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DEFINING FIRM COMPETITIVENESS: A MULTIDIMENSIONAL FRAMEWORK

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TRADE IMPACT FOR GOOD

Defining firm competitiveness: a multidimensional framework

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Abstract

Defining and measuring competitiveness remains a subject of interest as well as debate: policy makers need to understand how competitive their country is relative to others, and how their competitive position evolves overtime (Fagerberg et al, 2017). As such, well-known indicators of country performance have been developed over the years. While, the business and economic literature recognise that "*It is the firms, not nations, which compete in international markets*" (Porter, 1998), the existing indices do not asses the capabilities of businesses. This paper fills this gap by proposing a multidimensional framework of firm competitiveness. Through factor analysis, we test the framework using firm level data from the World Bank Enterprise Surveys on over 100 countries. Regression based sensitivity checks confirm that the firm level index built in this paper positively correlates with commonly used proxies of firm competitiveness, (i.e. labour productivity, the probability to export, etc.). The framework is applicable to firms of different size and export status.

Keywords: firm competitiveness, multidimensional index, factor analysis, latent variable models.

JEL classification*:* F23, C38, M21, L1

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1. Introduction

"Competitiveness" is a key concept in a world in which market forces determine economic outcomes. Competitiveness determines the ability to conquer new markets, to outplay other actors in the market, to attract investment and to grow. This is key for policy makers, who need to understand how competitive their country is relative to others, and how their competitive position evolves overtime (Fagerberg et al., 2017).

The need for evidence based policy explains the attention received in the media by composite indicators of 'competitiveness' that compare the performance of individual countries against their peers. The common ground among these indices is clear: capturing the conditions in which businesses operate within their countries with a focus on the macro-level of the economy. In other words, the available competitiveness indices do not asses the behaviour of businesses themselves.

Such a focus on the national level is not surprising, as both the literature on competitiveness and derived approaches were developed in the 1990s, when firm level data were scarce. Yet the availability of such data has changed dramatically in recent years. Indeed, much of the current theoretical and empirical trade literature focuses on the firm, formalized in the seminal theoretical model of Melitz (2003). A very rich and longstanding literature on firm competitiveness also exists in the business administration literature (Porter, 1990; Prahalad and Hamel, 1990; Buckley et al., 1992; Ma and Liao, 2006).

This paper aims at filling this gap by adding a firm level dimension to the most common approaches of measuring competitiveness. This focus on the firm is supported by the business as well as the economic literature. "*It is the firms, not nations, which compete in international*

markets", states Porter (1998) and is confirmed by Krugman (1998): "*Countries do not buy or sell goods overseas; companies do*".

The method adopted in this paper is a multilevel factor analysis with indicators at different levels of aggregation (firm level, business ecosystem and national level). Factor analysis allows to test our proposed framework of competitiveness and build a firm level index based on 70,723 firm observations across 100 countries for the 2006–14 period.

The results suggest that the proposed index is positively correlated with commonly used proxies of competitiveness, such as labour productivity, the probability to export, the percentage of inputs of foreign origin used by the firm and the share of total sales that were exported. Moreover, our framework is confirmed to apply to firms of different size and export status.

Finally, the use of data across countries of different development status, where the majority of observations are from low income countries, suggests that our framework is applicable independent of development status or income level.

The contribution of this paper is twofold. On one side it contributes to filling a gap in the literature, by building a multidimensional framework of *firm*'s competitiveness. On the other, it proposes to measure competitiveness - until now mainly proxied with several measures of productivity - by building a composite indicator through factor analysis.

The rest of the paper is structured as follows. Section 2 provides a review of the literature, Section 3 and 4 introduce the competitiveness framework and test it using factor analysis. Finally, Section 5 investigates the relevance of the index in regression analysis and Section 6 provides concluding remarks.

2. Review of the literature

1. Competitiveness of nations versus competitiveness of firms

The theory of competitiveness has its roots in the trade theory of competitive advantage. The major competing views of competitiveness emerged in the 1980s and 1990s and can be simplified in two streams. The first view associates competitiveness with lower labour costs and favourable home country policies (Brander & Spencer, 1985; Krugman, 1986). The second one highlights productivity as the catalyst of competitiveness and prosperity (e.g. Delgado et al., 2012; Krugman, 1990, 1994; Porter, 1990). The productivity-based view of competitiveness has established itself as the most used definition, remaining to date the most commonly used indicator of good performance and competitiveness.

However, from the point of view of policy makers wishing to raise the competitiveness of their country, using productivity[4] to measure competitiveness has two short-comings. First, it does not provide information on the determinants of competitiveness. Policy makers would therefore not know which policy tools to use in order to improve competitiveness. Second, productivity only reflects a static measure of competitiveness and does not provide information on whether the economy is ready to face changes in the economic environment.

Porter's seminal work of the 1990s set the basis for addressing the two shortcomings mentioned above. His so-called Diamond Model provided an approach to systematically

[4] Productivity is usually represented either as a function of inputs or as the ratio between outputs ($Y_{i,t}$) and inputs ($I_{i,t}$), indicating the effectiveness by which output has been created from each unit of input in time *t*, for country or firm *i* (Dahlstrom and Ekins 2005; Syverson 2011).

measure and compare determinants of competitiveness. The interesting aspect of Porter's Diamond Model rests in its ability to cover several economic theories in one concept.[5]

Even though the Diamond Model has met with some criticism, it is recognized as an important development in the study of international competitiveness, as it opened the discussion on the determinants and indicators of international competitiveness.[6] As such, it has inspired the creation of two leading indices of country competitiveness: the "World Competitiveness Rankings" by the International Institute for Management Development (IMD) and the "Global Competitiveness Index" by the World Economic Forum (WEF).

While we acknowledge the relevance of the existing indices, we propose to build a framework of firm, rather than country, competitiveness. In fact, as supported by Krugman in two seminal papers (1994, 1996), countries predominantly produce public goods and do not compete with each other on markets: firms do. Several frameworks of country and firm competitiveness have been proposed over the years, including Fagerberg et al. (2007), Prahalad and Hamel (1990) and Buckley et al. (1992).

2. Dimensions of firm competitiveness

A multitude of components can influence the ability of a firm to perform well. These components can be directly related to the characteristics of the firm or indirectly affect the firm through its business environment. The latter can be further separated into immediate and macroeconomic environment, according to whether it is close to the firm (clients,

[5] The product cycle theory and Rostow growth theory (Vernon, 1966 and Rostow, 1960); Marshall's industrial districts (1890); and the works of Schumpeter (1911).

[6] Magdalena Olczyk (2016) A systematic retrieval of international competitiveness literature: a bibliometric study

suppliers, competitors, etc.) or further away (national infrastructure, governance, trade policy, etc.) in terms of connection and ability to influence.

Moreover, since firms do not only need to compete today, but rather need to stay competitive over time, it is important to take into account not only the static but also the dynamic components of competitiveness.[7]

Hence, we employ a concept of competitiveness whereby firms need to:

- be able to meet consumers' demand - in terms of quantity, quality, price and timeliness of delivery - in their targeted market segment, at any given moment in time;
- be able to do so sustainably, i.e. over time, and thus adjust to changes in their environment;
- constantly be connected to the latest market relevant information.

The concept of competitiveness described above applies to all firms and what makes a firm competitive or not will very much depend on the market segment the firm has chosen to compete in. For ease of exposure and conceptualization, we organize these components under three main pillars: Compete, Connect and Change.

The first pillar centres on current operations allowing firms to be competitive in a static sense. The "change" pillar refers to the capacity to adjust to or embrace change and is recognized as essential to achieving adequate returns in a sustained manner.[8] This pillar therefore adds the

[7] Especially in more "dynamically competitive" industries (Bresnahan, 1999; Evans and Schmalensee, 2001; Ellig and Lin, 2001). "Productive efficiency" and "dynamic efficiency" are increasingly highlighted by the theoretical and empirical literature on gains from competition (Spence, 1984; Ahn, 2002; Feurer and Chaharbaghi, 1994).

