commerce, serving as a significant technological driver for the growth of international trade (Ma & Fang, 2021). The Internet lowers communication costs, facilitates transaction tracking, enhances efficiency in delivery processes, and reduces costs associated with drafting and signing contracts. These features collectively reduce the overall costs of global trade (Zhou et al., 2022). Clarke (2008) examines enterprise-level data and identifies a strong correlation between exports and Internet access. Kneller and Timmis (2016) demonstrate a causal relationship between broadband and exports, using the UK firm-level data. Several empirical studies confirm the positive relationship between the expansion of Internet access and export trade, using data from Chinese companies (Fernandes et al., 2019; Jiang et al., 2021; Mu et al., 2020). However, these studies are lack of international evidence. This research addresses the pivotal question: How do digital capabilities influence the likelihood of firms engaging in digital exports?

This research utilizes a logit regression model combined with the Entropy Balancing method, analyzing data from 20 countries to mitigate endogeneity issues and examine the influence of digital capabilities on digital exports. The study makes two key contributions to the existing literature. First, it provides empirical evidence of a positive link between digital capabilities and digital exports, supported by novel cross-country data. Second, it explores digital capabilities as an external factor, highlighting the challenges faced by financially constrained firms and SMEs in participating in digital export activities.

## 2. Data, variables and method

### *2.1. Data*

This study leverages newly available data from the World Bank Enterprise Surveys (WBES). Following data cleaning —removing entries with missing values and applying winsorization to continuous variables within the 1st and 99th percentiles to manage outliers—the final sample comprises 924 firms across 20 countries[1].

### *2.2. Variables*

*Dependent variable*: DE

DE is a dummy variable that takes the value of 1 if a firm exported the goods directly through electronic means and shipped by mail parcel or courier service and 0 otherwise. It is worth noting that our sample also includes firms with no export activity.

*Independent variable*: DC

Concerning our main variable of interest, which is the digital capability (DC), we start by examining the fundamental digital infrastructure of a firm – the fixed broadband internet. Utilizing the Internet in its operations enables firms to effectively communicate with customers, suppliers, distributors, and employees irrespective of their location (Hagsten & Kotnik, 2017). Moreover, internet usage facilitates firms in accessing timely and relevant information about various economic actors and market conditions, thereby aiding in their internationalization efforts. The adoption of Internet technologies also allows firms to lessen reliance on expensive intermediaries, which play a crucial role in establishing trade relationships. Lastly, as highlighted in existing literature, internet usage enables rapid cross-border interactions among firms and serves as a cost-effective means of participating in global markets. However, it is important to acknowledge that the quality of digital infrastructure—such as broadband penetration, speed, and reliability—varies across the 20 countries in our sample. These differences could influence the extent to which firms benefit from digital capabilities. While our analysis focuses on access to broadband as a key enabler, future studies might explore how variations in infrastructure quality impact the relationship between digital capabilities and international trade outcomes.

To resolve the omitted variable problem, we include several control variables in our model defined in Table 1. We build on the extant literature (Elia et al., 2021; Luu, 2023; Zhou et al., 2022) on the determinants of a firm's digital export in order to add variables to control the impacts on a firm's digital export.

[1] The list of countries: Barbados, Cambodia, Central African Republic, Chad, Costa Rica, El Salvador, Gambia, Georgia, Hong Kong, Kyrgyz, Lesotho, Mexico, Nepal, Pakistan, Seychelles, Sierra Leone, Singapore, Tanzania, Vietnam, West Bank, and Gaza.

**Table 1.** Statistical summary

| | Explanation | count | mean | sd | min | max |
|---|---|---|---|---|---|---|
| *DE* | | 924 | 0.22 | 0.41 | 0.00 | 1.00 |
| *DC* | | 924 | 0.16 | 0.37 | 0.00 | 1.00 |
| *Productivity* | Natural logarithm of the ratio of total sales to full-time employees | 924 | 15.27 | 3.42 | 9.05 | 22.80 |
| *FirmAge* | Natural logarithms of the number of years of firm establishment till the survey year | 924 | 3.01 | 0.93 | 1.10 | 7.62 |
| *FirmManager* | Natural logarithms of the manager's past experience in their current sectors | 924 | 2.89 | 0.61 | 1.10 | 3.93 |
| *Jointstock* | Value of 1 if a firm is a shareholding one with shares traded in the stock market | 924 | 0.03 | 0.18 | 0.00 | 1.00 |
| *Innovation* | Value of 1 if a firm launches a new product or new process and 0 otherwise | 924 | 0.31 | 0.46 | 0.00 | 1.00 |
| *Foreigntech* | Value of 1 if a firm has foreign technology and 0 otherwise | 924 | 0.29 | 0.45 | 0.00 | 1.00 |
| *Foreign* | Dummy variableValue of 1 if a firm has foreign ownership and 0 otherwise | 924 | 0.33 | 0.47 | 0.00 | 1.00 |
| *Certification* | Value of 1 if a firm has an foreign quality certification and 0 otherwise | 924 | 0.42 | 0.49 | 0.00 | 1.00 |
| *FinConstraint* | Value of 1 if a firm has a loan rejection or report a financial obstacle and 0 otherwise | 924 | 0.26 | 0.44 | 0.00 | 1.00 |

