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IDENTIFYING THE DRIVERS OF SME RESILIENCE: EVIDENCE FROM DEVELOPING COUNTRIES DURING THE COVID-19 PANDEMIC

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Identifying the drivers of SME resilience: evidence from developing countries during the COVID-19 pandemic

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Abstract

Defining and measuring resilience has become a subject of interest in a world characterized by crises. Calls for empirical work on the microeconomic drivers of the resilience of small and medium-sized enterprises have drawn attention to the need for an enterprise resilience index. This paper fills this gap by proposing a multi-dimensional framework for firm resilience. Factor Analysis of firm level data from surveys conducted in Benin, Cambodia and the Philippines before and during the COVID-19 crisis identifies a set of firm-level factors that drove successful SME performance during the pandemic. Structural Equation Modelling combines these factors into a firm level resilience index and confirms that the index is positively correlated with commonly used proxies of firm performance during crisis, such as not laying off employees and the stability of sales. The insights from the analysis indicate that investment in certain dimensions of firm performance in good times drives their resilience during crises.

Keywords: resilience, COVID-19, multi-dimensional index, latent variable models, SME

***JEL classification**:* F23, C38, M21, L11

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1. Introduction

Business as usual was dramatically interrupted in 2020 by measures to contain the spread of COVID-19. The pandemic significantly undermined the economic environment of small firms around the world, but the harsh conditions did not necessarily lead to poor performance in individual firms. Some companies can withstand disruption by reacting to new conditions in a way that makes them remarkably resilient (Tsiapa and Batsiolas 2019; Battisti et al. 2019; Torres, Marshall, and Sydnor 2019). Resilience enables firms to absorb shocks and bounce back such that they emerge from disruptive change as strong, or even stronger, than before (Walker and Salt 2006; Holling 1973; Conz, Denicolai, and Zucchella 2017).

Macroeconomic policy in the wake of the pandemic has been crafted to address the absence of resilience – through bailouts of businesses on the brink of bankruptcy, or through expansive monetary policy. In a context where small and medium-sized enterprises (SMEs) make up more than 90% of firms in most countries, represent 70% of jobs and more than a third of economic activity, factors that reduce their propensity to fail during crises is of preeminent interest to policy makers. In developing countries, where these SMEs play a key role in poverty alleviation, macroeconomic stability and the attainment of development objectives, the need for evidence on the drivers of their resilience is even more acute.

Previous efforts to inform evidence-based policy making have examined the national (WEF 2013), regional (Williams and Vorley 2014), and managerial (Korber and McNaughton 2018; Linnenluecke 2017) determinants of economic resilience. When research has studied the micro-economic drivers of SME resilience, it has largely focused on a single driver of resilience in a specific developed country location’s encounter with a single crisis. We know, for example, that human capital was important to SME resilience after Hurricane Katrina in the USA (Torres, Marshall, and Sydnor 2019), and that learning promoted small firm resilience in New Zealand during the global financial crisis (Battisti et al. 2019). Reviews of the literature have called for more empirical work on the enterprise drivers of resilience in general and have specifically highlighted the need for an enterprise resilience index comprised of actionable variables that are relevant to the SMEs that make up the bulk of the enterprise population vulnerable to shocks (Rose and Krausmann 2013; Wishart 2018; Bhamra, Dani, and Burnard 2011).

This paper aims at filling this gap by proposing a framework for SME resilience that builds on firm-level empirical evidence from developing countries. A qualitative analysis of the literature on firm resilience classifies the firm level drivers of resilience within a multidimensional framework. This framework is tested and confirmed using exploratory as well as confirmatory factor analysis with 770 firm observations across three developing countries: Benin, Cambodia and the Philippines. Factor analysis combines the relevant factors into a firm level resilience index.

Finally, a structural equation model (SEM) analysis combines the resilience factors, and consequent index, with novel data on the business impact of the COVID-19 crisis on those 770 firms. The results suggest that the proposed resilience index is positively correlated with commonly used proxies of firm performance during crisis, such as not laying off employees and the stability of sales during the crisis.

The contribution of this paper is twofold. On the one hand it adds to the conceptual literature on resilience by building a multidimensional framework for firm resilience. On the other, it proposes to measure resilience – until now mainly proxied by measures of survival, which conflate exposure and severity of the shock with firm-level inherent capacities – by building a composite indicator using measures of firm characteristics.

The rest of the paper is structured as follows. Section 2 provides a review of the literature and introduces the conceptual framework, while Section 3 introduces the methods and context of the study. The results of the Factor Analysis and Structural Equation Model are presented in Section 4 and 5. Finally, Section 6 discusses the results and some extensions, and Section 7 concludes.

2. Review of the literature

2.1. Defining firm resilience

Historically, engineering-based approaches to resilience defined it as the ability of something to resist a shock and return to a previous equilibrium – as in a bridge that remained after an earthquake (Holling 1973; Hynes et al. 2020; Walker and Salt 2006). Increasingly, however, there is recognition in ecology and other disciplines that successful reaction to some disturbances depends on the capacity of a system to absorb the shock, and react through the development of situation-specific responses, such that the recovered entity may look different from the original one. Indeed, evolutionary scholars define resilience as an on-going, dynamic process that anticipates turbulence, adapts to disturbances, and draws on the entity’s capacity to continuously transform itself to adjust to shifting conditions (Conz, Denicolai, and Zucchella 2017; Simmie and Martin 2010).

Applied to the business context, resilience becomes the capacity of an enterprise to continuously “adapt and grow in the face of turbulent change” (Fiksel 2006; Hamel and Valikangas 2003). Resilience in this sense embodies the capabilities and practice of withstanding disruption. Risks may manifest out of national and global trends (DMCC 2020; UNEN 2020; WEF 2020; WTO et al. 2019), changes in the business ecosystem (Duarte Alonso 2015; N. Williams and Vorley 2014), or even crises internal to the firm (Sullivan-Taylor and Branicki 2011).

Business risk is a function not only of the shocks firms are exposed to, but also the probability that they will materialize, and the expected costs they could incur. Disruptions in health, trade, climate and other domains are together combining to create a business landscape that is increasingly tumultuous. Calculations indicate that on average a company can expect to lose more than 40 percent of a year’s profits once a decade (Lund et al. 2020). Businesses are exposed to significant risks from new waves of the pandemic, cyberattack, climate change, recession, trade disputes, debt crises and civil unrest (Lund et al. 2020; WEF 2021).

Small and medium-sized enterprises (SMEs) are often acutely exposed and sensitive to crises. They predominate in sectors with exposure to international trade-induced disruption, such as tourism and the textiles and clothing trade (ITC 2020c). The remote location of many small businesses can also contribute to their exposure to risk (Scuderi, Tesoriere, and Fasone 2020). The resource scarcity endemic to SMEs, along with low diversification of input sources and marketing outlets, and low numbers of employees, increase sensitivity to shocks.

Small businesses in developing countries have a long and in-depth experience with crises. Their extensive track record and felt experience with "muddling through" – using their adaptive capacity to quickly and flexibly respond to disruption – renders them relatively strong at forming rapid responses to a shock after the fact compared to more rigidly organized, larger and older firms (Sullivan-Taylor and Branicki 2011; Dahles and Susilowati 2015). Their agility, innovativeness and small scale makes them move faster.

The net impact of any shock on an economy is determined by thousand of firm-level decisions about how to respond, whether to be resilient, and whether to shut down. The ability of the firm to withstand disruption in the short term – that is, its resilience – is crucial to determining long-term enterprise outcomes. Research suggests that firms who do the right things during a crisis are both resilient in the short term and more profitable in the years that follow (Torres, Marshall, and Sydnor 2019). As such, the common characteristics that resilient SMEs share give an indication of the microeconomic drivers of macroeconomic resilience and recovery after a crisis.

2.2. Dimensions of firm resilience

Enterprise resilience is multidimensional in nature. It is driven by several factors that influence its performance under stress (Fiksel 2015). Several conceptual frameworks have been proposed to understand resilience including in the fields of economics, management studies, engineering and even seismology (Bruneau et al. 2003; Weick and Sutcliffe 2007; WEF 2013; Rose and Krausmann 2013; Fiksel 2003; Darnhofer 2014).[5]

Previous research frameworks on resilience resonate with the empirical literature on the drivers of small firms' performance under duress. The factors driving firm resilience can be, in the context of this conceptual and empirical research, identified and categorized within three pillars: robust, related and responsive.

2.2.1. Robust

The engineering resilience framework developed by Bruneau et al. (2003) defines robustness as the effectiveness of pre-event mitigation efforts in reducing the initial shock factors that influence the probability of failure of critical infrastructure. The World Economic Forum's global risk report (2013) applies this Bruneau definition of "robustness" to the macroeconomic context as the "ability to absorb and withstand disturbances and crises". In the context of major

[5] Reviews of the literature on resilience relevant to SMEs can be found in (Bhamra, Dani, and Burnard 2011; Rose and Krausmann 2013; Wishart 2018).

economic or political disruption, it entails the ex-ante inclusion of slack, redundancies, fail-safes and firewalls in modular design of national decision-making procedures to limit damage.