[8] As Nelson (1996) reminded from Schumpeter's idea: "Static analysis is not only unable to predict the consequences of discretionary changes in the traditional ways of doing things; it can neither explain the occurrence of such productive revolutions nor the phenomena which accompany them. It can only investigate the new equilibrium position after the changes have occurred.

dynamic component of competitiveness. The "connect" pillar highlights the importance to connect efficiently to information channels to navigate a competitive environment. Whilst access to information on customers, competitors, suppliers, support institutions and other relevant actors in the economy has always been important for business, this aspect has arguably been revolutionized by the emergence and widespread use of digital technologies. As a consequence, access to information has become a key determinant of competitiveness in modern economies and deserves particular attention.

A multiplicity of factors at the firm level and in the firm's immediate or macroeconomic environment will determine firm level performance within the three pillars. In the following, the most relevant factors, as they emerge from the economics and the business administration literature, are described.

Compete

A firm's ability to compete at a given moment in time is reflected in its ability to meet quality, quantity and time requirements of the market at a competitive price. In economic models, this ability is typically described through the optimization of a production function under a set of restrictions, where the latter notably reflect access to inputs. In business administration the same concept is described by the optimization of a production process, where the management has a key role in designing and monitoring that process.

Indeed, competency of the manager turns out to be a good predictor of how well a firm performs in the market.[9] Management practices can improve productivity, through their impact on marginal productivity of inputs and resource constraints (e.g. Syverson, 2011), as

[9] Porter (1990) defines entrepreneurial and management skills as the ability to capitalize on ideas and opportunities by successfully implementing a business strategy.

well as growth and longevity (Bloom and Van Reenen, 2010). Years of managers' experience are found to affect performance as well (Bertrand and Schoar, 2003).

Another aspect that affects all four components (quantity, quality, timeliness, and price) of the ability to compete and that is highlighted in the literature is access to inputs and suppliers. Empirical evidence shows that access to foreign intermediate inputs can increase firms' efficiency by providing more diverse and higher quality inputs (Bas and Strauss-Kahn, 2014), especially for small and medium sized enterprises (SMEs), since they are able to raise their productivity via learning, variety and quality effects (Amiti and Konings, 2007). This aspect includes access to key utilities like water and electricity. The ability to conduct financial transactions smoothly also matters for production and sales processes.

The time dimension of the "compete" pillar will greatly depend on the quality of infrastructure and logistics services. Logistics costs are an important share of the value of final goods produced, especially for SMEs, and in developing countries (Schwartz et al., 2009)[10]. Though logistics costs are affected by firms' ability to manage logistics, they often depend on external factors. For example, an impact assessment study of the Peruvian road network's expansion between 2003 and 2010 estimates that total Peruvian exports would have been roughly 20% smaller in 2010 without the road development programme (Carballo et al. , 2013).

When it comes to the quality component, it is often not enough to produce at a certain quality, it is also necessary to signal to consumers that the relevant quality level is met. This aspect is particularly important in international trade and typically involves the adoption of standards. Adopting standards may increase sales on foreign markets, improve the image of a company,

[10] For example, in LAC logistics costs represent 18% to 35% of the final value of goods, while in OECD countries it remains close to 8%. For small companies, the share may be over 42%, mainly due to high inventory and warehousing costs.

or even decrease associate trade costs due to facilitated custom control regime (Cranfield et al., 2011; Latouche and Chevassus-Lozza, 2015; Carballo et al., 2015; Goedhuys and Sleuwaegen, 2016). Proving that standards are met, typically involves going through a certification process. As a consequence the cost of such processes have implications for firms' ability to compete. Empirical evidence shows that certification may restrain producers in accessing foreign markets, since they incur extra costs, both fixed and variable, which ultimately increase the product price (World Bank, 2005; Kox and Nordås, 2007; Beghin et al., 2009).

Last but not least, another external factor that has an important influence of firms' ability to compete abroad is their country's trade policy and the trade policy applied by partner countries. Ample evidence shows that trade liberalization leads to better economic outcomes (Wacziarg and Welch, 2008; Nicita and Rollo, 2015), and it affects the degree of competitiveness firms face in a market (Melitz, 2003; Melitz and Ottaviano, 2008).

Change

The ability to pre-empt or adjust to changes in the competitive environment can be thought of as the ability to change the production function. In this context, a first thing that comes to mind is the role of innovation. The ability to change the way to produce through investment in physical capital or the investment in new skills sets is also relevant. All three aspects are discussed in the economic as well as business administration literature.

Access to finance is an important determinant of firm performance along a number of distinct aspects, including investment, growth, firm size distribution (Ayyagari et al., 2011), and innovation (Beck et al. 2008). Musso and Schiavo (2008) show how access to external finance in France has a positive effect on firm performance in terms of sales, capital stock and

employment. Access to finance is consistently cited as one of the primary obstacles affecting SMEs (Ayyagari et al., 2012). It also determines the firm's ability to enter export markets and expand abroad (Bellone et al., 2010; and Berman and Héricourt, 2010), which are capital intensive efforts, involving high up-front costs and high variable costs. The access to and extension of credit greatly depends on a supportive legal and regulatory framework. Coricelli et al. (2010) shows that in countries characterized by weak financial market institutions and limited market capitalization, a significant proportion of firms have no access to bank loans.

A skilled and educated workforce is central to the ability of firms to anticipate change or to adjust to it, and an important determinant of economic growth (Barro, 1991; Benhabib & Spiegel, 1994; Woessmann, 2011). Several papers (from Burki and Terrell, 1998 to Backman, 2014) provide evidence of the link between work force education, experience and cognitive skills and firm productivity. Local availability of talented workforce is not only a strong predictor of productivity, but also of export diversification (Cadot et al., 2011). Matching the skills needs firms have with the skills supplied by countries' education systems is not always an easy task, and a usual source of inefficiency (Jansen and Lanz, 2013).

R&D and innovation have been shown to be important components for countries' competitiveness, as they allow growing and catching-up if needed (Griffith et al., 2004; Fagerberg and Verspagen, 2002). Firm level evidence goes in the same direction. Innovative firms have higher levels of productivity and economic growth (Cainelli et al., 2004; Crespi and Zuniga, 2012). They are also more likely to export, and to do it successfully (Love and Roper, 2015; Cassiman et al., 2010). The capacity to innovate is defined in different ways: as the ability to generate innovative outputs (Neely et al., 2001) or as the ability to continuously transform knowledge and ideas into new products, processes and systems (Lawson and

Samson, 2001). In both cases, the capacity to innovate is closely related to the capability to change.

Connect

Access to market relevant information like consumer demand, competitor behaviour or input availability has always been important for competitiveness (Cacciolatti and Lee, 2015). The need for information can seem endless (indeed, typical economic models assume "perfect information") and includes aspects like information about the legal requirements firms have to meet in order to sell or export, or information about the status of trade agreements their country is a signatory of. In a period where digital technologies have revolutionized every single aspect of dealing with data and of connecting different market players, access to information has become a key determinant of survival.

In the trade literature information costs are a standard component of trade costs (Anderson and van Wincoop, 2004). Business literature and surveys confirm that information on export opportunities is costly (Bacchetta and Jansen, 2003) and can become a bottleneck for exports in particular for small and medium-sized enterprises (ITC, 2015). The business ecosystem – including reliable access to ICT infrastructure - is particularly important for SMEs, which oftentimes are unable to gather relevant business information (Kitching et al., 2015; Reid, 1984; Seringhaus, 1987; Christensen, 1991).

A somewhat different but equally relevant role of connectivity is to facilitate research and innovation. In this context, economic research has highlighted the importance of business-to-business networks (Schoonjans et al., 2013). Clusters can create links between firms and boost knowledge sharing and positive synergies, either between firms (business-to-business networks, as for Winters and Stam, 2007) or between firms and external actors, such as

universities or R&D institutes (Acs et al., 1994). The use of technology in the firm's network can also have positive spillovers on firms' performance (Paunov and Rollo, 2016).

