Textile manufacturing in eight developing countries: How far does the business environment explain firms' productive inefficiency?

Mohamed Chaffai, UREP, Sfax University, Tunisia

Tidiane Kinda, CERDI - CNRS, University of Auvergne, France

Patrick Plane, CERDI - CNRS, University of Auvergne, France

Corresponding author:
Patrick Plane, Director, CERDI, 65, bd François Mitterrand, 63000 Clermont Ferrand, France
email: P.Plane@u-clermont1.fr
Tel: 33 4 73 17 74 02
Fax: 33 4 73 17 74 28

Abstract

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Production frontiers and technical inefficiency determinants are estimated by using stochastic frontier models. Textile manufacturing is considered for a sample of eight developing countries encompassing about one thousand firms. We find that the most influential individual inefficiency determinants relate to in-house organization. Both access to financing and infrastructural services (e.g. power supply, modern information technologies…) also matter. Information about determinants is then regrouped into three broad categories of factors (e.g. managerial organization, economic environment, institutions). Results do not reject the hypothesis that managerial know-how and the quality of institutions are the most important determinants. The impact of the external economic environment is of less importance although statistically significant. Sector-based simulations are then proposed in order to assess productivity gains which would occur if firms had the opportunity to evolve in most favorable environments within the sample. Domestic and international production contexts are considered, respectively. When referring to domestic benchmarks, the contribution of in-house organization prevails as the main source of gains for the eight countries. The role of institutions proves dominant for Egypt and India when focusing on international simulations.

1. Introduction

Competitiveness can be a “dangerous obsession” (Krugman 1994), but it is a paramount constraint for firm survival and the long run domestic development of small open countries). Beyond the impact of macroeconomic policy, particularly the exchange rate instrument that helps to attain this objective by modifying relative prices, competitiveness mainly depends on firm productive performance which is influenced by producers’ behavior but also by the external environment of organizations (Dollar and Wolff 1993, Hausmann, Rodrik, 2007). The present study relies on the empirical exploration of firms’ data for textile manufacturing in eight developing countries covering the period of mid two thousands: Brazil (2003), Ecuador (2003), Egypt (2004), India (2000), Morocco (2004), Pakistan (2002), South Africa (2003), Sri-Lanka (2004). Microeconomic statistical information has been pooled to constitute an only one international panel which has been constituted from a standardized questionnaire of the World Bank’s *Investment Climate Assessment* (ICA) . We refer to the technical inefficiency concept which allows a direct comparison of productive performance across firms and countries and then identify the implication of economic, institutional and in-house environments on this outcome.

Four reasons underlie the specific interest for textile and the focus on upward activities, downward transformations (garment and clothes) being excluded from the empirical work. (i) First, this sector is one of the most important in developing countries, especially in those this study is interested in. Together, production and transformation of fibers account for more than one third of the manufacturing added value or formal employment, encompassing several hundreds of firms. (ii) Second, textile manufacturing is strongly exposed to the implications of the process of globalization. Competition increased with the end of the *Multifibre Agreement* which restricted exports from China and India for thirty years (1974-2005). New competitive pressures resulted from this evolution with world prices tending to fall in terms of US dollars. Firm’s productivity is an evident option to face this price erosion. (iii) Third,, although sectoral heterogeneity exists across firms in terms of products or technology (Pack, 1984), it seems easier to control for these heterogeneity within textile than for more sophisticated manufacturing goods.