Robust firms have strong management and operational procedures that build shock absorbers into operations which enable it to withstand pressure during a crisis (Madni and Jackson 2009). Pre-crisis practices such as the establishment of business plans, risk mitigation and business contingency plans, as well as strategic resourcing through inventory management, and savings, enhance robustness to disturbance (Rose and Krausmann 2013; Sullivan-Taylor and Branicki 2011; Weick and Sutcliffe 2007). These strategies often incorporate slack into the business operations, in the form of extra inventory, business lines or financial resources that can be drawn upon as needed (Gittell et al. 2006; Linnenluecke 2017; Meyer 1982; Tognazzo, Gubitta, and Favaron 2016).

Planning for the future of the company strengthens its core business model and thereby makes it more robust to disturbance. Strategic planning establishes a shared vision for the future of the business which encourages the kind of directed innovation firms need to craft their crisis response (Santos and Partidário 2011). Business continuity plans and enterprise risk management techniques build risk reduction and response practices into the operating policies of the firm, making them ready for deployment in case of disaster (UNDRR 2020).

Strong inventory management can influence firms' robustness to disturbances by building leeway into the system (Deloitte 2020; Rose and Krausmann 2013). Companies with stronger inventory practices have a better sense of which input needs are more acute and worthy of management attention in the short run. This ability was particularly valuable in the face of COVID-19, as strained supply chains made it harder to access inputs quickly. Similarly, high quality record keeping practices enable managers to identify buffers they can draw on during a crisis (Macuzić et al. 2016).

Good financial management influences how a company can respond to changes in the economic environment. Not all firms have access to an effective financial system and the option of opening a bank account, and as such lack of bank account ownership can be a sign of poor availability of financial services that in turn undermines resilience. Notwithstanding these structural factors, holding a bank account in any circumstances is a strong sign of good savings behaviour and solid financial management. When a firm has a bank account, it can use it to save funds that help tide it over tough times (Cowling, Brown, and Rocha 2020; Lyons et al. 2020; Pomeroy et al. 2020). Established banking history facilitates the establishment of a relationship with their bank to facilitate better access to loans and other support that a bank may offer in times of crisis.

2.2.2. Related

Regional studies scholarship often employs a capital or resource-based approach to understanding whether the unit of study has the capacity to recover, and the social capital embedded in relationships are a crucial ingredient in this calculus (Mayunga 2007). In an enterprise context, internal and external relationships determine its strength under duress. Companies with stronger ties to other actors in the business ecosystem have a network for strong social capital that they can draw on to access resources and support during a crisis (Torres, Marshall, and Sydnor 2019).

Cooperation among companies in a sector to solve common day-to-day problems can support the dissemination of information about major challenges and their solutions (Williams et al. 2017). These connections are often forged through engagement with a business support organisation (BSO). Yet these relationships should be supple, not rigid, to allow firms to experiment their way towards a successful response during the recovery process. Overly rigid ties with other firms in the sector can prevent firms from the sort of visionary innovation needed to overcome some challenges (Conz, Denicolai, and Zucchella 2017).

Contagion occurs when companies are dependent on suppliers or buyers that fail. Firms that are diversified -- sourcing inputs from multiple sources, producing in multiple locations, making differing things, using multiple transport links and selling through different market outlets – are less affected by harm from any one actor in their business ecosystem (Rose and Krausmann 2013). Firms use information on buyers and suppliers to build diversified, healthy networks of market relationships. Although ensuring redundancy of supply and marketing relationships may come at the cost of reduced efficiency, this diversification enhances resilience, and so can be in the long-term interest of the firm, even if it increases costs and/or reduces output in the short run (Hynes et al. 2020).

At the same time, the depth and breadth of an SME's network bodes well for its resilience, since firms with higher global connectedness (via supply chains and exports) are more resilient to domestic pandemic shocks (Hyun and Kim 2020). Indeed, strong contractual relations in coordinated supply chains can foster the resilience of SME suppliers, including when lead firms protect SMEs through long-term, stable buyer-supplier relationships founded on information sharing, trust and mutual support (ITC 2020c; 2020d; Conz, Denicolai, and Zucchella 2017).

Finally, firms with strong internal linkages amongst employees and management, including through effective innovation, learning, trust and decision-making, are better equipped to navigate through shocks (Battisti et al. 2019).

2.2.3. Responsive

In the business management literature, the popular resilience framework of Weick and Sutcliffe (2001) rests upon the notions of resourcefulness – defined as the capacity of managers to identify potential problems, establish priorities and mobilize resources to avoid damage or disruption – as well as the rapidity with which managers make decisions and implement them. Similar notions appear in most resilience frameworks (WEF 2013; Bruneau et al. 2003; Madni and Jackson 2009). This measure of "ingenuity under stress" (Bruneau et al. 2003) tends to be higher among firms who have already been through a crisis and learned how to navigate it. Availability and good management of human, technological and financial capital can give birth to an effective response that kick-starts the recovery process (Battisti and Deakins 2017; Conz, Denicolai, and Zucchella 2017; North 1990; Sullivan-Taylor and Branicki 2011; Tsiapa and Batsiolas 2019; WEF 2013).

The institutional economics literature refers to this capability as “adaptive efficiency” (North 1990) and it is truly the black box of the resilience world. From a microeconomic perspective, it captures the innate ability of a firm to respond during a crisis with inventive and well-adapted strategies that enable it to absorb a shock and transform itself to thrive in the new reality. Firms’ ability to create, transfer and integrate new knowledge into their operations through ongoing learning enables them to better align with novel developments and is for this reason a strategic resource that is an asset for resilience (Battisti et al. 2019). Indeed, the ability to continuously transform knowledge and ideas into new products, processes and systems is essential to a company’s capacity to change (Battisti and Deakins 2017; Lawson and Samson 2001). This adaptive capacity is also key to appropriately and quickly responding to crises, and relies on enterprises having the skills and funds to spearhead innovation (Păunescu and Mátyus 2020).

A high level of worker skills – as well as their diversity and match with enterprise needs – is an enabler of enterprise responsiveness during a crisis, since workers that possess the right skills and know the product and production process well are more likely to come up with creative solutions to problems (Agrawal et al. 2020; ITC 2020a). For instance, when COVID-19 confinement rules forced many SMEs to shut their doors, many enterprises drew on the digital skills of their employees to put their full offering online and thereby kept money flowing in (Ungerer and Portugal 2020).

Firms may have commendable ideas about how to change in response to crises, but they require access to finance to fuel their response. Companies with better cash flow management have more liquidity to finance short-term coping strategies and are, for this reason, more resilient (Pal, Torstensson, and Mattila 2014).

Investments in research and development (R&D) teach firms how to learn, use technologies and respond to the latest market developments, habits that enable them to be nimble under pressure (Tsiapa and Batsiolas 2019). Companies who invest in R&D and have appropriately-skilled employees are able to create new products and services that respond to the latest market trends. This tacit knowledge of the innovation process, as evidenced by a record of regular product and service innovation, is an asset for crisis-facing firms. Enterprises with a history of product and service invention are better able to respond in an agile manner to shocks through the creation of new business offerings adapted to the new circumstances. This responsiveness, in turn, renders them resilient to crisis (Duarte Alonso 2015; Tsiapa and Batsiolas 2019; ITC 2020b).

3. Methodology

In this paper, we aim at building an index of resilience that captures evidence underlying the pillars of resilience identified in the preceding review of the literature: robust, related and responsive. This section introduces the data upon which the empirical work is based and describes the empirical strategy whose results can be found in Section 4.

3.1. Data

The data used in this work was collected by the International Trade Centre (ITC), a United Nations agency, in collaboration with national institutions. In 2019, before COVID-19 hit, ITC collaborated with institutions in three countries – Benin, Cambodia, and the Philippines – to conduct an in-depth assessment of the competitiveness of enterprises through ITC's SME Competitiveness Survey. The questionnaire was administered to 502, 400, and 514 businesses respectively in Benin, Cambodia, and the Philippines.

In each of the three countries, a sample of firms was randomly selected from across the country to participate in the SME Competitiveness Survey. The sample was spread across regional districts and included firms of all sizes (micro, small, medium-sized and large). Data were collected on firms operating in the primary (i.e. agriculture and mining), manufacturing and services sectors.[6]

In mid-2020, a follow-up survey was carried out in the three countries to assess the business impact of COVID-19. Among the respondents from the SME competitiveness survey in the three countries, 44, 272, and 454 of them respectively in Benin, Cambodia, and the Philippines, for a total of 770, also took part in the follow-up interview about the impact of COVID-19 on their businesses.

The dataset retained in this paper focus on the 770 respondents that took part both in the SME Competitiveness Survey and in the COVID-19 Business Impact Survey, allowing for an assessment of whether and to what extent certain pre-crisis factors influenced business outcomes during the crisis. The sample includes companies of different size, sector and region of the respective country, as *Table 1* in Appendix 1 shows in more detail.

More specifically, half of the sample is composed of companies in manufacturing, services companies make up one third of the sample, and the primary sector accounts for 18% of respondents. With less than 100 employees, nine out of ten companies in the sample are classified as micro, small or medium-sized enterprises (SMEs).[7]

The analysis uses several variables from the dataset to build the resilience index. *Table 10* presents the description of each variable used in this paper (see Appendix 1).

3.2 Empirical strategy

This paper measures enterprise resilience through a three-step empirical strategy: qualitative analysis, Factor Analysis and Structural Equations.