3. Construction of indices

In this paper, we aim at building an index for competitiveness that captures the underlying described above. The most common types of multidimensional indices are composite indices. They seek to aggregate a number of relevant dimensions to capture a complex phenomenon. The final index $I(x^i)$ is expressed by the general formula (Decancq and Lugo, 2013) in **Equation 1** :

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

where w represents the weights, $I(\cdot)$ the transformation function and β a parameter linked to the elasticity of substitution. This general formula for index construction reveals the three crucial choices to be made in order to build a composite index: selecting the transformation function, the parameter β and the weights associated to each dimension.

Transformation functions applied to the original data allow standardizing all variables when these are available in different units and bringing them to a common scale.[11] Transforming the raw data also reduces the importance of outliers or extreme values and adresses the issue of non-normality.[12]

[11] See for instance Smithson (2006, page 21) that argues that aggregation into a single measure is only sensible when the variables are on a common scale.
[12] For more on transformation functions, see table 2 in Decancq, K., & Lugo, M. A. (2013).

The selection of the parameter β will determine the degree of substitution between the sub-indices $I_j(x^i)$. The most common choice is $\beta = 1$ implying a infinite degree of substitution.[13]

Finally, the most crucial decision in the construction of a composite index is the choice of weights. Three broad categories of weights exist: 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 x.

This paper uses statistical methods to estimate the weights used in the aggregation of the final measure of competitiveness. Factor analysis is a well-known method, aimed to explain a set of observed variables (i.e. indicators) in terms of a lower number of latent – or unobserved - variables (i.e. factors). The method is suitable for our purpose as we aim at measuring the latent concept "competitiveness" in terms of the three latent pillars Connect, Compete, Change.

Factor analysis is particularly well suited for the construction of multidimensional indices for various reasons. First, since no indicator is sufficient on its own to predict the underlying latent variable, factor analysis truly acknowledges multidimensionality as essential in the construction of the final index. Second, factor analysis allows estimating weights (also known as factor loadings) associated to each observed indicator in the measurement of the latent

[13] Well-known examples using such parametrization are: the Life Conditions Index (Boelhouwer, 2002), the Commitment to Development Index13, the Index of Multiple Deprivation13, Social Progress Index (Desai, 1993), the Proportional Deprivation Index (Halleröd, 1995, 1996), the Index of Economic well-being (Osberg and Sharpe, 2002), the Human Development Index, UNDP, 1990 - current).

factor. These estimated factor loadings relieve the researcher from subjectively designing the weighting scheme in the aggregation step.

In particular, Confirmatory Factor Analysis (CFA) is based on a pre-specified theoretical model. CFA allows the researcher to set in advance the number of latent concepts as well as which observed indicators are influenced by a specific latent variable. This paper relies on CFA to estimate the weights used in the aggregation of the indicators used to measure the latent variables Compete, Connect, Change. For simplicity, we set $\beta = 1$ such that the formula in **Equation 1** reduces to the standard arithmetic mean, as per **Equation 2**. This has the advantage of simplifying the construction of the sub-indices for our three pillars Compete, Connect and Change:

Equation 2 $Pillar_j(x_j^i) = w_{j1}\, I(x_{j1}^i) + \cdots + w_m I(x_{jm}^i)$

where w_{jm} represents the weight associated with indicator m in pillar j estimated using CFA.

The final formula for the Competitiveness index is:

Equation 3 $Competitiveness(x^i) = \omega_1 Compete(x_1^i) + \omega_2 Connect(x_2^i) + \omega_3 Change(x_3^i)$

where the weights ω are either normatively set to one or estimated by a second order factor analysis. In this paper we report the index of competitiveness using the original data, with no transformation.[14]

The competitiveness framework used in CFA is explained in the next section. The framework is based on the review of the literature; as such, we define our choice of weights as "hybrid",

[14] We have also transformed the data using Box-Cox or Yeo-Johnson power transformations (on previously rescaled data). Results are available upon request, and produce very similar measures of competitiveness.

rather than purely data-driven: while factor analysis is a statistical method and the calculated weights are data-driven, CFA is based on a framework produced through normative criteria.

4. A multidimensional competitiveness framework

In this section, we first introduce the data upon which our empirical work is based. We then build our competitiveness framework, based on the review of the literature from Section 2 and available data. Finally we introduce the empirical framework and show the results of the confirmatory factor analysis.

a. Data

This paper uses several datasets with the standardized World Bank Enterprise Surveys (WBES) being the main source of data for the firm level data.[15] The WBES dataset reports the answers from enterprise surveys deployed on a representative sample of formal firms in the non-agricultural sector, by country. Firms are selected through stratified random sampling (more information on the data can be found in Dethier et al., 2011).

Our analysis retains only the last year available for each country from the cross-section of firms. We analyse information for 70,723 firm observations across 100 countries for the 2006–14 period.

[Table 1 here]

Table 1 reports information on country coverage, while Table 2 summarizes data coverage across firm size categories, world regions and income levels. It shows that the vast majority of the countries included in the data we analyse are low and middle income countries, from all

[15] Downloaded on January 2016 from https://www.enterprisesurveys.org/portal/login.aspx

geographic regions. Most firms in the sample are small firms, firms that report employing less than 20 full-time workers.

[Table 2 here]

The WBES reports the answers to a wide number of questions on firms' characteristics and obstacles faced by firms in their activities. We use firm level variables to account for the capacities of firms to be competitive, and we build proxies for the quality of the business ecosystem using firm level variables. We build these variables from the WBES, as averages or shares (depending on the type of variable we use) of firm level answers at the industry *j* country *c* cell, for the latest available year. The choice of the industry-country combination is motivated by the possibility that, within the same country, different industries are affected differently by similar issues, and also by the fact that different sectors might perceive the same issue differently. The industry *j* is defined using the ISIC code provided in the WBES dataset. Table 3 provides a description of the variables included in the analysis as well as their source.

[Table 3 here]

This data is then merged with other macroeconomic datasets from several sources: the World Bank Doing Business Indicators, the World Bank and Turku School of Economics' Logistics Performance Index, the ISO Survey of Management System Standard Certifications, the World Bank Worldwide Governance Indicators, ITU's ICT Development Index, UNESCO Institute for Statistics (UIS) and the World Intellectual Property Organization (WIPO). All trade statistics and customs tariff data derive from the ITC Market Analysis Tools.

b. The competitiveness framework

In this paper, we set up a competitiveness framework based on the review of the literature conducted in Section 2.Hence, we classify the components of firm competitiveness according to how they affect competitiveness into three pillars: *Compete*, *Connect* and *Change*. These three pillars reflect traditional static and dynamic notions of competitiveness. We also consider the three layers of the economy at which these components intervene: firm capabilities, the business ecosystem and the national environment. Figure 1 depicts the competitiveness framework.