The first objective of this paper is both, to highlight productive efficiency differences across firms and with respect to best international standards; to shed some light on the reasons why theses differences arise. For this investigation, World Bank Investment Climate (ICA) surveys are used. They possess valuable characteristics and have stimulated the emergence of an applied literature on firm productivity level comparisons across countries. Recent papers by Dollar *et al* (2005, 2006) but also by Eifert *et al* (2007) fall into this category. Not only ICA surveys refer to a standard questionnaire providing homogeneous data on firms' production, investment and employment decisions, but they also cover various factors relating to public regulation, governance, and access to finance or infrastructural services. Therefore, they rely on large random samples of domestic firms that are supposed to reflect the true sector-based population of each country. Statistical inference can then be carried out on average country distributions. Stochastic frontier production functions incorporating technical inefficiency determinants are estimated. Three broad categories of detreminants are considered: in-house organization, external economic environment, institutional context. The role of explanatory factors is tested by considering each of them on an individual basis or under the form of an aggregated information reflecting the three categories by using the principal component analysis (PCA). In-house organizational factors are found to be important. Entrepreneurship matters more than external economic factors such as the hard infrastructure. The Role of institutions is quite ambiguous. Their impact proves limited when self-perceptions are considered. Importing additional information from the World Bank *Doing Business* changes the conclusion. Indeed, national institutions prove to vary significantly across the eight countries we deal with and affect the average technical inefficiency distributions.

The second objective of the paper is to predict potential gains of technical efficiency under the hypothesis that all sampled firms could operate in an equivalent environment. Predictions are made with respect to the most favorable production context we may empirically observe in accordance with the adjusted efficiency measures as proposed by Coelli et al (1999). Domestic and international scenarios are then successively considered. The impact of organizational factors is strongly prevalent in the nationwide scenario. Institutional factors prove to be dominant for Egypt and India when the international framework is considered. The rest of the paper is organized as follows: Section 2 discusses the sector-based data surveys for the eight above mentioned countries. We draw attention to the main characteristics of firms' production but also to their productive environment. Section 3 briefly describes the stochastic frontier methodology and the adjusted efficiency measures. Section 4 is devoted to comment empirical results. Some robustness tests are proposed on the basis of which the simulations we referred to are established. Section 5 provides conclusions..

2. Descriptive statistics on textile sectors and investment climates

ICA data are used for eight developing countries with the aim to shed light on relative productivity differentials across firm and country distributions. Differences may arise because of a wide range of factors which can be considered on an individual basis or under the form of various aggregated information reflecting different explanatory determinants (g-categories). In an influential paper dealing with productivity and technical choice in the Philippines's textile industry, Pack (1984) established four types of explanatory factors that respectively affect the functioning of the whole economy, the sector industry, the technical competence of a firm or the efficiency of individual workers. More recently the World Bank (2003) referred to macroeconomic conditions, the quality of infrastructures, and the role of institutions. We marginally differ from this second approach, the first two categories being put together and assimilated to the external environment impact while a third category tries to capture the in-house organizational effect.

ICA data and firm production characteristics

Table 1 provides the descriptive statistics for three firm size groups according to the number of employees. *In an alternative breakdown, firms of more that 500 employees were considered separately to question the argument of scale economies. The small number of firms on which the effect was tested did not meet this hypothesis. To some extent South Africa illustrates this result, national firm distribution being quite different from what it is elsewhere. If we hypothesize that large firms prevail and contribute to 75% of the firm population, they do not reveal either a higher productivity level or a higher capital-labor ratio than for firms of the intermediate group. Medians and standard deviations are given for each of the country distributions.* The total number of firms is 899, national representations varying from 16 for South Africa to 275 for Pakistan.