3.3.1. Qualitative analysis

First, qualitative analysis of the literature on SME resilience is undertaken to identify the firm level factors that affect the capacity of a firm to withstand a crisis. These factors are classified within a multidimensional framework of robust, related and responsive pillars of firm

[6] More details about sampling in each country can be provided upon request.

[7] Micro-sized firms are considered an implicit subcategory of small firms such that the term "SMEs" referred to in this paper includes micro firms.

resilience. These pillars reflect the multidimensional nature of resilience. They are latent concepts, themselves dimensions that make up resilience, and mediate between the shock, the exposure and sensitivity of the firm, and outcomes after the crisis has passed. They are cumulatively important in determining the resilience of firms during a crisis. Taken together, they indicate that it is insufficient to simply establish slack in management systems in advance, nor to just have a dense support network, nor be agile. An individual firms' resilience profile may be stronger in one dimension. But ultimately enterprises should aim to be strong across all three dimensions. This analysis was presented in section 2.2.

3.3.2. Factor analysis

Second, linear factor analysis is used to estimate the framework using variables in the three-country dataset that correspond to the factors identified in the first step as relevant to the resilience pillars. Although there are many methodologies available to build multidimensional indices, factor analysis is particularly well suited for constructing a resilience index as it embraces the multi-dimensionality of resilience through the combination of multiple indicators needed to measure the concept (Falciola, Jansen, and Rollo 2020).

Factor analysis is a statistical method commonly used to measure unobserved latent variables. It relies on a combination of different indicators to predict the underlying latent variable (i.e. resilience) and obtain factor scores (i.e. a Resilience index). Furthermore, factor analysis allows the estimation of parameters, known as factor loadings, that are associated with each observed indicator's strength in generating the measurement of the latent factor. These factor loadings are then used to construct weights which are used in conjunction with each observed indicator for the construction of the final index of resilience (see Appendix 2). This relieves the researcher from subjectively designing the weighting scheme to be used in the aggregation step.

In the present context the latent, unobserved resilience variable is measured through a linear factor analysis model in which observed driving variables combine to measure resilience. This is shown visually in Figure 1, where observed variables are represented by rectangles whereas the latent variable is in an ellipse.

The measurement model for resilience is estimated through the linear factor analysis model specified in Equation 1:

Equation 1

$$\begin{bmatrix} Bank\ acc_i \\ \vdots \\ Network_i \\ \vdots \\ Skills_i \\ \vdots \\ Cash\ flows_i \end{bmatrix} = \begin{bmatrix} \lambda_{0,1} & \lambda_{1,1} \\ \vdots & \vdots \\ \lambda_{0,5} & \lambda_{1,5} \\ \vdots & \vdots \\ \lambda_{0,10} & \lambda_{1,10} \\ \vdots & \vdots \\ \lambda_{0,13} & \lambda_{1,13} \end{bmatrix} [\iota \quad R_i] + \begin{bmatrix} \varepsilon_{i,1} \\ \vdots \\ \varepsilon_{i,5} \\ \vdots \\ \varepsilon_{i,10} \\ \vdots \\ \varepsilon_{i,13} \end{bmatrix}$$

or, put more simply, the equivalent Equation 2:

Equation 2

$$x_i = \Lambda\, Resilience_i + \varepsilon_i \qquad i = 1, \dots, n$$

where i denotes the observation at the firm level, x is a vector of observed indicators, Λ is a matrix of coefficients, Resilience is a matrix including the latent variable for resilience R_i as well as the intercept and ε denotes the error.

We estimate the unknown parameters of the factor analysis model by maximum likelihood. To provide a scale for the latent factor, we constrain the factor loading of the first indicator $\lambda_{1,1}$ to 1. We call factor loadings each specific entry $\lambda_{j,k}$ in the matrix Λ. These factor loadings are our coefficients of interest as they show the correlations between each variable and the latent factor they explain. They will be used later on to build weights in the construction of the Resilience index.

3.3.3. Structural equation model

Third, structural equation model (SEM) analysis connects the data on resilience factors to the data from the COVID-19 Business Impact Survey from the same firms. It analyses the impact of firm resilience, measured by pre-crisis characteristics, on performance during COVID crisis. The SEM models how these resilience factors drive a latent resilience variable which in turn explains whether firms performed well during the COVID-19 crisis.

Performance during the crisis is proxied by an observed variable from the COVID-19 Business Impact Survey data, which was collected from the same firms who were also interviewed prior to the pandemic. A good measure of firm outcomes during the pandemic proxies well its ability to maintain its capabilities, assets and operations despite disturbance. Revealed ability to maintain the firm's human resource assets is a good proxy of this performance, since it indicates that the enterprise operations continue to generate enough revenues, or draw on savings and support, to maintain the capacity of the firm to sustain continued functioning. As such, we use data on whether the respondent firm laid off any employees in response to the COVID-19 pandemic as the outcome measure of choice to proxy performance during crisis. This "no lay off" dummy variable is equal to 1 if the firm did not lay off any employees owing to the pandemic (until June 2021), and equal to 0 if the firm did lay off at least one employee owing to the pandemic.

This data is deployed in a structural equal model (SEM), presented in *Figure 2*, to understand how resilience, and its drivers, affected the performance of companies during the crisis. The SEM subsumes the measurement of the latent resilience variable corresponding to the model presented in the previous section. The structural part of the model is a linear probability regression where we regress the probability of not laying off employees on our measure of resilience along with selected control variables – including firm's age, size, and trade status – as well as country and sector fixed effects. In the figure, the observed variables are represented once again by rectangles whereas the latent variables are in ellipses.

Equation 3 describes the SEM model where we regress the probability of not laying off employees on resilience and relevant control variables:

Equation 3A $\quad x_i = \Lambda \, Resilience_i + \varepsilon_i$

Equation 3B $NoLayOff_{it} = \beta_0 + \beta_1 Resilience_{it-1} + \beta_2 FirmAge_{it-1} + \beta_3 Size_{it-1}$

$$+ \beta_4 Trade_{it-1} + \delta_s + \delta_c + \epsilon_{it}$$

where i denotes the observation at the firm level and t denotes the time at which the data was collected: in year t-1 for the SME Competitiveness Survey and year t for the COVID-19 Business impact survey. The first equation describes the measurement part of the model where x is a vector of observed drivers of resilience, Λ is a matrix of coefficients, Resilience is a matrix including the latent variable for resilience as well as the intercept and ε denotes the error. Age is measured by the number of years the enterprise has been in operation. Size is measured as the number of employees at the time of the COVID-19 survey in mid-2020. Trade is measured as the percentage of the enterprise's sales that are directly exported to another country. Sector fixed effects δ_s control for services, manufacturing, or primary sector operations. Country fixed effects δ_c hold for Benin, Cambodia and the Philippines.

We estimate the unknown parameters of the initial factor analysis part of the model, as encapsulated in formula A in Equation 3, by maximum likelihood. To provide a scale for the latent factor, we constrain the factor loading of the first indicator to 1. Equation 3B is a linear regression of the outcome NoLayOff in time t on our measure of resilience and control variables for the firms $i = 1, \dots, n$ in time t-1 Note that both equations are estimated simultaneously.

4 Results

4.1. Factor analysis

The literature review suggests that the drivers of SME resilience can be grouped into three robust, related and responsive pillars. We thus propose to initially model resilience using the indicators discussed in the literature review grouped into their three pillars. This initial model is estimated using confirmatory factor analysis. The results are displayed in *Table 2*.

The result of *Table 2* indicate that the observed indicators are significant drivers of latent robust, related and responsive pillars of resilience. However, there is positive, high and significant covariance between the three pillars.

This is confirmed graphically in Figure 3, where the correlation coefficients of the boxes in the upper right triangle of the figure are positive and statistically significant. Visually, the boxes in the lower left triangle of the figure demonstrate the close clustering of latent variable indices along the diagonal of perfect correlation. Furthermore, the density plots on the diagonal of Figure 3 show that the latent resilience variables are approximately normally distributed.

The high and positive correlation among the three pillars and resilience suggest that the pillars may be better proxied by the resilience index alone. We investigate the hypothesis of a single latent resilience variable through exploratory factor analysis which enables us to falsify whether one, or three, concepts underly the data.

The results of the exploratory factor analysis, shown in *Table 3*, suggest that there is indeed only one latent concept. One latent resilience factor suffices to explain approximately 80% of the variance and is associated with an eigenvalue of almost 4, indicating its sufficiency and rigor in underlying the data in the model. An eigenvalue of 4 means that the resilience factor retained explains roughly the same amount of variance as 4 distinct variables. As a general rule of thumb, we discard factors that display eigenvalues lower than 1 as they are not considered stable (Girden 2001). Moreover, both Kaiser-Myer-Olkin measure of sampling adequacy and the Cronbach's alpha scale reliability coefficient indicate that the variables have a high shared covariance and probably measures the same underlying concept. This indicates that the high degree of interaction between the robust, related and responsive pillars of resilience obviates the need to distinguish between them in defining the resilient performance of firms. Instead, the latent relationship between microeconomic characteristics of SMEs and their performance under duress is captured by one underlying variable: resilience.