[Figure 1 here]

In order to measure the three latent pillars - in view of the empirical analysis - we rely on observed indicators:

i. *Compete*: this pillar centres on present operations of firms and their efficiency in terms of cost, time, quality and quantity. The literature has shown the importance of strong managers, of meeting quality and sustainability standards and of access to banking services and inputs. We proxy these concepts with the following firm level variables from the WBES: a dummy indicating if a firm has a quality certification, another dummy for using a bank account and the years of manager's experience. At the level of the business ecosystem, two proxies are included: the percentage share of firms experiencing power outages and the percentage share of firms experiencing losses when shipping to domestic markets, in industry *j* from country *c*. These proxies indicate the importance of a reliable administration of electricity and of a reliable network of suppliers to be able to operate and timely buy inputs. Power outages, in fact, can hamper

the firm's ability to operate. Finally, we proxy the national environment with several macroeconomic indicators from different sources: the ease of getting electricity, the ease of trading across the border, the applied tariff rate, the logistic performance, the number of quality standards issued in the country, and the governance index.

ii. *Connect*: this pillar focuses on gathering and exploiting information and knowledge. Technology is crucial to firm's capability to connect to clients and suppliers, and to be aware of the competitors. We proxy for this capacity with a dummy indicating if the firm uses email and another dummy for the use of website. We proxy for the quality of the business ecosystem to support firms' connectivity with the share of firms considering electricity as an obstacle to their operations in industry j in country c. In fact, if electricity is an obstacle, the use of ICT would be affected. The institutional support provided to connectivity at the national level is proxied with the ITC access score and with the Government online service score.

iii. *Change*: this pillar captures the capacity of a firm to execute change in response to, or in anticipation of, dynamic market forces and to innovate through investments in human and financial capital. It incorporates the dynamic dimension of competitiveness. Having access to credit, talent and innovation affects the capacity of firms to change and remain competitive over time. We proxy for this with several dummies indicating if the firm provides training to its employees, if the firm has financial audit, bank financing and a foreign license. The quality of the business ecosystem is proxied with the percentage share of firms reporting access to finance, business licensing, and an

inadequately educated workforce as an obstacle to their operations. To capture how the national framework supports the business environment, and the firm, we use the ease of getting credit score, the school life expectancy, the ease of starting a business score, and the resident patent applications and trademark registrations by country.

c. Factor analysis

We specify our econometric model as a Confirmatory Factor Analysis (CFA), as described in Bollen (1989) and Muthén (1984). Earlier applications of factor analysis in a cross-country dimension can be found in Adelman and Morris (1965), Temple (1999), Temple and Johnson (1998) and Fagerberg and Srholec (2008).

As shown in Figure 1, we measure the latent factor 'Competitiveness' by the three latent pillars: Compete, Connect and Change. We estimate the model following a two-step procedure. First, we estimate each pillar separately, through linear factor analysis.[16] We then predict values for Compete, Connect and Change and aggregate them into one index of competitiveness through an arithmetic mean.[17]

As traditional in the factor analysis literature, we estimate the unknown parameters of the model by maximum likelihood. To identify the model, we constrain the factor loading of the

[16] To deal with the substantial amount of missing values, we propose to use a full information maximum likelihood method implemented in Stata 14 (StataCorp, 2015) as an option to the sem command. This technique assumes joint normality of all variables as well as the missing values to be missing at random (MAR), so that maximum likelihood can be coupled with a simple imputation procedure. Using this method, we estimate the coefficients in each pillar using the imputed sample of 70'723 observations.

[17] We build the indicators for Compete, Connect and Change as well as the final index of competitiveness using available(i.e. non-missing) information only.

first observed indicator to be one. In the case of linear factor analysis, we use the regression method known as the *Thomson method* to predict the factor scores.

d. Results

We report the results from the estimation of the factor analysis specified in Figure 1.

The estimation results of the competitiveness path diagram are displayed in Table 4. All the coefficients are reported in their standardized forms with their corresponding robust standard errors in parenthesis.

[Table 4 here]

Focusing on our first latent concept, Compete, we see that all the estimated coefficients (i.e. the factor loadings) are of expected sign and significant at the 1% level. Notably, all the variables are positively associated with the Compete pillar except for: the share of firms experiencing power outages (Power Outages), the share of firms affected by losses when shipping to domestic markets (Shipping losses) or the rate of tariff on imports (Applied tariff rate). This is an indication that the results are in line with expectations. An increase in the indicators that are negatively associated with Compete (like Power Outages) means that more firms complain about experiencing problems with the business ecosystem, like having power outages, an element which usually cuts or reduces production and daily activities at the level of any enterprise. Since all indicators related with the business ecosystem identify obstacles or constraints, these indicators should not positively be associated with any of the pillars of competitiveness. The coefficient of “Applied tariffs” is also negative as expected: higher tariffs on imported goods are an obstacle to the purchase of inputs.

With regard to the second latent concept, Connect, the variables measuring an enhanced connectivity – for instance whether a firm uses emails or a website to communicate with suppliers or clients - are positively associated with the latent variable, whereas the share of firms reporting to have experienced electricity as an obstacle to their operations is negatively correlated with our Connect pillar. Once again this indicates that the framework proposed is working in line with expectations, economic literature and intuition.

Finally, the last column of Table 4 summarizes the estimation results associated with the third pillar, Change. Again, we see that all the coefficients are of expected sign and significant at the 1% level.

[Table 5 here]

As a robustness check, we also estimate the whole model at once, instead of estimating it using a two steps procedure. The coefficients, in line with previous results, are reported in Table 5. Finally, to account for the fact that the model includes both continuous and binary variables, we also perform a nonlinear factor analysis - using the empirical Bayes method - as described in Muthén (1984). The results, qualitatively similar to those from the linear factor analysis, are reported in Table 6.

[Table 6 here]

Based on the sign of the coefficients as well as their significance in Tables 4 to 6, we can conclude that the variables chosen in each pillars are measuring our latent concepts of Compete, Connect and Change.

5. Relevance of the Competitiveness Index

In order to verify that our indices for Compete, Connect and Change, as well as our final index, proxy competitiveness, we regress each index on a battery of firm *i* proxies of competitiveness (z_i). We choose those mainly used in the literature: labour productivity (windsorized, so as to reduce the outlier bias), the percentage of inputs of foreign origin used by the firm, the share of total sales that are exported, and the exporting status.

Table 7 presents the estimation results from the regression of the predicted values for Compete (C_i^1), Connect (C_i^2) and Change (C_i^3) (obtained through CFA as described in Section 3 and 4), on the proxies of competitiveness.

Equation 4 $$z_i = \alpha + \beta_1 * C_i^1 + \beta_2 * C_i^2 + \beta_3 * C_i^3 + \gamma_j + \gamma_c + \varepsilon_i$$

The regression (as per **Equation 4**) includes country (γ_c) and sector (γ_j) fixed effects, to control for country *c* and sector *j* characteristics that affect all firms within the same country or sector equally, and has robust standard errors. We find a positive and significant correlation between the three predicted values for Compete, Connect and Change and the main proxies of competitiveness (z_i).

[Table 7 here]

We then regress the competitiveness index (CI_i) (built as the arithmetic mean of the three pillars) on the main proxies of competitiveness (Equation 5), and customize the baseline specification to differentiate between exporting and non-exporting firms (Equation 6) and between firms of different size (Equation 7).

Equation 5 $$z_i = \alpha + \delta_1 * CI_i + \gamma_j + \gamma_c + \varepsilon_i$$

Equation 6 $$z_i = \alpha + \delta_{exp} * CI_i * exp + \delta_{nexp} * CI_i * nexp + \gamma_j + \gamma_c + \varepsilon_i$$

Equation 7 $$z_i = \alpha + \delta_S * CI_i * S + \delta_M * CI_i * M + \delta_L * CI_i * L + \gamma_j + \gamma_c + \varepsilon_i$$

Once again, we include country and sector fixed effects, and standard errors are robust (as per Equation 5). Table 8 shows that the index is positively and significantly correlated with all proxies. Interestingly, when in column (7) we differentiate between exporting and non-exporting firms, results are maintained for both types of firms. Similarly, when we split firms by size in columns (8-10), results apply to firms of all sizes. These results provide further evidence both of the fact that our index is a valid measure of competitiveness, and that our proposed framework of competitiveness applies to all firms, independently of their exporting status and of their size.

[Table 8 here]

Finally, we verify the robustness of our indices by conducting graphic analysis. We start by examining the relationship between our competitiveness index and GDP per capita (PPP). Higher GDP per capita being typically associated with higher levels of productivity, we would also expect it to be associated with higher levels of competitiveness. In Figure 2a, we plot the predicted values for the Competitiveness Index (normalized between 0-100 and averaged by country) on GDP per capita. The plot confirms that firms in richer countries tend to perform better in terms of competitiveness.