*Source:* own elaboration

### *2.3. Method*

We follow the current literature on firm's digital export Elia et al. (2021) to specify the benchmark model as follows:

$$\begin{aligned} Pr(DE_{ik} = 1) &= Pr\,(\beta_0 + \beta_1 DC_{ik} + \beta_2 CONTROL_{ik} + \gamma_{ck} + \varepsilon_{ik} > 0) \\ &= F(\beta_0 + \beta_1 DC_{ik} + \beta_2 CONTROL_{ik} + \gamma_{ck} + \varepsilon_{ik}), \end{aligned} \quad (1)$$

where subscripts *i, k,* and *c* refer to firm, sector, and country respectively. $\gamma_{ck}$ stands for country-sector-fixed effects that are used to control for factors such as subsidies policies that vary by country and industry. Furthermore, sector fixed effects can control for industry-specific factors like technological intensity or competitive dynamics, while country fixed effects help account for variations in national policies, such as subsidies, trade regulations, or digital infrastructure development. $DE_{ik}$ denotes the digital export decision of firm *i* in sector *k*. $DC_{ik}$ is a firm's digital capability. $CONTROL_{ik}$ reflects a set of control variables. $\varepsilon_{ik}$ has a normal distribution with zero mean and unit variance. As $DE_{ik}$ is a dummy variable, we apply the logit technique to estimate Equation (1). *Pr* is a probability, and *F* probability distribution is logistic. All results reported are the marginal effects at the mean level. We report cluster standard errors at a sector-location level.

There are several concerns regarding the model specification (1). Firstly, one potential issue is endogeneity, where the observed outcomes may actually be determinants of a firm's improvement in digital capability, leading to reverse causality. For example, firms already engaged in digital export activities might have a stronger incentive to invest in digital

infrastructure to support their operations, such as improving internet access or adopting advanced technologies. Another concern is the omitted variables bias, as there may be unmeasured variables associated with digital capability that also influence a firm's digital exports.

To address these issues of biased estimation, we utilize the Entropy Balancing (EB) technique introduced by Hainmueller (2012)[2]. This method involves adjusting the weights assigned to observations associated with the treatment factor (such as digital capability status) to achieve balance across all relevant covariates. Essentially, it extends the conventional practice of assigning weights based on propensity scores. The calculation of the projected counterfactual mean is involved in this process.

$$E\left[\widehat{DE}(0)\middle|DC=1\right]=\frac{\sum_{i|DC=0} DE_i DC_i^{EB}}{\sum_{i|DC=0} DC_i^{EB}}. \quad (2)$$

In this scenario, the weight assigned to each reference unit, denoted as $DC_i^{EB}$, is determined through a process that involves minimizing a loss function. This function evaluates the difference between the distribution of control weights obtained and the original foundational weights. In EB, the loss function seeks to minimize the divergence between the reweighted treatment and control groups, ensuring that the distributions of covariates are balanced across the two groups. This is achieved while retaining as much information as possible from the original sample. The balance constraints are crucial as they determine the covariates whose means are aligned between the groups. These constraints can either be based on pre-specified criteria drawn from prior studies—emphasizing variables known to influence the dependent variable—or selected empirically based on the data characteristics. In this study, this minimization process adheres to various constraints, including balance constraints, which are based on the researcher's preferences. Thus, while the method holds promise in theory, its ability to determine appropriate weight assignments may encounter challenges if the balance constraints are not well chosen.