Table 3 also shows the factor loadings from the exploratory factor analysis. We can see that all the variables have a positive impact on the latent resilience factor. The results confirm that the correlation structure of the data is well explained by one latent underlying concept, resilience. Given these findings, we proceed with confirmatory factor analysis using a single latent resilience variable. *Table 4* reports the results of the factor analysis as specified in Figure 1 and Equation 1. To allow for comparison and whenever possible, the coefficients are reported in their standardized form with their respective standard error in parenthesis. All the estimated coefficients are significant at the 1% level and positive. This indicates that the selected variables from the dataset are significant drivers of a common latent concept of resilience. We retain this specification as our baseline model.

Table 5 presents selected goodness of fit statistics for the baseline model presented in *Table 4*. The chi-square likelihood ratio statistic tests the extent to which the model is able to reproduce the covariances that were observed in the sample. The test statistic compares the baseline model to the saturated model. The saturated model is used for comparison as it is the model that perfectly reproduces all of the variances, covariances and means such that it has the best fit possible. As shown by the first line of column 1, we reject at the 5% level that the model fits as well as the saturated model.

In light of this result, we re-specify the model using modification indices to improve its fit to the data. Modification indices consider a fully constrained model where there is no correlation allowed between the observed indicators other than through the latent factor of resilience, i.e. no paths exist between the measurement errors of the observed indicators. It then assesses what would happen in terms of goodness-of-fit if we decided to free a parameter by adding a path between two variables in our model. It does so by estimating the change in the model's goodness-of-fit statistic following the removal of a single parameter restriction from the model.

Column 2 and 3 of *Table 5* presents the goodness of fit statistics for a model where the measurement errors are allowed to correlate amongst themselves. We test for omitted paths using modification indices. While the model presented in column 2 adds all paths significant at the 5 percent level, the model in column 3 only adds paths significant at the 5 percent level and supported by the theory.[8] Comparing the results of the chi-square likelihood ratio test, we see that only the modified model in column 2 concludes at the 5% level (or any other level) that the model fits as well as the saturated model.

Table 5 also presents additional fit statistics including the Root Mean Square Error of Approximation (RMSEA), the Comparative Fit Index (CFI), the Standardized Root Mean Square Residual (SRMSR) and the Coefficient of Determination (CD). While the baseline model has a decent fit, using modification indices to respecify the model clearly improves its fit to data. Both modified models presented in column 2 and 3 fit well the data according to commonly accepted standards. Browne and Cudeck (1993) suggested that RMSEA values of 0.08 and below correspond to an acceptable fit whereas values lower than 0.05 indicate a good fit. For the CFI, an accepted ground rule of good fit is a value of 0.90 or higher. The SRMSR is a popular absolute fit indicator and Hu and Bentler (1999) suggested that a value of 0.08 or smaller signals a good fit. Finally, the CD is comparable to a R-squared estimate in an OLS regression, and a value close to 1 suggests a good fit.

Although modification indices (MIs) are useful in identifying sources of misfit in a model, using them too sweepingly also carries risks.[9] As such, we retain the model presented in column 3 as our main specification. This partially modified model incorporates a select few additional paths included solely if they are supported both by the data and the theoretical framework derived from the literature review. As a ground rule, we use modification indices to identify paths that are significant at the 5% level and we add them to the model if it is supported by the theoretical framework we derived from the literature review, such that we allow correlation between the measurement errors only within pillars. In this sense, this final, partially modified model is a safe compromise between the baseline model (with no added paths) and the modified model (including all paths suggested by the modification indices within and across pillars). For sake of completeness, the results of the alternative models can be found in Appendix 3 (Tables 1A and 2A).

[8] The results in column 3 thus stem from a model wherein paths of correlation between errors of variables are only allowed if those two variables fall under the same pillar in the theoretical framework. For example, the errors of record-keeping and inventory management would be permitted to correlate since they are both specified within the theoretical framework as driving the robust pillar of resilience. However, errors of record-keeping and R&D variables would not be permitted to correlate since they belong to the robust and responsive pillars respectively.

[9] First, modification indices (MIs) are purely determined by data and might lack theoretical grounding. It happens that the largest MIs only represent some idiosyncratic characteristics of the data and are not supported by theory at all. Second, (MacCallum, Roznowski, and Necowitz 1992) conducted a comprehensive simulation study of MIs and concluded that specifying a model solely based on MIs rarely leads to the true population model. Third, MIs tend to lead to over-fitting the data and thus reducing the generalizability of the results.

4.2. Structural Equation Model for Resilience

Table 6 reports the results of the SEM as specified in Figure 2 and Equation 3.[10] To allow for comparison and whenever possible, the coefficients are reported in their standardized form with their respective standard error in parenthesis. We only report the coefficients from the second stage of the SEM, for parsimony and clarity. The results from the first stage (the factor analysis) are strong and can be provided upon request.

The first column of *Table 6* presents the results of the most parsimonious model where we only consider the impact of being resilient without additional controls on the probability of laying off employees. We see that the coefficient for Resilience is strongly significant (at the 1% level) and positive. This indicates that more resilient firms surveyed in Benin, Cambodia and the Philippines were less likely to lay off employees during the COVID pandemic. This implies that a firm at the 95th percentile of the resilience index distribution was 27% less likely to lay off employees during the crisis than one at the 5th percentile.[11]

This result -- that more resilient firms were less likely to lay off employees during the COVID crisis -- holds true when we control for age, size and trade as shown by columns 2 to 4 of *Table 6*. The positive effect of resilience on the probability of not laying off employees is maintained when we add either sector fixed effects, country fixed effects or both as shown by columns 5 to 7 of *Table 6*. The coefficients from the control variables in columns 6 and 7 show that firms that have been in operations for longer, firms of larger size and firms that export a higher share of their production were less likely to lay off employees.

These results indicate that there is a positive and statistically significant relationship between the pre-crisis drivers of resilience and actual revealed firm performance during the COVID-19 crisis in the studied countries. To ensure these findings are robust to the performance measure of choice, we test the use other proxies to measure the firm's ability to maintain operations during a crisis. Revealed ability to continue to sell firm output is another good proxy of this performance, since it indicates both that enterprise operations continue to function and also that the company is able to bring in revenues to sustain continued functioning.

As such, we adopt the stability of sales during the COVID-19 pandemic as an alternative outcome measure to proxy performance during crisis. This is a dummy variable equal to 1 if the company did not report lower domestic sales to either consumers or businesses or improved exporting, and to zero otherwise. As the results presented in *Table 7* show, companies with better performance on the resilience factors identified above were more likely to have stable sales during the COVID-19 pandemic. We see that the coefficient for Resilience is significant at the 1% level and positive. As in Table 6, this shows that more resilient firms were more likely

[10] All the SEM presented in this section allow correlation between measurement errors. Paths are added whenever modification indices suggest it and if supported by the theoretical framework built relying on the literature review. SEMs where measurement errors are constrained to be uncorrelated can be found in Appendix and show similar results.

[11] The resilience index value for the 95th percentile of firm was 0.90, while for the 5th percentile it was 0.35.

to report stable sales during the COVID crisis. Indeed, a firm at the 95th percentile of the resilience index distribution was 17% more likely to maintain stable sales during the crisis than one at the 5th percentile. The result is robust to the inclusion of firm level controls, such as age, size and trade, as well as to the inclusion of sector fixed effects. However, when country fixed effects are included the main result is no longer significant. This indicates that most of the variation in the data comes from variations across countries in the performance of companies within the same sector.

The foregoing analysis of the structural determinants of binary outcome variables (no layoff and stable sales) has been conducted using linear probability models. An alternative formulation elucidates the robustness of the findings to the econometric model of choice. As such, a logistical regression model is used to estimate both the no-layoff and stable-sales models using maximum likelihood with a logit link function.[12] The results, qualitatively similar to those presented in *Table 6* and *Table 7*, are reported in Appendix 3.

The analysis of this section indicates that when the drivers of resilience are estimated simultaneously in a resilience variable with outcomes during a crisis, those drivers play an economically and statistically significant role in determining firm success. In the context of the COVID-19 pandemic in developing countries, SMEs holding certain key characteristics had the ingredients for strong resilience that drove their performance, regardless of their size or age. These results hold irrespective of the outcome measure or econometric model of choice. Indeed, they underscore the relevance of resilience as a concept driving policy and management action before, during, and in the recovery from disturbance. As the next section shows, however, the capacity to deal with hard times is not universally shared. The evidence suggests that smaller firms tend to fall short.

5 Discussion

A global pandemic was a low-probability, high-impact so-called “black swan” risk in autumn 2019. By mid-2021, COVID-19 had infected nearly 110 million people, caused close to 1.5 million deaths and induced US$10 trillion in economic losses (Yeyati and Filippini 2021; The Economist 2021). Evidence suggests that the measures adopted to stem the spread of COVID-19 have had a devastating effect on small and medium-sized enterprises. Survey data from 136 countries indicates that approximately 20% of SMEs expected to close, or had already done so, owing to the COVID-19 pandemic (ITC 2021).

SMEs in Benin, Cambodia and the Philippines have been strongly affected by the pandemic. Benin is a Least Developed Country (LDC) in Western Africa where growth dropped to 3.2% in 2020, down from almost 7% growth in 2019, owing in large part to the COVID-19 crisis. This has had a strong effect on SMEs, who represent about 98% of all businesses and contribute about half of gross domestic product (INSAE 2008). Virtually all SMEs surveyed in the country

[12] To provide a scale for the latent resilience variable, we adopt as a normalization constraint a zero mean and unity variance.

reported being affected by COVID-19, with 39% saying they had been strongly affected (ITC 2020a).