[Figure 2 here]

The chart yields an interesting opportunity to interpret the distances between the average country scores and the fitted line. First, while the relationship between GDP per capita and competitiveness is positive, firms can perform well even in low income countries. For example

firms in Moldova, a lower-middle income country like Pakistan, have the same average competitiveness score as firms in a country with a much higher GDP per capita, such as Argentina. One must conclude from Figure 2a that income cannot explain everything.

This is best shown by plotting the predicted values of the three sub-indices Compete, Connect, and Change on GDP per capita, as per Figure 2b, 2c, 2d. The interesting finding is that countries (or rather firms within countries) can over perform in one pillar of competitiveness and have an average performance in the other pillars. Armenia provides an interesting example: while the country performs well in both the Compete and Change plots, compared to its peers at the same income level, the area of competitiveness where the distance from the fitted line is the highest is the Connect pillar. This is not surprising for a regional leader in IT and high-tech industry like Armenia - historically a high tech "Silicon valley" for the Soviet Union.

Lastly, Figure 3 illustrates how the performance gap between large and small firms changes with GDP per capita. The figure reflects that the gap is higher in lower income countries than in richer countries. This finding serves as an additional robustness check as it is supported by several policy papers[18]. Data available for Latin American and European countries reported by McDermott and Pietrobelli (2015), for example, and that show that productivity gaps between large and small firms are higher in low income countries than in high income countries. The competitiveness index makes it possible to replicate this finding for a significantly larger set of countries.

[Figure 3 here]

[18] IADB (2010), OECD (2014), ITC (2015).

Interestingly, several countries with a relatively low competitiveness gap between large and small firms in Figure 3 also belong to the group of over-performers in terms of competitiveness in Figure 2. Whilst there are multiple potential reasons for this overlap, the finding begs the question whether there may be a relationship between GDP per capita growth and the competitiveness gap between large and small firms. Further research in this direction is encouraged.

6. Conclusive remarks

This paper contributes to the academic and policy debate on competitiveness by developing a competitiveness index based on firm level factors in addition to standard macroeconomic variables used in well-known competitiveness rankings. The proposed index thus allows to capture the fact that it is firms that compete with each other in international markets, not countries.

The multi-dimensional competitiveness index built using our proposed framework is positively correlated with commonly used proxies of firm performance, such as labour productivity, the probability to export, the percentage of inputs of foreign origin used by the firm and the share of total sales that were exported. Aggregated at the country level, the competitiveness index is also positively correlated with GDP per capita.

The framework of competitiveness applied for building the index includes both a static and a dynamic dimension of competitiveness. This implies that our index provides insights on the expected future performance of countries based on today's competitiveness of their firms. The concept of competitiveness used also gives an explicit role to the need to connect to

information and data, thus acknowledging the relevance of the digital revolution for firms' competitiveness.

Summarizing several dimensions of firm competitiveness into one single measure is a challenging task, but important and relevant to the policy debate since it can allow policy makers to monitor not only the health of their firms but also the efficiency of the policies put in place to help them.

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

- To identify variables that may positively or negatively affect competitiveness in their country both in static and in dynamic terms.
- To identify whether economic bottlenecks may be due to weaknesses at the firm level or in the transmission from macro policies to the firm level.
- To identify variables and design policies that can reduce the performance gap between small and large firms.

We therefore consider that this index can provide useful guidance to address a number of challenges that policy makers in developing countries face and that have sometimes been associated with scepticism towards globalization. Those challenges include the challenge to move the economy from one development stage to the next (a challenge related to the concept of dynamic competitiveness in our paper) and challenges to make firms of all sizes take advantage of globalization. Both of these challenges are also intimately linked to the achievement of the Sustainable Development Goals.

Critics of the use of competitiveness indices may be concerned that an index like the one presented in this paper may reinforce existing differences across countries, sectors or firms,

as more performing players would potentially find it easier to attract foreign investment. Such concerns have notably been expressed in the context of the ongoing debate on the performative capacity of economics (e.g. MacKenzie et al., 2007). Whilst the presented index can certainly serve as a signal for investors, we consider that it represents from a developmental point of view a signal of higher quality than existing indices, because of the inclusion of firm level information and the resulting potential to draw attention to small and medium sized players in the economy.

While we highlight the importance of including firm level data in competitiveness analysis, we acknowledge well known concerns about the quality (and quantity) of firm level data available for many developing countries (e.g. Jerven, 2013). Accordingly, we want to stress the importance of data collection/availability for evidence-based policy. The quality of policy analysis would greatly benefit from strengthened statistical capacities of local institutions, especially in developing countries where these capacities tend to be weaker. Efforts in this direction would also contribute to achieving the 19th target of Sustainable Development Goal 17: "[…] support statistical capacity-building in developing countries".

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Appendix I: Tables and Figures

Figures

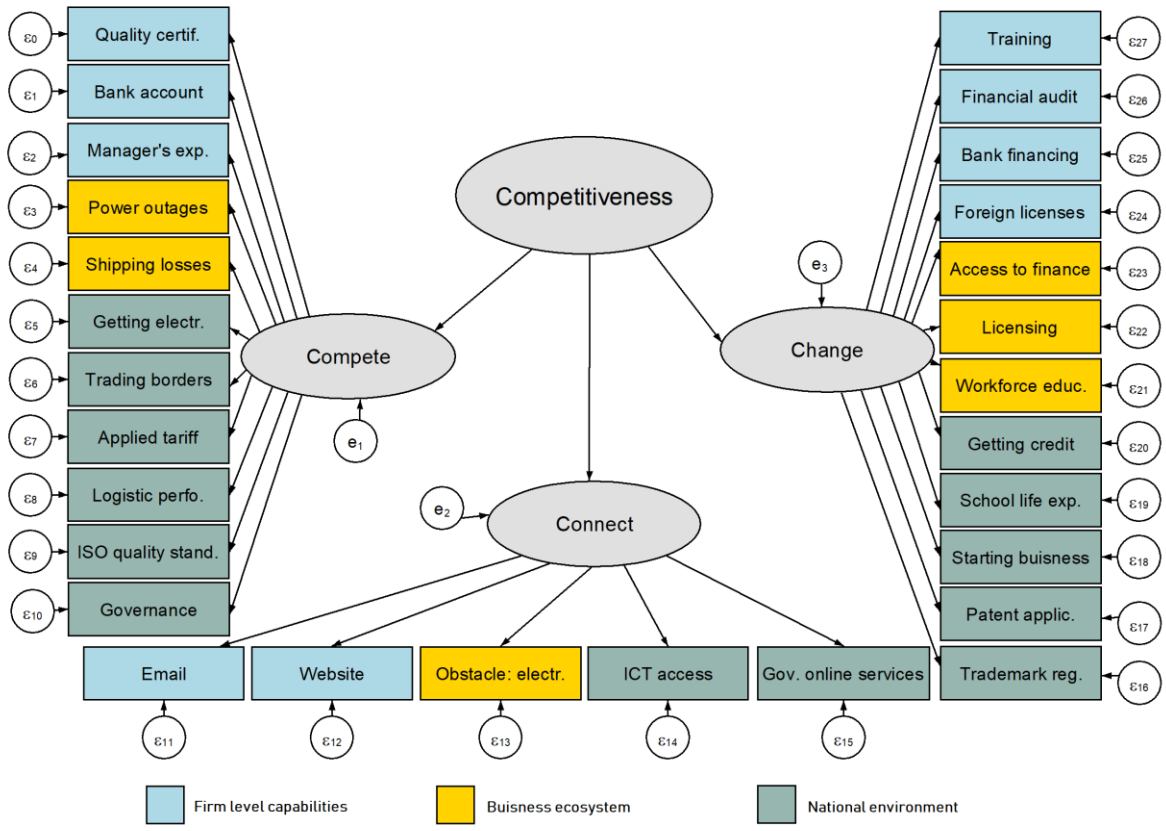

Figure 1 : Competitiveness path diagram where observed variables are indicated by rectangles, latent variables by ellipses and measurement errors by circles.