Table 1 Firm- size and the main characteristics of the production

Firm-size distributions	Variables	Median	Standard deviation	Firm-size Composition (%)	Number of firms (N)
		Brazil 2003 (91)			
< 20	Q/L K/L	11.75 3.77	54.38 32.15	21	19
[20,99]	Q/L K/L	11.54 3.37	21.01 9.58	43	39
≥ 100	Q/L K/L	14.81 5.55	15.00 26.34	36	33
		Ecuador 2003 (21)			
< 20	Q/L K/L	4.51 13.77	5.15 14.14	19	4
[20,99]	Q/L K/L	8.31 3.14	8.40 9.42	48	10
≥ 100	Q/L K/L	10.05 11.04	11.87 7.76	33	7
		Egypt 2004 (92)			
< 20	Q/L K/L	1.87 4.27	4.98 6.98	41	38
[20,99]	Q/L K/L	1.88 5.47	6.48 6.51	34	31
≥ 100	Q/L K/L	2.31 3.92	20.60 10.31	25	23
		India 2002 (195)			
< 20	Q/L K/L	4.80 4.75	31.84 83.20	41	80
[20,99]	Q/L K/L	3.85 3.95	9.12 11.46	34	66
≥ 100	Q/L K/L	5.49 3.49	13.77 44.38	25	49
		Morocco2004 (148)			
< 20	Q/L K/L	6.46 7.16	8.18 13.82	22	33
[20,99]	Q/L K/L	7.99 6.12	9.49 25.94	54	80
≥ 100	Q/L K/L	5.66 4.67	22.55 19.26	24	35
		Pakistan 2002 (276)			
< 20	Q/L K/L	5.94 5.09	41.64 26.51	35	96
[20,99]	Q/L K/L	5.189 7.249	21.554 9.663	54	150
> 100	Q/L K/L	5.27 1.79	7.37 8.04	11	30
		South Africa 2003 (16)			
< 20	Q/L K/L	-	-	-	-
[20,99]	Q/L K/L	11.23 5.71	10.62 5.43	25	4
≥ 100	Q/L K/L	6.98 2.40	6.40 4.25	75	12
		SriLanka2004 (62)			
< 20	Q/L K/L	1.390 3.37	0.76 3.56	40	25
[20,99]	Q/L K/L	1.99 1.91	3.74 13.64	42	26
≥ 100	Q/L K/L	2.89 2.83	6.92 14.85	18	11

What the national distributions suggest is that efficient firms are located in Brazil and South Africa where organizations are not necessarily capital intensive. The lowest productive performance tends to be in Egypt and Sri-Lanka. Partial productivity does not seem to correlate with size. For all the countries but South Africa, the most important firm size group is less than 20 employees (Egypt, India) or between 20 and 100 (Brazil, Ecuador, Morocco, Pakistan, Sri Lanka). Descriptive statistics do not permit us to assert that surveyed firms and the disaggregation according to the size criterion are fully representative of what national firm populations are. However, from this table, we cannot reject some results which have already established in the past, including that small firms are not more labor-intensive and less efficient in transforming inputs in outputs (Little, 1987) .

Environments of the production and firm relative productivity

The external economic environment.

The quality of roads, transportation, telecommunication and power provision varies considerably including within the boundaries of a country. Many authors have referred to the loss of economic efficiency due to the failure in the provision of public utilities. The ICA questionnaire tries to appraise what these constraints mean through qualitative questions about the severity of the problems they have to manage. Unreliable public supply leads to excessive costs. Firms with easy access to electricity supply, modern telecommunication services and efficient transport tend to invest more intensively and prove more productive. Competition is also an important channel and increases with the degree of openness. Although the causality is subject to debate, the dominant idea is that the higher the export ratio of sales, the higher the productive performance. By producing for external markets, competition provides a permanent challenge. The situation is quite different when production is assigned to domestic customers, and firms benefit from import restrictions. ICA surveys incorporate several items addressing these points.

The degree of openness being given, the size of the city as measured by the number of inhabitants where the firm is located is also an influential element reflecting the acuteness of the local competition. The ICA questionnaire is coded in such a way to distinguish 5 types of towns, from the capital city to the smallest agglomeration of less than 50,000 inhabitants. Larger markets attract more firms, which makes competition tougher. This variable potentially interacts with the quality of infrastructures. In remote areas with a low density of population, bottlenecks in the delivery of infrastructural services can be a natural protection. It may benefit to producers against the surplus of consumers enhancing excess profits or a waste of resources. A “quiet life” and managerial inefficiency are likely as well as a non-optimal scale of production when firms evolve in areas with a small population. Agglomeration economies are thought to arise from a variety of mechanisms. Indeed, on the demand side, large agglomerations mean that consumers have the possibility of comparing products with a price-quality criterion; on the supply side, concentration means the possibility for similar firms to share the same suppliers, the existence of thick labor markets ironing out firm-level shocks or facilitating matching, or the possibility to learn from the experience and innovation of others (Duranton and Puga, 2004). As shown by Fujita et al (1999), the grouping of firms, which goes hand in hand with large cities, enhances external economies of scale and stimulates dynamic competitiveness. To survive in the Schumpeterian “creative destruction” environment, organizations are more likely to adopt the most efficient productive conventions they encounter. A higher average productivity of firms and workers in large cities can result from a stronger Darwinian selection of firms.