Cambodia is an LDC in South-east Asia which has had very strong income growth in the years preceding the pandemic, with GDP growing by 7.1% in 2019, the fastest rate among the ASEAN economies. However, as in many other countries, growth turned negative in 2020 as a result of the COVID-19's economic impacts. SMEs represent 99% of registered businesses in Cambodia and employ about 70% of workers (Phurik-Callebaut 2020).

Small and medium-sized enterprises (SMEs) employ 60% of the workforce in the Philippines, an emerging economy in South-East Asia. In reaction to the spread of the pandemic, the Filipino government declared a state of calamity on 16 March 2020 and imposed an enhanced community quarantine across the whole of Luzon Island. The Filipino economy shrunk by 9.6% in 2020 after expanding 5.9% in 2019 (PSA 2021). With businesses shut down – except for those that provide food, healthcare, banking or business process outsourcing services, or export-oriented industries – many SMEs were put in dire straits (Raga 2020; ITC 2020b).

The econometric analysis presented in this paper has identified a set of factors driving a latent resilience concept that in turn influences the performance of companies under stress. These factors can be combined into a resilience index to make that latent concept manifest. Combining these factors into a resilience index provides a quantitative measure of the pre-crisis resilience of companies.

Econometric analysis of the index yields interesting insights into how the ex-ante resilience of firms influences the probability of successful performance during a crisis. Analysis indicates that the firm-level resilience index is statistically correlated with outcomes during the COVID-19 pandemic. As implied by the above SEM results, the resilience index is indeed highly statistically correlated with the probability that firms did not lay off employees during the pandemic as well as with the likelihood of having stable sales. The positive relationship between the pre-pandemic resilience index and pandemic-period performance can be seen visually in Figure 4. Companies with a higher resilience index were more likely to not layoff employees and have stable sales during the crisis.

The analysis is applicable to firms of different sizes, and indeed the validity of the model and its results hold across firm size.[13] Yet the distribution of the resilience index differs across firm size. The average resilience index of firms with less than 20 employees (defined here as micro and small) is lower than that of those with 20 or more employees (medium or small). This is shown visually in Figure 5, where the median resilience index score for medium and large firms is higher than for micro and small firms.

[13] When the factor analysis and SEM are run with only micro and small firms, the results hold: the latent resilience variable, with the same driving factors, positively influences performance during the crisis. Similarly, when the sample is limited to medium and large firms, the results hold. However, in both cases, the results are no longer statistically significant, likely owing to small sample sizes.

This difference is statistically significant, as indicated in *Table 8* column 1, according to the following model:

Equation 4 $$Resilience_i = \beta_0 + \beta_1 FirmCharacteristic_i + \delta_{cs} + \epsilon_i$$

Where $Resilience_i$ indicates the standardised resilience score calculated by factor analysis, and $FirmCharacteristic_i$ indicates the relevant firm characteristic we want to test:

- Small: a dummy variable equal to one for micro and small-sized firms;
- Size: a categorical variable for micro, small, medium and large firm sizes, increasing in size;
- Women led: a dummy variable equal to one if the enterprise is led by a woman; and
- Youth led: a dummy variable equal to one if the enterprise is led by youth.[14]

Sector-Country fixed effects control for variation within services, manufacturing, or primary sector operations in each specific country.

Small is negatively and statistically (at a 1% level) significant, both when fixed effects for sector and country are excluded and when they are included (columns 1 and 5 respectively). Furthermore, average resilience index values are increasing in firm size: the size variable is positively and significantly associated with resilience index value (column 2 and 6). Combined with the evidence that the model holds for both micro-small and medium-large firm sizes, this implies that the nature of the relationship between the drivers of resilience and actual crisis outcomes is for the most part similar across size classes, but is shifted in degree, with those drivers more prevalent among medium and large firms.

The challenges faced by enterprises with fewer employees in acquiring the fundamental drivers of resilience are also faced by enterprises led by youth and women, according to the data. *Table 8* also shows that youth-led (columns 3 and 7) and woman-led (columns 4 and 8) firms have poorer performance on the resilience index. The disadvantages faced by smaller companies in being resilient are echoed, it seems, by companies whose leaders account for a minority of entrepreneurs in the surveyed countries.

The divergence in index scores across firm sizes extends to the sub-index level, where micro and small firms have lower values on the robust, relate and responsive pillars of resilience. We calculated index values for each pillar using the driving factors for each pillar identified in the factor analysis, and tested the following equation:

Equation 5 $$Pillar_i = \beta_0 + \beta_1 Small_i + \delta_{cs} + \epsilon_i$$

Where $Pillar_{it}$ indicates that we use three dependent variables, the robust, relate and respond standardized scores, and $Small_{it}$ is once again a dummy variable indicating if the enterprise is

[14] Youth-led firms have managers who are 34 years of age or less. Woman-led firms are at least 30% owned by women and have a female manager.

micro or small. Once again Sector-Country fixed effects control for variation within services, manufacturing, or primary sector operations in each specific country.

The findings of regressions using those pillar indices, both with and without fixed effects, corroborate the lower average robustness, relatedness and responsiveness of smaller firms. *Table 9* shows that the fact of being micro or small in size was a statistically significant driver of negative enterprise performance on each of those resilience pillars.

This implies that smaller firms fall short when it comes to virtually all the ingredients behind resilience – robust firm operations that are strong and incorporate slack, strong relationships that can be drawn on in crisis, and the inventive and creative habits that drive responsiveness. However, the extent to which they fall short is less severe when it comes to relationships. This in turn suggests that smaller firms may draw on interpersonal relationships as a coping strategy to a greater degree than larger firms when faced with disruption. This is consistent with evidence that social capital is essential to SME resilience, and particularly so for those located in developing countries and which are family firms.[15]

The findings suggest that although a set of factors are revealed effective in generating resilience during the COVID-19 crisis, and that firms across all size classes were able to demonstrate those characteristics and succeed during the pandemic, smaller firms were less likely to have these resilience drivers in general. The implication – that SMEs tend to have a resilience shortfall that undermines their ability to cope with crisis – is not surprising giving complementary evidence that approximately twice the proportion of SMEs expected to close owing to the COVID-19 pandemic as large companies, according to survey data from 127 countries (ITC 2021). Given that SMEs generate at least a third of GDP and often account for more than half of employment, their shortcomings on the resilience index have real welfare and growth ramifications.

6 Conclusion

This paper contributes to the academic and policy debate on resilience by developing a resilience index based on enterprise factors identified through empirical analysis of firm-level data during the COVID-19 crisis. The proposed index builds upon existing literature to construct a framework to understand enterprise resilience with indicators that drive pillars of resilience that can be used to understand, and measure, the characteristics that make companies resilient.

Resilience is a general attribute of firms that influences their performance under duress. Unlike competitiveness or profits, resilience remains largely hidden until crisis hits, at which point it becomes essential. The factors highlighted in this paper shed light on the underlying characteristics that enhance enterprise ability to cope with any crisis, whether it is a pandemic

[15] (Mzid, Khachlouf, and Soparnot 2019; Asamoah, Agyei-Owusu, and Ashun 2020; Torres, Marshall, and Sydnor 2019; Jia et al. 2020).

or a hurricane. They make companies ready for the shock, giving them relationships to draw on for help, and encouraging them to respond in a timely and effective manner to disruptions.

The multi-dimensional resilience index built using the proposed framework is positively correlated with commonly used proxies of firm performance during crises, such as keeping employees on the payroll and the stability of sales. Analysis across firm size reveals that the median resilience index value for micro and small firms is lower than that of medium and large firms, but the discrepancy is attenuated when it comes to the relatedness drivers of resilience.

Summarizing the many dimensions of firm resilience into one single measure is a challenging task, but important and relevant to the policy debate since it can allow policy makers to invest in the characteristics of firms that ensure their viability amidst disruption. Furthermore, it has predictive potential for the ex-ante identification of enterprises vulnerable to harsh consequences of future catastrophes. Pre-emptive investments in these general resilience factors can also reduce the expenditures on private sector bail-outs during crises.

For policy makers, this index can be a useful instrument as it allows them:

- To identify factors that may reinforce the resilience of their country's SMEs and thus the macroeconomic stability of their country.
- To identify firms, sectors or regions which are vulnerable to shocks and allocate resources accordingly.
- To identify private sector support strategies that encourage managers to effectively and efficiently invest in risk reduction strategies.

The proven utility of certain factors in improving SME performance during crisis is crucial given evidence that shocks are an increasingly common part of the market landscape (Lund et al. 2020). Some firms are clearly more exposed to these risks, with smaller companies in certain sectors counted among them (OECD 2020). The factors influencing business success during crisis affect the long-term distribution of enterprises in the business cycle, including through corporate concentration.

Although government support for SMEs was fundamental during the COVID-19 crisis, pre-emptive policy and programmes to enhance SME resilience may be a lower-cost method of helping such firms to help themselves. In that sense, it is important for policy makers and business support institutions to help companies build the competencies they need to be more resilient. The analysis presented in this article indicates that investment in SME management and financial skills, social capital and connectedness, and research and innovation experience, can pay dividends in terms of reducing employee layoffs and stabilizing sales in times of economic stress.