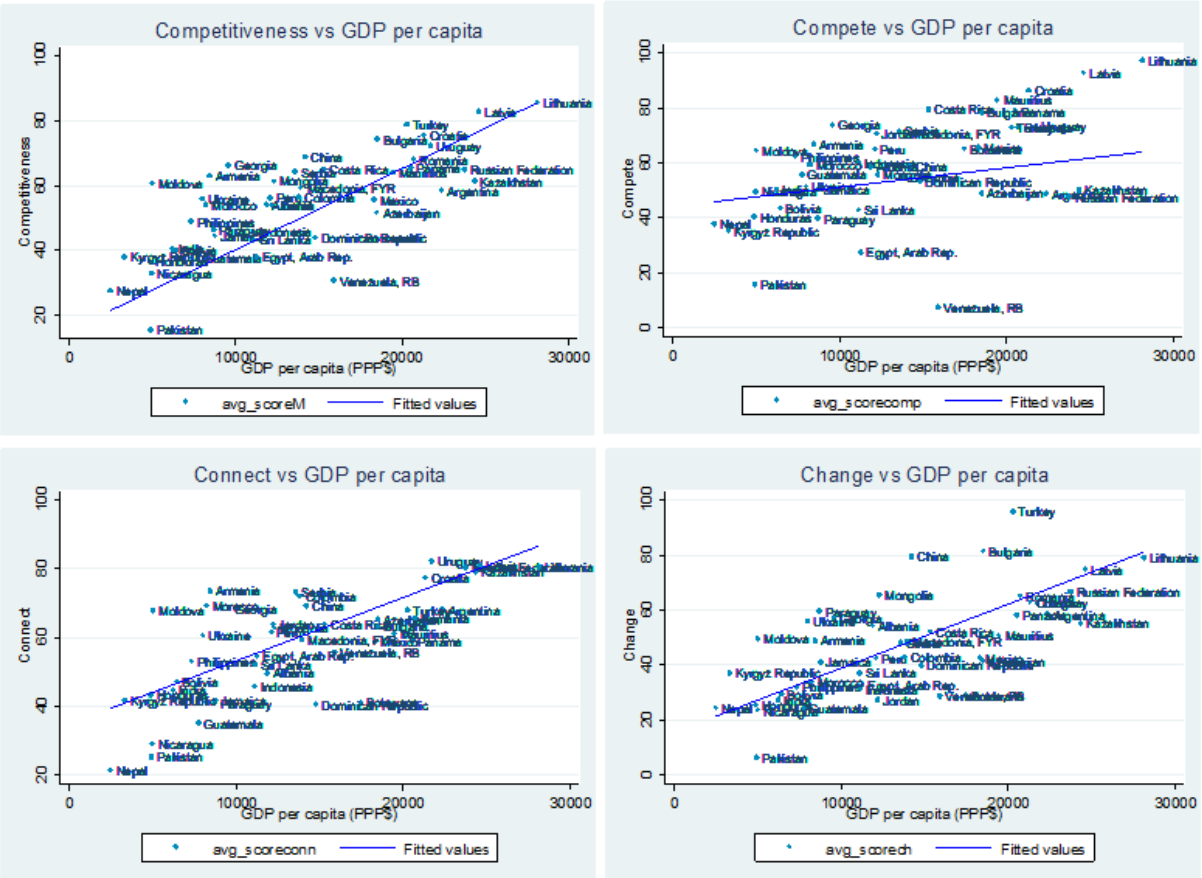

Figure 2a, b, c, d: Competitiveness Indices by income

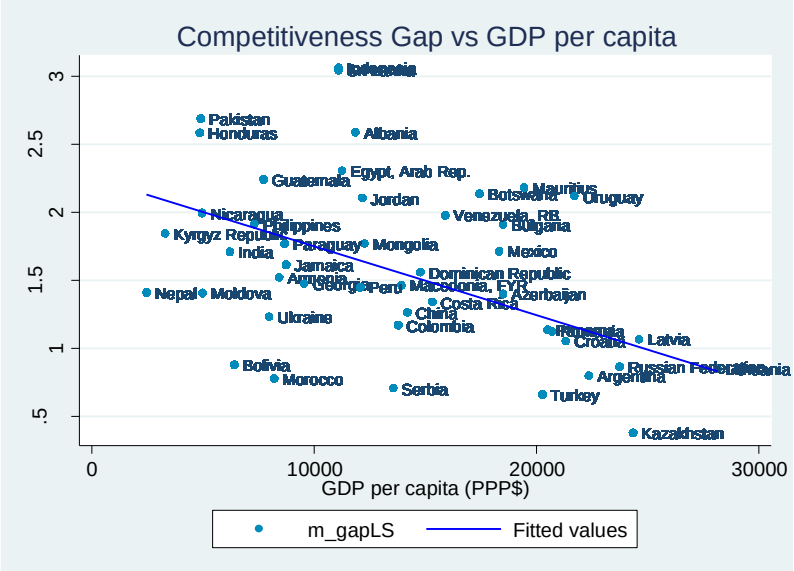

Figure 3: Competitiveness Gap by income: Gap between Large and Small firms

Tables

Table 1: Data coverage by country and year

Country	Year	Observations	Percentage share in total	Country	Year	Observations	Percentage share in total	Country	Year	Observations	Percentage share in total
Angola	2010	360	0.509	Indonesia	2009	1444	2.042	Poland	2013	542	0.766
Albania	2013	360	0.509	India	2014	9281	13.123	Paraguay	2010	361	0.51
Argentina	2010	1054	1.49	Israel	2013	483	0.683	Romania	2013	540	0.764
Armenia	2013	360	0.509	Jamaica	2010	376	0.532	Russian Federation	2012	4220	5.967
Azerbaijan	2013	390	0.551	Jordan	2013	573	0.81	Rwanda	2011	241	0.341
Burundi	2014	157	0.222	Kazakhstan	2013	600	0.848	Senegal	2014	601	0.85
Burkina Faso	2009	394	0.557	Kenya	2013	781	1.104	Sierra Leone	2009	150	0.212
Bangladesh	2013	1442	2.039	Kyrgyz Republic	2013	270	0.382	El Salvador	2010	360	0.509
Bulgaria	2013	293	0.414	Cambodia	2013	472	0.667	Serbia	2013	360	0.509
Bolivia	2010	362	0.512	Lao PDR	2012	270	0.382	Suriname	2010	152	0.215
Brazil	2009	1802	2.548	Lebanon	2013	561	0.793	Slovak Republic	2013	268	0.379
Barbados	2010	150	0.212	Sri Lanka	2011	610	0.863	Slovenia	2013	270	0.382
Botswana	2010	268	0.379	Lesotho	2009	151	0.214	Sweden	2014	600	0.848
Chile	2010	1033	1.461	Lithuania	2013	270	0.382	Swaziland	2006	307	0.434
China	2012	2700	3.818	Latvia	2013	336	0.475	Chad	2009	150	0.212
Cote d'Ivoire	2009	526	0.744	Morocco	2013	407	0.575	Tajikistan	2013	359	0.508
Cameroon	2009	363	0.513	Moldova	2013	360	0.509	Timor-Leste	2009	150	0.212
Colombia	2010	942	1.332	Madagascar	2013	532	0.752	Trinidad and Tobago	2010	370	0.523
Cape Verde	2009	156	0.221	Mexico	2010	1480	2.093	Tunisia	2013	592	0.837
Costa Rica	2010	538	0.761	Macedonia	2013	360	0.509	Turkey	2013	1344	1.9
Czech Republic	2013	254	0.359	Mali	2010	360	0.509	Tanzania	2013	813	1.15
Dominican Republic	2010	360	0.509	Myanmar	2014	632	0.894	Uganda	2013	762	1.077
Egypt	2013	2897	4.096	Montenegro	2013	150	0.212	Ukraine	2013	1002	1.417
Estonia	2013	273	0.386	Mongolia	2013	360	0.509	Uruguay	2010	607	0.858
Ethiopia	2011	644	0.911	Mozambique	2007	479	0.677	Venezuela	2010	320	0.452
Gabon	2009	179	0.253	Mauritania	2014	150	0.212	Vietnam	2009	1053	1.489
Georgia	2013	360	0.509	Mauritius	2009	398	0.563	Yemen	2013	353	0.499
Ghana	2013	720	1.018	Malawi	2014	523	0.74	South Africa	2007	937	1.325
Guinea	2006	223	0.315	Nigeria	2014	2676	3.784	Zambia	2013	720	1.018
Gambia	2006	174	0.246	Nicaragua	2010	336	0.475	Zimbabwe	2011	599	0.847
Guatemala	2010	590	0.834	Nepal	2013	482	0.682				
Guyana	2010	165	0.233	Pakistan	2013	1247	1.763				
Honduras	2010	360	0.509	Panama	2010	365	0.516				
Croatia	2013	360	0.509	Peru	2010	1000	1.414				
Hungary	2013	310	0.438	Philippines	2009	1326	1.875				