Moreover, in our approach, we establish a balance between the two sets by using the same covariates employed in the one-to-one matching. However, it's important to note that factors specific to particular years and sectors are not taken into account in this context. The results presented in Table 2 indicate that all covariates in both the treated and control groups exhibit statistically insignificant differences in means. This suggests that entropy balancing effectively

[2] Instrumental variables are often used to address endogeneity issues by relying on external instruments that are correlated with the independent variable but uncorrelated with the error term. However, finding valid instruments can be challenging, particularly in studies like this one where identifying external factors specific to digital capabilities might be limited. Propensity score matching, on the other hand, seeks to create comparable treatment and control groups by matching observations based on a propensity score, which estimates the likelihood of treatment assignment given observed covariates. While effective, PSM can sometimes fail to achieve balance for all covariates and does not inherently account for imbalances in higher moments (e.g., variances or distributions). Entropy Balancing stands out as it directly reweights observations to achieve perfect balance on covariate means (and optionally higher moments), offering a more flexible and precise way to address endogeneity and omitted variable bias. This makes it particularly suitable for this study, where the goal is to accurately isolate the effects of digital capabilities on digital exports across a diverse, multi-country dataset.

achieves the balance between these two groups. Our findings remain consistent even when the balance constraints were adjusted, whether by relaxing or tightening the criteria.

*Table 2*. Balancing test

| | Panel A: Unmatched | | | Panel B: Balanced sample | | |
|---|---|---|---|---|---|---|
| | Untreated | Treated | p-value | Untreated | Treated | p-value |
| *Productivity* | 15.27 | 15.24 | 0.00 | 15.24 | 15.24 | 0.99 |
| *FirmAge* | 2.97 | 3.20 | 0.00 | 3.2 | 3.2 | 0.99 |
| *FirmManager* | 2.88 | 2.95 | 0.00 | 2.95 | 2.95 | 0.99 |
| *Jointstock* | 0.02 | 0.03 | 0.00 | 0.03 | 0.03 | 0.99 |
| *Innovation* | 0.30 | 0.39 | 0.00 | 0.28 | 0.28 | 0.99 |
| *Foreigntech* | 0.29 | 0.28 | 0.00 | 0.29 | 0.29 | 0.99 |
| *Foreign* | 0.34 | 0.29 | 0.00 | 0.29 | 0.29 | 0.99 |
| *Certification* | 0.42 | 0.39 | 0.00 | 0.39 | 0.39 | 0.99 |
| *FinConstraint* | 0.26 | 0.25 | 0.00 | 0.25 | 0.25 | 0.99 |

*Source:* own elaboration

Derived from the concept of entropy balance, our model can be expressed in the following manner:

$$Pr(DE_i = 1) = Pr\ (\beta_0 + \beta_1 DC_i^{EB} + \beta_2 CONTROL_i + \gamma_{ck} + \varepsilon_i > 0)$$
$$= F(\beta_0 + \beta_1 DC_i^{EB} + \beta_2 CONTROL_i + \gamma_{ck} + \varepsilon_i), \quad (3)$$

where $DC_i^{EB}$ captures the entropy balancing weight.

We first investigate the connection between digital capability and digital export, using the EB approach to fix the endogeneity consequence. Furthermore, we re-regress equation (3) with sub-samples by firm size and financial constraints to investigate how digital capability improves a firm's digital export (Reuber & Fischer, 2011). Lastly, we check the robustness by using alternative measures of the firm's digital capability.

## 3. Empirical findings

Table 3 displayed regression estimation results for equation (3). Having a digital capability of internet utilization raises the probability of digital export by 71%. This result is aligned with Luu (2023) and Elia et al. (2021), who find that firms leveraging digital capabilities are likely to improve exports through e-commerce because of the efficient allocation of resources (Akhtar et al., 2019), innovative business management, improved information processing (Elia et al., 2021). The impact of digital capabilities on digital export is greater compared to their influence on traditional export. For instance, Dong et al. (2024) found a positive and significant effect of digitalization on export performance, with a correlation coefficient of 0.36, indicating a substantial impact across various contexts and industries. Similarly, Dwi Handoyo et al. (2024) observed that internet use promotes manufacturing exports, particularly in high-technology sectors within OECD countries, although the effect varies by technology intensity and region. Our result remains robust with alternative measures of digital capabilities such as having a

website or social media page[3].

**Table 3**. Estimation results

| | (1) |
|---|---|
| VARIABLES | DE |
| *DC* | 0.71*** |
| | (0.268) |
| *Productivity* | -0.11** |
| | (0.055) |
| *FirmAge* | -0.47*** |
| | (0.129) |
| *FirmManager* | 0.33 |
| | (0.201) |
| *Jointstock* | 1.17** |
| | (0.588) |
| *Innovation* | 0.45 |
| | (0.319) |
| *Foreigntech* | -0.29 |
| | (0.349) |
| *Foreign* | -0.31 |
| | (0.280) |
| *Certification* | -0.13 |
| | (0.273) |
| *FinConstraint* | -0.60 |
| | (0.390) |
| Constant | 0.85 |
| | (0.762) |
| Observations | 626 |
| pseudo-R-squared | 0.0854 |