The lessons learned from the COVID-19 pandemic have relevance in shaping policies for SME resilience to risks forecasted in the years to come. Climate change is predicted to be the next big threat on the horizon (WEF 2020). As Nobel prize winner Joseph Stiglitz and climate expert Nicholas Stern put it, 'The climate emergency is like the COVID-19 emergency, just in slow motion and much graver' (Hepburn et al. 2020). This index may be of use not only in understanding what has happened before – notably the COVID-19 crisis – but also to predict, and prepare, for the SME impact of climate crises to come.

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Appendix 1: Figures and Tables

Figures

Figure 1: Path diagram for the measurement model

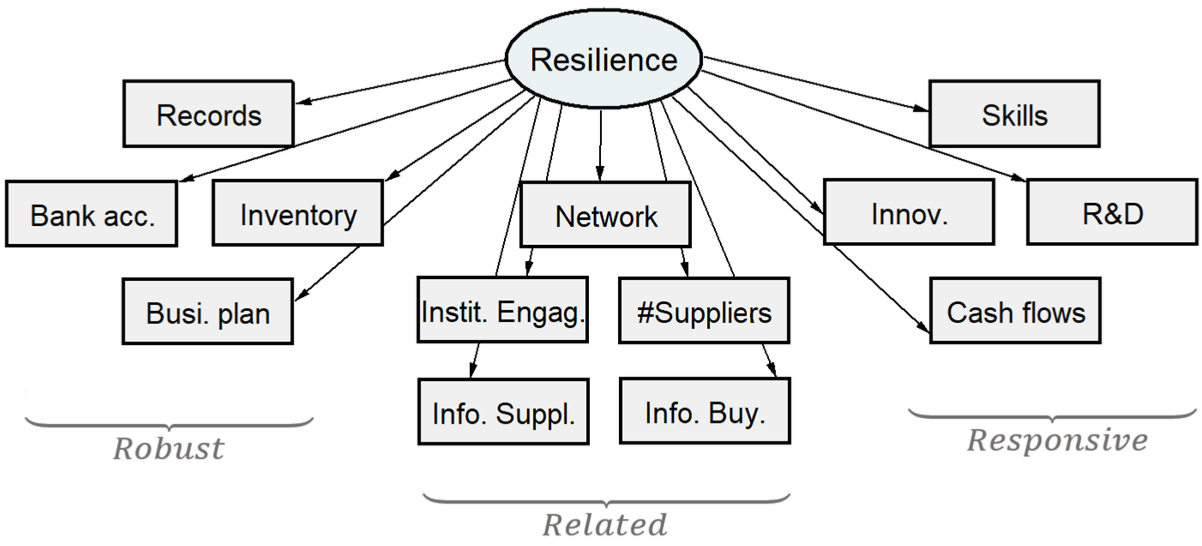


Figure 2: Path diagram for the Structural Equation Model of the impact of Resilience on the probability of not laying off employees

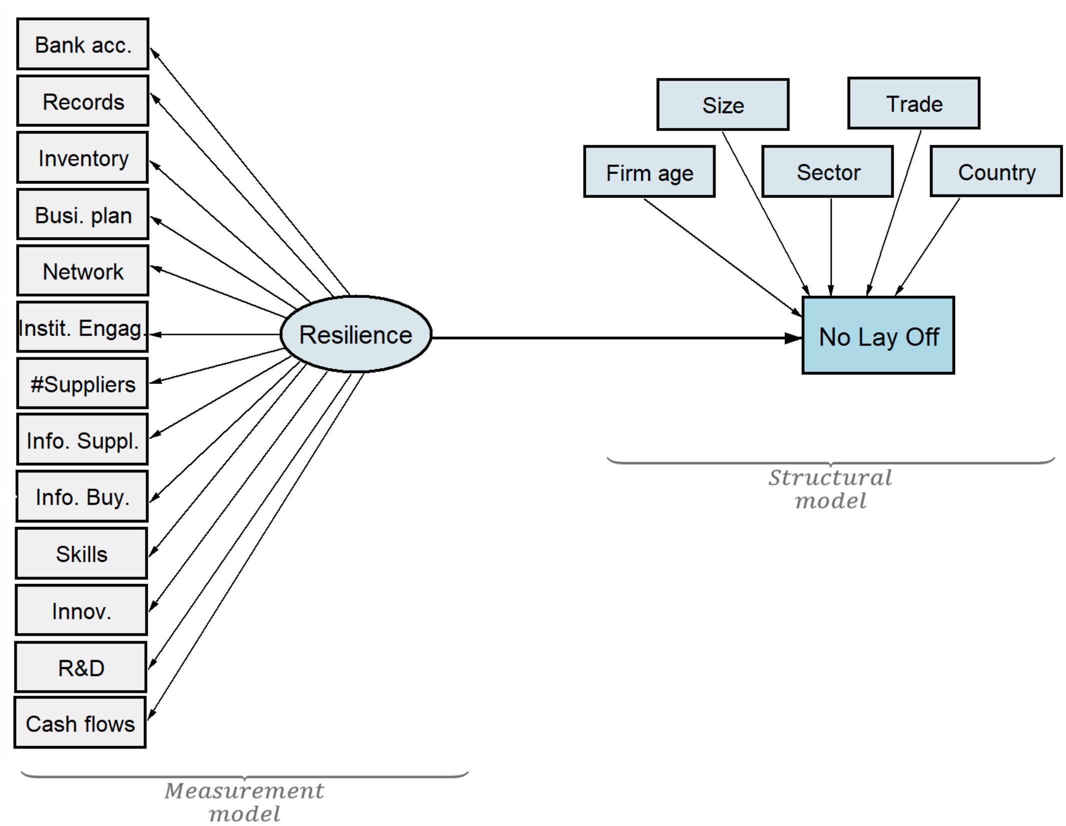


Figure 3: Correlation and density plots of the Resilience index and its pillars.

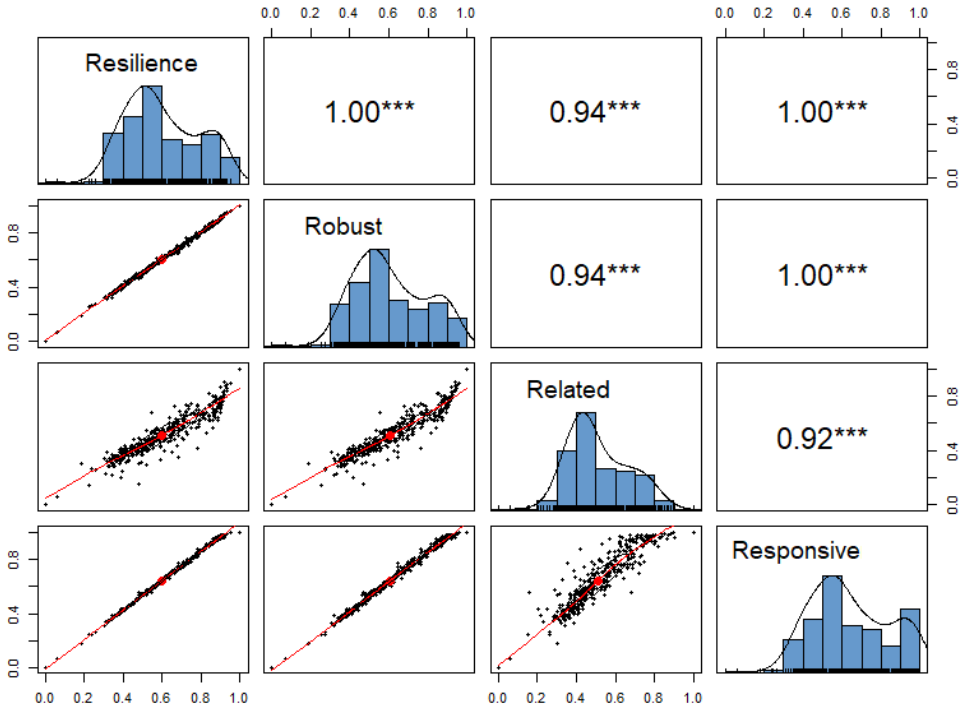


Figure 4: Probability of success during COVID-19 increasing in resilience index

a. Probability of not laying off increasing in resilience index b. Probability of stable sales increasing in resilience index