Table 2: Data coverage by firm size, sector, income level and world region

Group	Observations	Percentage share in total
Size Category		
small (<20)	31668	44.78
medium (20-99)	24989	35.33
large (100 or over)	14066	19.89
Sector		
Manufacturing	41000	57.97
Services	29723	42.03
Income level		
High-income economies	1880	2.66
Low-income economies	33722	47.68
Lower-middle-income economies	16297	23.04
Upper-middle-income economies	18824	26.62
World region		
East Asia & Pacific	8407	11.89
Europe & Central Asia	14811	20.94
Latin America & Caribbean	13083	18.5
Middle East & North Africa	5866	8.29
South Asia	13062	18.47
Sub-Saharan Africa	15494	21.91
Total	70723	100

Table 3: Description of variables used in the factor analysis

Variable name	Description	Mean	Standard deviation	Source
Firm-level capabilities				
Quality certification	A dummy equals to one if the firm has an internationally-recognized quality certification. The question refers exclusively to internationally recognized certifications. For example: the ISO 9000 series (Quality management systems), the ISO 14000 series (Environmental management systems), HACCP (Hazard Analysis and Critical Control Point) for food (especially, but not exclusively, for seafood and juices), and AATCC (American Association of Textiles Chemists and Colorists) for textiles. Certificates granted only nationally not recognized in international markets are not included.	0.26		Enterprise Surveys (http://www.enterprisesurveys.org), The World Bank (2005–2014)
Bank account	A dummy equals to one if the firm has a checking or savings account.	0.87		
Manager's experience	Logarithm of years of the managers' experience	2.68 [17]	0.67	
email	A dummy equals to one if the firm uses email to communicate with clients or suppliers	0.74		
website	A dummy equals to one if the firm has its own website.	0.50		
Training	A dummy equals to one if the firm offers formal training programs for its permanent, full-time employees.	0.40		
Fiancial audit	A dummy equals to one if the firm had its annual financial statements checked and certified by an external auditor.	0.55		
Bank financing	A dummy equals to one if the firm has a line of credit or a loan from a financial institution.	0.35		
Foreign licences	A dummy equals to one if the firm uses technology licensed from a foreign-owned company, excluding office software.	0.14		
Immediate buisness environment				
Power outages	Percentage share of firms experiencing power outages in industry j of country c.	59.16	22.16	Authors' own calculation; Firm level data source: Enterprise Surveys (http://www.enterprisesurveys.org), The World Bank (2005–2014)
Shipping losses	Percentage share of firms experiencing losses when shipping to domestic markets in industry j of country c.	17.19	11.86	
Obstacle: electricity	Percentage share of firms experiencing electricity as being an obstacle to their current operations.	47.40	21.18	
Access to finance constraint	Percentage share of firms reporting access to finance as an obstacle to their current operations.	45.22	17.81	
Licensing constraint	Percentage share of firms identifying buisness licensing and permits as an obstacle to their current operations.	30.55	16.44	
Inadequate workforce education	Percentage share of firms identifying an inadequately educates workforce as an obstacle to their current operations.	39.14	20.48	
National environment				
Getting electricity	Doing Business 'Ease of getting electricity' score (0–100). All procedures required for a business to obtain a permanent electricity connection and supply for a standardized warehouse.	63.72		World Bank, International Finance Corporation, Doing Business 2014: Understanding Regulations for Small and Medium-Size Enterprises, http://www.doingbusiness.org/ methodologysurveys/
Trading across borders	Doing Business 'Ease of trading across borders' score (0–100). The indcator measures the time and cost (excluding tariffs) associated with exporting and importing a standardized cargo of goods by sea transport.	58.00		
Applied tariff rate	Applied tariff rate, trade-weighted mean, all products (%).A tariff is a customs duty that is levied by the destination country on imports of merchandise goods. Trade-weighted average tariff is calculated for each importing country using the trade patterns of the importing country's reference group (based on 2013 trade statistics). To the extent possible, specific rates have been converted to their ad valorem equivalent rates and included in the calculation of weighted mean tariffs. Preferential tariff arrangements (tariff preferences) have been taken into account.	0.09	0.04	ITC, based on data from ITC Market Analysis Tools, 2006–2015 (www.intracen.org/marketanalysis).

Logistic performance	A multidimensional assessment of logistics performance, the Logistics Performance Index (LPI), compares the trade logistics profiles of 160 countries and rates them on a scale of 1 (worst) to 5 (best). The ratings are based on 6,000 individual country assessments by nearly 1,000 international freight forwarders, who rated the eight foreign countries their company serves most frequently.	2.89		World Bank and Turku School of Economics, Logistics Performance Index 2014, http://lpi.worldbank.org/
ISO quality standards	Number of "ISO 9001:2008 Quality management systems" certificates issued (per million people).	21385.50	65497.25	ISO, The ISO Survey of Management System Standard Certifications, 2013, www.iso.org
Governance	Governance index. Average score over six dimensions of governance: voice and accountability, political stability and absence of violence, government effectiveness, regulatory quality, rule of law, and control of corruption.	-0.37		World Bank, Worldwide Governance Indicators (2014), http://info.worldbank.org/governance/wgi/index.aspx#home
ICT Access	ICT access sub-index score (0–10). Composite index that weights five ICT indicators (20% each): (1) Fixed-telephone subscriptions per 100 inhabitants; (2) Mobile-cellular telephone subscriptions per 100 inhabitants; (3) International Internet bandwidth (bit/s) per Internet user; (4) Percentage of households with a computer; and (5) Percentage of households with Internet access.	4.73		ITU, Measuring the Information Society 2014, ICT Development Index 2014 (2013 data except for Tajikistan, 2008), http://www.itu.int/en/ITU-D/Statistics/Pages/publications/mis2014.aspx
Government online service	Government's online service index score (0-1). Each country's national website is assessed for content, features, accessibility and uptake, including the national central portal, e-services portal, and e-participation portal as well as the websites of the related ministries of education, labour, social services, health, finance, and environment, as applicable.	0.47		UNPAN, e-Government Survey 2014, http://www2.unpan.org/egovkb/
Getting credit	Doing Business 'Ease of getting credit' score (0–100). The index measures the legal rights of borrowers and lenders with respect to secured transactions through one set of indicators and the sharing of credit information through another.	19.87		World Bank, Ease of Doing Business Index 2014, Doing Business 2014, http://www.doingbusiness.org/reports/global-reports/doing-business-2014
School life expectancy	School life expectancy, primary to tertiary education (years). Total number of years of schooling that a child of a certain age can expect to receive in the future, assuming that the probability of his or her being enrolled in school at any particular age is equal to the current	12.56	2.46	UNESCO Institute for Statistics (UIS), 2001–2013, http://stats.uis.unesco.org
Starting a business	Doing Business 'Ease of starting a business' score (0–100). The index measures the number of procedures, time and cost for a small and medium-size limited liability company to start up and formally operate.	80.36		World Bank, Ease of Doing Business Index 2014, Doing Business 2014, http://www.doingbusiness.org/methodology/starting-a-business
Patent applications	Resident patent applications, equivalent count by applicant's origin (per million people). Patent filings made by applicants at their home office (national or regional), also called domestic applications. Applications at regional offices are equivalent to multiple applications, one in each of the state members of those offices, therefore each application is multiplied by the corresponding number of member states, except for the European patent Office (EPO) and the African Regional Intellectual Property Organization (ARIPO), for which designated countries are not known, in which case each application is counted as one application abroad if the applicant does not reside in a member state; or as one resident and one application abroad if the applicant resides in a member state.	65.47	141.44	WIPO, 2000–2013, http://www.wipo.int/portal/en/index.html
Trademark regulations	Resident trademark registrations, equivalent class count by applicant's origin (per million people).	611.93	654.1	WIPO, 2004–2013, http://www.wipo.int/portal/en/index.html