Access to financing potentially plays an important role on the productivity level. Manufacturing activities are spread out over time. The adoption of the efficient technology requires investment today with the payoffs coming later; even ongoing productive activity requires inputs in advance with revenues realized at a later point in time. Inadequacies in finance create barriers and impede new entry into markets. These inadequacies limit the competitive discipline facing incumbent firms, dulling their incentives to innovate and improve their productivity. Developed financial markets reduce firms’ reliance on their own cash flows and money from families and friends. As a result, they lead to faster growth in productivity (see World Bank, 2005; Levine, Loayza, and Beck, 2000). Two variables have been considered in this paper to appraise the role of financial services. The overdraft facility, is linked to the working capital and the possibility for firms to manage liquidity constraints, to face the instabilities of the environment. The access to financing for longer periods has a more permanent impact. It reflects the ability for firms to snap up opportunities to invest, to incur large sunk costs, especially to enter into export markets.

The institutional environment.

Institutions define the rules of the economic game. They shape activity and have a strong bearing on the organization of production as well as investment decisions. Governments play a key role in providing public facilities and formal rules, such as laws delineating property rights or the judicial institutions liable to enforce these rights in a transparent way. Conflicting with this normative representation of the State, political *economy* suggests that politicians and public bureaus can increase transaction costs. Potential arbitrariness takes many forms. The standard ICA questionnaire stresses this dimension through a wide range of items such as State intervention and red tape of public administration, corruption, cronyism and more generally, the inability to uphold public order. Through the ICA questionnaire, entrepreneurs are asked to give their opinion on the business-government relations in several fields affecting production activities. They have to assess the labor regulations and external trade facilities through the number of days they need to import or export. Firms are also asked to state how confident they are in the capacity of the judicial system to resolve conflict and enforce contractual and property rights in business disputes. A major problem with ICA surveys is that many firms do not respond to some questions. Average regional perceptions that can be considered by firms' size category can be used as relevant determinants under the assumption that this problem is the same for all firms. The ICA database can also be extended with the country-based information of the World Bank's *Doing Business* report. Institutions are then considered homogeneous across a country whatever the sector of activity and wherever the firm is located. This option can be restrictive. For example, the time taken to transfer property title in Brazil varies between 15 days in Brasilia and 65 days in Salvador (WDR, 2005). Even within a single location, the same conditions can affect firms differently according to their activities. The combination of ICA surveys and *Doing Business* might be seen as a pragmatic solution to overcome statistical problems. *Doing Business* collects information on many topics in relation with public regulations and the transactions costs affecting business operations.[1]

Managerial know-how and in-house organization.

There is no clear-cut conclusion about the relationship between productive efficiency and firm size. Large formal companies have potential advantages. They are intrinsically capable of coping with informational imperfections. However some authors consider that small organizations are more appropriate to manage severe market and government failures. Firm

[1] These procedures may be in relation to starting or closing a business, dealing with licenses and registering property, trading across borders, making contracts or firing workers. All these elements complement firms' perceptions and potentially reduce the subjectivity underlying their answers.

size has been considered here according to the number of permanent workers (less than 20, from 20 to 99, 100 and more). Organizational or managerial efficiency depends on the quality of human resources including sector or experience within the firm of the top manager. The human capital quality of the firm as measured by the percentage of the workforce having a high-level of education also matters. Several variables can be used to capture this effect such as the number of school-years from the elementary to the university levels. The same conclusion applies to the percentage of the total permanent employees who benefit from in-house formal training. The production performance is also determined by the mobilization of new information technologies, especially telecommunication services including internet access. Foreign companies can be seen as an additional source of know-how connected with good practices in management. They generally reduce the fixed costs of producing technological innovations and the marginal cost of their replication in the domestic environment. Moreover, foreign firms or their participation in domestic firms' capital can be instrumental in having access to external markets more easily.