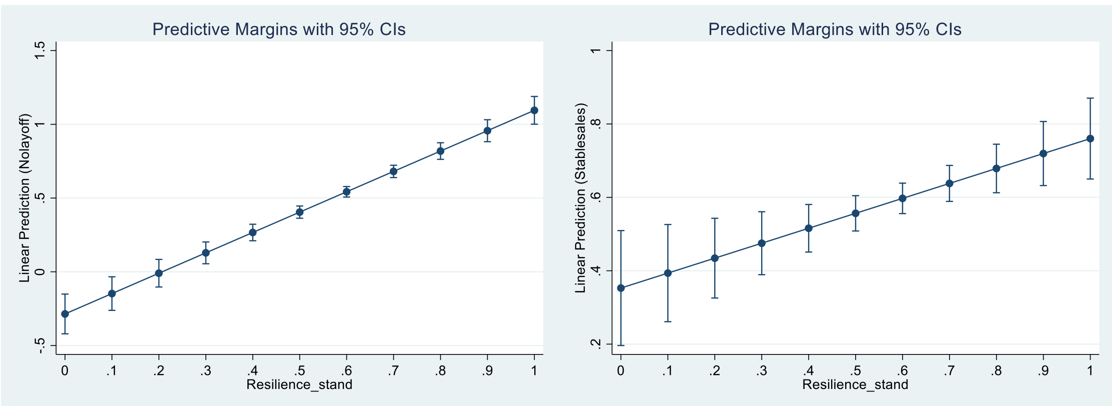
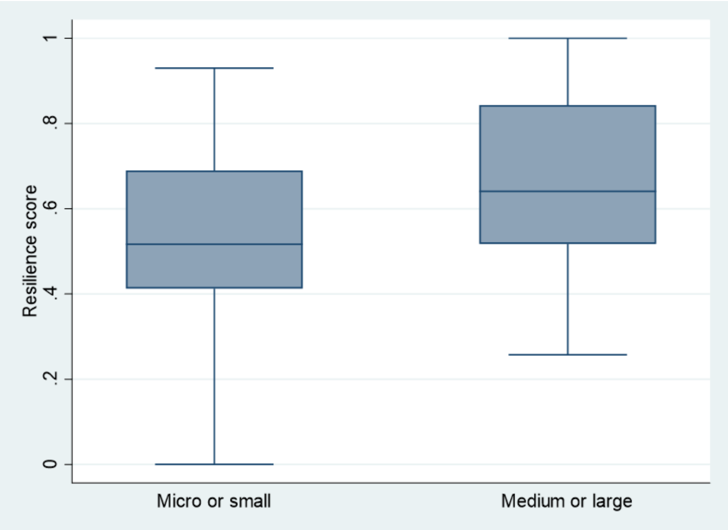


Figure 5: Box plot of resilience index by firm size



Tables

Table 1: Data coverage by country, firm size and sector

Group	Observations	Percentage share in total
Country		
Benin	44	6%
Cambodia	272	35%
Philippines	454	59%
Size Category		
micro (<5 employees)	116	15%
small (5-20)	431	56%
medium (20-99)	147	19%
large (100 or over)	76	10%
Sector		
Manufacturing	404	52%
Services	225	29%
Primary	141	18%
Total	770	100

Table 2: Estimation results for the linear factor analysis by pillar

Components of Resilience by Pillar					
Robust		**Related**		**Responsive**	
Bank account	0.111*** (0.0495)	Network	0.500*** (0.0424)	Skills	0.759*** (0.0245)
Business plan	0.822*** (0.0226)	Institution engagement	0.212*** (0.0514)	Innovation	0.451*** (0.0414)
Records	0.097*** (0.0496)	Number of suppliers	0.187*** (0.0519)	R&D	0.286*** (0.0476)
Inventory	0.696*** (0.0282)	Available info. on suppliers	0.678*** (0.0358)	Cash flows	0.792*** (0.0229)
		Available info. on buyers	0.810*** (0.0320)		
Observations	444		444		444
Standard errors in parentheses *** p<0.01, ** p<0.05, * p<0.1					
cov(Robust,Related)	0.682*** (0.0452)	cov(Relate,Responsive)	0.680*** (0.0450)	cov(Responsive,Robust)	1.060*** (0.0240)

Table 3: Exploratory factor analysis: factor loadings

One latent factor	
Eigenvalue	3.71054
Cumulative variance explained	80.57%
Kaiser-Myer-Olkin measure of sampling adequacy	0.8394
Scale reliability coefficient	0.7686
Variable	Factor loadings
Bank account	0.1473
Business plan	0.7523
Records	0.1381
Inventory	0.6922
Network	0.4152
Institution engagement	0.2229
Number of suppliers	0.1681
Available info. on suppliers	0.6136
Available info. on buyers	0.6742
Skills	0.6983
Innovation	0.5819

R&D	0.4639
Cash flows	0.7086

Table 4: Estimation results for the linear factor analysis

Resilience					
Bank account	0.126***	Network	0.327***	Skills	0.756***
	(0.0499)		(0.0465)		(0.0246)
Business plan	0.816***	Institution engagement	0.217***	Innovation	0.497***
	(0.0217)		(0.0484)		(0.0401)
Records	0.112***	Number of suppliers	0.169***	R&D	0.342***
	(0.0501)		(0.0492)		(0.0467)
Inventory	0.719***	Available info. on suppliers	0.537***	Cash flows	0.773***
	(0.0268)		(0.0384)		(0.0243)
		Available info. on buyers	0.560***		
			(0.0352)		
Observations	444		444		444

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 5: Goodness of fit statistics for the linear factor analysis

	Baseline	After modification indices	
		All paths	Selected paths
	(1)	(2)	(3)
Likelihood ratio test, p>chi2	0.000	0.868	0.000
RMSEA	0.128	0.000	0.079
CFI	0.727	1.000	0.907
SRMR	0.088	0.023	0.068
CD	0.883	0.877	0.856

Table 6: Estimation results for the SEM – Resilience affects the probability of not laying off employees

Linear probability model based on SEM: impact of resilience on not laying off employees

VARIABLES	(1) No Lay off	(2) No Lay off	(3) No Lay off	(4) No Lay off	(5) No Lay off	(6) No Lay off	(7) No Lay off
Resilience	0.636***	0.631***	0.628***	0.618***	0.572***	0.236***	0.230***
	(0.032)	(0.034)	(0.033)	(0.034)	(0.042)	(0.054)	(0.057)
Firm age		0.032	0.047	0.050	0.051	-0.079**	-0.076**
		(0.040)	(0.038)	(0.037)	(0.037)	(0.033)	(0.033)
Size			-0.237***	-0.157***	-0.144***	-0.094**	-0.091**
			(0.036)	(0.053)	(0.053)	(0.045)	(0.047)
Trade				-0.110**	-0.108**	-0.077*	-0.077*
				(0.054)	(0.053)	(0.045)	(0.045)
Constant	1.085***	1.040***	1.087***	1.105***	1.150***	0.784***	1.946***
	(0.060)	(0.082)	(0.080)	(0.080)	(0.094)	(0.071)	(0.110)
Sector Fixed Effect	No	No	No	No	Yes	No	Yes
Country Fixed Effect	No	No	No	No	No	Yes	Yes
Observations	444	444	444	444	444	444	444

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 7: Estimation results for the SEM – Resilience affects the probability of stable sales

Linear probability model based on SEM: impact of resilience on Stable Sales

VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Resilience	0.248***	0.215***	0.216***	0.239***	0.178***	0.053	0.014
	(0.049)	(0.049)	(0.049)	(0.049)	(0.057)	(0.083)	(0.025)
Firm age		0.189***	0.180***	0.174***	0.186***	0.102**	0.119***
		(0.045)	(0.045)	(0.044)	(0.044)	(0.046)	(0.046)
Size			0.140***	-0.037	-0.021	-0.022	-0.018
			(0.045)	(0.065)	(0.065)	(0.064)	(0.062)
Trade				0.244***	0.254***	0.283***	0.300***
				(0.049)	(0.064)	(0.061)	(0.061)
Constant	1.214***	0.944***	0.916***	0.876***	1.048***	0.718***	1.646***
	(0.063)	(0.093)	(0.093)	(0.092)	(0.113)	(0.100)	(0.129)
Sector Fixed Effect	No	No	No	No	Yes	No	Yes
Country Fixed Effect	No	No	No	No	No	Yes	Yes
Observations	438	438	438	438	438	438	438

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 8: Resilience index influenced by size of firm and age, gender of its leader

	Dependent variable: Resilience index							
VARIABLES	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Small (dummy)	-0.107***				-0.093***			
	(0.018)				(0.013)			
Size (categorical)		0.057***				0.064***		
		(0.010)				(0.007)		
Youth led			-0.061**				-0.028	
			(0.026)				(0.019)	
Woman led				-0.010				-0.050***
				(0.023)				(0.017)
Constant	0.668***	0.461***	0.586***	0.598***	0.659***	0.444***	0.581***	0.605***
	(0.014)	(0.027)	(0.010)	(0.010)	(0.010)	(0.019)	(0.007)	(0.007)
Country-Sector Fixed Effect	No	No	No	No	Yes	Yes	Yes	Yes
Observations	444	444	380	433	444	444	380	433
R-squared	0.077	0.063	0.015	0.000	0.538	0.558	0.469	0.484

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 9: Smallness negatively associated with each pillar of resilience

	Dependent variable: pillar of resilience					
	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	Robust	Relate	Respond	Robust	Relate	Respond
Small (dummy)	-0.107***	-0.094***	-0.113***	-0.094***	-0.085***	-0.098***
	(0.017)	(0.015)	(0.019)	(0.013)	(0.012)	(0.014)
Constant	0.675***	0.572***	0.714***	0.667***	0.566***	0.704***
	(0.014)	(0.012)	(0.015)	(0.010)	(0.009)	(0.011)
Country-Sector Fixed Effect	No	No	No	Yes	Yes	Yes
Observations	444	444	444	444	444	444
R-squared	0.078	0.082	0.074	0.534	0.456	0.537

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table 10: Description of variables used in the factor analysis