*Source:* own elaboration
*Notes*: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Regarding the control variables in Table 3, the coefficient of the variable *Productivity* is negative and statistically significant. The negative association between productivity and digital exports, where highly productive firms may prefer traditional exports, can be attributed to several underlying mechanisms. Firstly, highly productive firms often operate in industries

[3] A potential measure of digital capability is whether a firm uses an e-mail to communicate with a client or a supplier. Unfortunately, this variable has no observation in our country sample.

where traditional export methods are more established and efficient, such as manufacturing, where high-tech exports are prevalent (Bertschek et al., 2015). These firms may have already optimized their processes and supply chains for traditional exports, making the transition to digital exports less appealing due to the potential disruption and initial costs involved (Wang et al., 2024). Additionally, the digital economy's impact on productivity is not uniformly positive; it follows an inverted U-shaped curve, suggesting that beyond a certain point, further digitalization may not yield additional productivity gains, especially in complex industries (Suo et al., 2024). This could deter highly productive firms from investing heavily in digital exports.

Moving to other variables, if the firm age increases by 1%, the chance of exporting digitally decreases by 47%. This is especially true for aging companies who find difficulties in broadening their global footprint by engaging international markets through e-commerce (Pergelova et al., 2019) as they are under high pressure to adapt to technology development to achieve and maintain sustained competitive advantage (Hånell et al., 2019). The orientation toward the stock market plays a vital role for a firm going global digitally. Firms having shares traded on the stock market tend to have wider business network and receive support from international partnerships. This could be an effective strategy for entering foreign markets in early phases (Hånell et al., 2019). The effects of the remaining control variables are mute as their coefficients are not statistically significant.

Furthermore, we run a regression of data in the sub-sample by financial constraints and firm size. These variables may have been chosen due to their significant moderating effects, as suggested by previous research or empirical evidence. For instance, financial constraints are critical in determining a firm's capacity to invest in digital infrastructure and technology. Firms with greater financial flexibility are likely to be more proactive in leveraging digital capabilities for export activities, while those facing financial obstacles may struggle to do so. Similarly, firm size often correlates with resource availability, operational flexibility, and scalability, all of which influence a firm's ability to adopt digital capabilities and participate in digital exports. Larger firms are typically better equipped to handle the costs and complexities of digital transformation, whereas smaller firms may face limitations that hinder their internationalization efforts. Results in Table 4 indicate that the effect of digital capabilities on digital export becomes more pronounced with firms having no financial constraint and those with large-sized firms. Align with the study of Luu (2023), SMEs or firms with weak resources struggle to access the international market digitally. This could be explained by significant investments in technologies and skilled workers that are frequently unavailable to SMEs (Peruchi et al., 2022). Therefore, it is imperative for regulators to devise distinct policies aimed at encouraging struggling businesses to enhance their digital export performance.

## 4. Conclusions

This study offers international evidence based on firm-level data from 20 countries, indicating that broadband infrastructure promotes export trade. Employing the Entropy Balance approach to address endogeneity issues, the study reveals that digital capability increases the likelihood of digital exports. Additionally, financially constrained firms or SMEs face challenges in engaging with cross-country e-commerce.

The research also holds significant implications for developing or emerging countries in

promoting international trade development in the digital economy. First, emerging countries should continue investing in information technology infrastructure, enhancing technological capabilities and promoting the adoption of information technology, and the Internet. Second, these countries, such as Vietnam, should capitalize on the opportunities brought by the digital transformation of their economies and societies. In particular, they should prioritize lowering trade barriers and enhancing trade efficiency by fostering the development of cross-border e-commerce platforms. Third, e-commerce development programs focusing on SMEs or financially constrained firms should be developed by governments to build capacities, provide training for businesses to apply e-commerce, and support businesses in opening websites and digital transformation.

**Table 4.** Estimation results based on subsample by financial constraint and firm size

| | (1) | (2) | (3) | (4) |
|---|---|---|---|---|
| | No financial constraint | Having financial constraint | SMEs | Large-sized firms |
| VARIABLES | DE | DE | DE | DE |
| DC | 0.81*** | 0.13 | 0.42 | 2.16*** |
| | (0.289) | (0.611) | (0.302) | (0.594) |
| Observations | 447 | 176 | 388 | 238 |
| pseudo-R-squared | 0.106 | 0.108 | 0.114 | 0.206 |

*Source:* own elaboration
*Notes*: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1.
The same set of control variables are included.

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