Table 4: Estimation results for the linear factor analysis by pillar

	Components of Competitiveness by Pillar					
	Compete		**Connect**		**Change**	
Firm level	Quality certification	0.130*** (0.0042)	Email	0.426*** (0.0044)	Training	0.169*** (0.0043)
	Bank account	0.166*** (0.0045)	Website	0.369*** (0.0045)	Financial audit	0.022*** (0.0044)
	Manager's experience	0.149*** (0.0041)			Bank financing	0.154*** (0.0042)
					Foreign licenses	0.030*** (0.0054)
Business ecosystem	Power outages	-0.636*** (0.0031)	Obstacle: electricity	-0.593*** (0.0029)	Access to finance constraint	-0.501*** (0.0047)
	Shipping losses	-0.111*** (0.0060)			Licensing constraint	-0.458*** (0.0053)
					Inadequate workforce education	-0.049*** (0.0066)
National Environment	Getting electricity	0.721*** (0.0029)	ICT Access	0.802*** (0.0026)	Getting credit	0.421*** (0.0039)
	Trading across borders	0.745*** (0.0033)	Government online service	0.712*** (0.0027)	School life expectancy	0.838*** (0.0021)
	Applied tariff rate	-0.562*** (0.0030)			Starting a business	0.447*** (0.0039)
	Logistic performance	0.562*** (0.0032)			Patent applications	0.604*** (0.0035)
	ISO quality standards	0.093*** (0.0020)			Trademark regulations	0.839*** (0.0030)
	Governance	0.842*** (0.0022)				
	Observations	70723		70723		70723

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 5 : Estimation results linear factor analysis on the whole model

	Components of Competitiveness					
	Compete		**Connect**		**Change**	
Firm level	Quality certification	0.130*** (0.0041)	Email	0.426*** (0.0038)	Training	0.169*** (0.0041)
	Bank account	0.166*** (0.0042)	Website	0.369*** (0.0039)	Financial audit	0.022*** (0.0042)
	Manager's experience	0.149*** (0.0041)			Bank financing	0.154*** (0.0041)
					Foreign licenses	0.029*** (0.0049)
Business ecosystem	Power outages	-0.636*** (0.0030)	Obstacle: electricity	-0.593*** (0.0032)	Access to finance constraint	-0.501*** (0.0035)
	Shipping losses	-0.111*** (0.0050)			Licensing constraint	-0.458*** (0.0038)
					Inadequate workforce education	-0.049*** (0.0045)
National Environment	Getting electricity	0.721*** (0.0027)	ICT Access	0.802*** (0.0026)	Getting credit	0.421*** (0.0039)
	Trading across borders	0.745*** (0.0026)	Government online service	0.712*** (0.0027)	School life expectancy	0.838*** (0.0019)
	Applied tariff rate	-0.562*** (0.0030)			Starting a business	0.447*** (0.0038)
	Logistic performance	0.562*** (0.0030)			Patent applications	0.604*** (0.0035)
	ISO quality standards	0.093*** (0.0041)			Trademark regulations	0.839*** (0.0021)
	Governance	0.842*** (0.0018)				
	Observations	70723		70723		70723

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 6: Estimation results of non-linear factor analysis by pillar

	Components of Competitiveness by Pillar					
	Compete		**Connect**		**Change**	
Firm level	Quality certification	1 (constrained)	Email	1 (constrained)	Training	1 (constrained)
	Bank account	1.831*** (0.0741)	Website	0.369*** (0.0045)	Financial audit	0.128*** (0.0244)
	Manager's experience	0.339*** (0.0143)			Bank financing	0.931*** (0.0335)
					Foreign licenses	0.237*** (0.0429)
Business ecosystem	Power outages	-49.31*** (1.5866)	Obstacle: electricity	-10.92*** (0.1719)	Access to finance constraint	-25.62*** (0.7346)
	Shipping losses	-4.50*** (0.2731)			Licensing constraint	-21.60*** (0.6609)
					Inadequate workforce education	-2.912*** (0.4037)
National Environment	Getting electricity	47.67*** (1.5200)	ICT Access	1.197*** (0.0187)	Getting credit	24.32*** (0.7090)
	Trading across borders	53.86*** (1.7674)	Government online service	0.118*** (0.0017)	School life expectancy	5.851*** (0.1604)
	Applied tariff rate	-0.082*** (0.0028)			Starting a business	13.10*** (0.4006)
	Logistic performance	0.653*** (0.0204)			Patent applications	254.2*** (6.6163)
	ISO quality standards	20597.2*** (775.55)			Trademark regulations	1622.3*** (43.378)
	Governance	1.611*** (0.0518)				
	Observations	70723		70723		70723

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 7 : Regression results by pillar, with country and sector fixed effects

	(1)	(2)	(3)	(4)	(5)	(6)
VARIABLES	ln(Lab Prod usd) wind	Percentage of imported inputs	Percentage of sales exported	Exporter	Exporter	Exporter
				LPM	Logit	Margin
Compete	0.041***	1.112***	0.681***	0.021***	0.127***	0.019***
	(0.007)	(0.206)	(0.128)	(0.002)	(0.014)	(0.002)
Connect	0.062***	1.107***	1.028***	0.023***	0.183***	0.027***
	(0.003)	(0.069)	(0.042)	(0.001)	(0.006)	(0.001)
Change	0.087***	1.439***	1.096***	0.032***	0.215***	0.032***
	(0.006)	(0.159)	(0.091)	(0.002)	(0.011)	(0.002)
Observations	23351	16248	26453	26546	26546	26546
R-squared	0.226	0.254	0.126	0.175		

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1

Table 8 : Regression results for the competitiveness index (arithmetic mean) country and sector fixed effects.

VARIABLES	(1) ln(Lab Prod usd) wind	(2) Percentage of imported inputs	(3) Percentage of sales exported	(4) Exporter	(5) Exporter	(6) Exporter	(7) ln(Lab Prod usd) wind	(8) ln(Lab Prod usd) wind	(9) Percentage of imported inputs	(10) Percentage of sales exported
				LPM	Logit	Margin				
Competitiveness	0.191***	3.493***	2.981***	0.073***	0.541***	0.080***				
	(0.005)	(0.143)	(0.092)	(0.001)	(0.013)	(0.002)				
Competitiveness*(Exporter)							0.177***			
							(0.006)			
Competitiveness*(Non Exporter)							0.172***			
							(0.006)			
Competitiveness*(Small)								0.169***	3.039***	1.952***
								(0.006)	(0.158)	(0.095)
Competitiveness*(Medium)								0.171***	3.065***	2.008***
								(0.006)	(0.155)	(0.094)
Competitiveness*(Large)								0.174***	3.125***	2.181***
								(0.006)	(0.154)	(0.093)
Prob > F							0	0	0	0
Observations	23351	16248	26453	26546	26546	26546	23351	23351	16248	26453
R-squared	0.225	0.254	0.126	0.174			0.232	0.229	0.257	0.157

Robust standard errors in parentheses

*** p<0.01, ** p<0.05, * p<0.1