Variable name	Description	Mean	Standard deviation
Robustness			
Records	A dummy equals to one if the firm keeps any records of revenues, expenses, liabilities and/or assets	0.94	0.24
Bank account	A dummy equals to one if the firm has a dedicated business bank account.	0.81	0.39
Inventory	A variable ranging in value from 0 to 100. Respondents were asked to "please rate the efficiency of this company's inventory management system": six answer options on a Likert scale ranged from inefficient (value of 0) to highly efficient (value of 100).	71.68	25.1
Business plan	A variable ranging in value from 0 to 100. Respondents were asked to "please rate the extent to which this company has the capability to present a fully costed business plan to a bank for the purposes of getting a loan": six answer options on a Likert scale ranged from no capability (value of 0) to full capability (value of 100).	70.28	27.12
Relate			
Network	A variable ranging in value from 0 to 100. Respondents were asked "to what extent do companies in your sector exchange market information which may be beneficial to the sector as a whole (e.g. market trends)": six answer options on a Likert scale ranged from no extent (value of 0) to great extent (value of 100).	54.31	30.87
Institutional Engagement	A dummy equal to one if the firm said it was engaged with one or more institution. Respondents were asked: "are you actively engaged with any of the following types of institutions: trade promotion organisations, investment promotion organisations, chambers of commerce, and sector associations".	0.04	0.19
Number Suppliers	A variable for responses to the question "how many suppliers do you currently have"	6	18.65
Information on Suppliers	A variable ranging in value from 0 to 100. Respondents were asked to "please rate the availability of market information on potential suppliers": six answer options on a Likert scale ranged from very low (value of 0) to very high (value of 100).	59.88	25.25
Information on Buyers	A variable ranging in value from 0 to 100. Respondents were asked to "please rate the availability of market information on potential buyers": six answer options on a Likert scale ranged from very low (value of 0) to very high (value of 100).	59.15	25.95
Responsive			
Skills	A variable ranging in value from 0 to 100. Respondents were asked to "please rate the extent to which the skill set of currently employed workers matches the needs of this company": six answer options on a Likert scale ranged from poor match (value of 0) to good match (value of 100).	76.01	23.17
Innovation	A variable ranging in value from 0 to 100. Respondents were asked to "please rate the frequency with which your company develops and implements new or improved processes or products": six answer options on a Likert scale ranged from rarely (value of 0) to often (value of 100).	59.45	27.16
R&D	A variable ranging in value from 0 to 100. Respondents were asked to "please estimate the level of resources your company commits to research and development": six answer options on a Likert scale ranged from no resources (value of 0) to high level of resources (value of 100).	55.38	27.95
Cash Flow	A variable ranging in value from 0 to 100. Respondents were asked to "please rate this company's ability to manage its cash flow to reliably execute payments": six answer options on a Likert scale ranged from no ability (value of 0) to very good ability (value of 100).	75.18	23.31
Controls			
Size	A variable for the number of full-time employees	96.06	394.64
Sector	Primary defined as ISIC codes 1 to 9; Manufacturing ISIC 10 to 32; and Services 33 to 98.		
Trade	A variable for the share of enterprise sales that are exported	7.14	22.94
Firm Age	A variable for the difference between the year the survey was conducted and the respondent answer to the question "in what year did this establishment begin operations".	15.98	12.58
Woman-led	A dummy equal to one if the enterprise is managed by a woman and at least 30% owned by women.	0.25	0.43
Youth-led	A dummy equal to one if the enterprise manager is under the age of 35.	0.12	0.33
Outcomes			
No layoff	A dummy equal to 1 if the respondent did not say they laid off employees during the COVID crisis. The survey question asked "have you adopted any of the following strategies to cope with the crisis: laid off employees"	0.28	0.45
Stable Sales	A dummy equal to 1 if the respondent did not say they had lowered domestic sales. The survey question asked "has the coronavirus (COVID-19) pandemic affected the ability to purchase inputs for your enterprise and/or sell outputs: lower domestic sales to consumers, or lower domestic sales to businesses".	0.68	0.47

Source : SME Competitiveness Surveys in Benin, Cambodia and the Philippines

Appendix 2: Construction of composite indices

Composite indices aggregate a number of relevant dimensions into one single index to capture a complex phenomenon. Factor analysis is often used to construct multi-dimensional composite indices. The final index $I(x^i)$ is expressed by the general formula (Decancq and Lugo 2013) in Equation 1A :

Equation 1A $$I(x^i) = \begin{cases} \left[w_1 I_1(x_1^i) + \cdots + w_m I_m(x_m^i)\right]^{1/\beta} & for\ \beta \neq 0 \\ I_1(x_1^i)^{w_1} I_2(x_2^i)^{w_2} \ldots I_m(x_m^i)^{w_m} & for\ \beta = 0 \end{cases}$$

where w represents the weights, $I(\cdot)$ the transformation function and β a parameter linked to the elasticity of substitution. Operationalizing this general formula for index construction requires making decisive choices such as selecting the transformation function, the parameter β and the weights associated to each indicator.

The most prevailing transformation functions standardize the indicators to a common scale to ensure that aggregation into one single index is reasonable. Some also safeguard against outliers or extreme values by controlling their impact on the index even when the original distribution is skewed. In our case, we standardize all continuous variables on a common scale ranging from 0 to 100. Moreover, we set the parameter $\beta = 1$ as it is one of the most common choice. Well-known examples using such parametrization are the Life Conditions Index (Boelhouwer 2002), the Commitment to Development Index[16], the Index of Multiple Deprivation[17], Social Progress Index (Desai 1993), the Proportional Deprivation Index (Halleröd 1995; 1996), the Index of Economic well-being (Osberg and Sharpe 2002), and the Human Development Index (UNDP 1990).

In the construction of a composite index, the choice of weights is a central issue. Weights can be classified into three broad categories: normative, data-driven or hybrid. Normative weights depend on value judgements, whereas data-driven weights are estimated using the distribution of the x's. Hybrid weights are a compromise between the two previous categories, and rely on both subjective choices and the distribution of the variables. In this paper, we propose to use a data-driven method to estimate the weights associated to each indicator used to construct our measure of resilience. Finally, our index of Resilience is given by

Equation 1A $$Resilience(\mathrm{x}^{\mathrm{i}}) = w_1 x_1^i + \cdots + w_m x_m^i$$

where w_m represents the weight associated with indicator m estimated using factor analysis.

[16] https://www.cgdev.org/commitment-development-index-2018

[17] https://www.gov.uk/government/collections/english-indices-of-deprivation

Appendix 3: Robustness checks

This Appendix displays some robustness checks for the linear factor analysis model first. Table A1 and A2 present respectively: the linear factor analysis results of the alternative model with all paths added after using modification indices; and of the one for the selected model, where selected path were added. We see that the results are similar to those presented in Table 4.

Table A1: Baseline model: Estimation results for the linear factor analysis – all paths added

Resilience					
Bank account	0.148*** (0.0521)	Network	0.240*** (0.0483)	Skills	0.818*** (0.0230)
Business plan	0.804*** (0.0236)	Institution engagement	0.198*** (0.0494)	Innovation	0.422*** (0.0426)
Records	0.170*** (0.0535)	Number of suppliers	0.194*** (0.0513)	R&D	0.223*** (0.0487)
Inventory	0.715*** (0.0277)	Available info. on suppliers	0.431*** (0.0380)	Cash flows	0.752*** (0.0265)
		Available info. on buyers	0.529*** (0.0380)		
Observations	444		444		444

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Table A2: Baseline model: Estimation results for the linear factor analysis – selected paths added

Resilience					
Bank account	0.096** (0.0512)	Network	0.261*** (0.0489)	Skills	0.790*** (0.0243)
Business plan	0.787*** (0.0251)	Institution engagement	0.230*** (0.0491)	Innovation	0.466*** (0.0418)
Records	0.091* (0.0521)	Number of suppliers	0.155*** (0.0504)	R&D	0.282*** (0.0486)
Inventory	0.746*** (0.0270)	Available info. on suppliers	0.492*** (0.0411)	Cash flows	0.734*** (0.0286)
		Available info. on buyers	0.561*** (0.0376)		
Observations	444		444		444

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

Secondly, we report some robustness checks for the SEM model presented in section 4.2. Table A3 shows the estimation results of a logit model to account for the binomial nature of the outcome variables used (i.e. No lay off and Stable Sales). The comparison with the linear probability model presented in Tables 6 and 7 is complicated due to the impossibility to standardize the coefficients in the case of nonlinear models. However, in qualitative terms, we do not see any strong differences in the logistic estimation results presented in Table A3, compared to our baseline specification, more strongly so for the SEM where No Lay off is the outcome variable. Stable sales is not robust to the inclusion of sector and country fixed effects.

Table A3: Estimation results for the SEM – Robustness check using a logit model

Logit model based on SEM: impact of resilience on not laying off employees and on stable sales

VARIABLES	(1) No Lay off	(2) No Lay off	(3) Stable Sales	(4) Stable Sales
Resilience	1.174***	1.021***	0.311***	-0.046
	(0.148)	(0.256)	(0.093)	(0.108)
Firm age	0.026***	-0.055**	0.014**	0.002
	(0.009)	(0.017)	(0.007)	(0.008)
Size	-0.002***	-0.002**	-0.000	-0.000
	(0.001)	(0.001)	(0.000)	(0.000)
Trade	-0.022**	-0.011	0.017***	0.030***
	(0.006)	(0.010)	(0.007)	(0.007)
Constant	1.158***	6.402***	0.473***	1.709***
	(0.177)	(0.791)	(0.131)	(0.239)
Sector Fixed Effect	No	Yes	No	Yes
Country Fixed Effect	No	Yes	No	Yes
Observations	444	444	438	438

Standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1