A selection of the main Investment Climate variables is presented in Table 2. We regroup them into the three above-mentioned g-categories; the number of firms being given in parentheses under the variable. The number of South African firms is narrow, but these ones are both, large and open, as shown by the export sales ratio or the participation of foreigners in the ownership. The opposite situation prevails in Pakistan, where firms mainly produce to satisfy domestic demand and do not solicit foreign financial participation. The role of new information technologies which we appraise by the percentage of computer users and access to the Internet is not necessarily correlated with size, but seems to be higher in countries with the highest *per capita* income GDP. The difference between Ecuador, 2180 dollars in 2004, and India (620$) clearly illustrates this point.

Except for South Africa and Morocco, some constraints on public services are strong. This is the case for power supply. It is especially damageable for small firms' productivity level as the size of generators tends to be larger than the capacity required by their potential production. Electricity problems prove of importance in Pakistan and Sri-Lanka. It is also significant for an upper-middle income country such as Brazil. As regards financing, the constraint is abnormally high. It conflicts sometimes with information about overdraft facilities although the liquidity constraints are quite different from the time frame underlying the financing of investments. In Morocco, although 67% of the 148 respondent firms benefit from overdraft facilities, more than 75% of producers complain about structural problems concerning access to commercial bank financing. A similar comment applies to Ecuador and, surprisingly, to Brazil.

Information about the quality of the institutional environment is quite poor. Corruption seems to be significant for 67% of entrepreneurs in Brazil, much more than in Egypt (43%). It is a also a severe constraint in Pakistan (41.7%), although informal payments are limited to about 2% of sales, much less than in Ecuador where this phenomenon accounts for 8% with only 33% of firms complaining about corruption. The absence of any normative reference about what the rules are or should be, as well as the subjectivity underlying firms' perceptions, is likely to be the main difficulty in determining the impact of the institutional environment using ICA data.

Table 2 Main variables reflecting organizational, economic and institutional environments: country means (number of firms in parentheses)

Countries	Brazil	Ecuador	Egypt	India	Sri Lanka	Morocco	Pakistan	South Africa
Firms and in-house organization								
Size (number of permanent workers)	181,8 (91)	104,7 (21)	133,0 (92)	224,2 (195)	66,0 (62)	92,2 (148)	87,7 (276)	665,9 (16)
Export (% of sales)	8,5 (91)	13,7 (11)	8,4 (92)	9,0 (183)	16,0 (62)	28,9 (148)	6,3 (268)	12,1 (16)
Foreign ownership (% of capital)	5,6 (91)	5,7 (21)	2,0 (92)	0,4 (194)	11,1 (62)	12,0 (148)	0,4 (276)	17,7 (16)
Education (%,workforce, more 12 years)	8,7 (90)	21,2 (20)	10,7 (91)	17,2 (186)	3,2 (62)	8,5 (148)	4,9 (275)	8,8 (16)
Computer users (% of workforce)	19,5 (91)	22,4 (21)		16,1 (190)	8,9 (62)	11,0 (146)	5,4 (276)	20,5 (16)
Use of website (% of total firms)	76,9 (91)	61,9 (21)	21,7 (92)	25,9 (185)	19,4 (62)	15,3 (144)	6,9 (276)	62,5 (16)
External economic environment								
Electricity constraint +	33,0 (91)	28,6 (21)	28,3 (91)	28,7 (195)	37,1 (62)	8,1 (148)	42,4 (276)	12,5 (16)
Telecom constraint +	6,6 (91)	14,3 (21)	4,3 (92)	5,1 (195)	8,1 (62)	2,0 (148)	6,5 (276)	0,0 (16)
Transport constraint +	16,5 (91)	9,5 (21)	3,3 (90)	11,3 (195)	4,8 (62)	3,4 (148)	11,2 (276)	18,8 (16)
Financial constraint +	57,1 (91)	42,9 (20)	20,7 (66)	17,4 (195)	9,7 (62)	75,7 (148)	42,8 (275)	6,3 (16)
Overdraft facility (% of total firms)	78,0 (91)	76,2 (21)	6,5 (92)	65,1 (195)	64,5 (62)	67,6 (148)	18,5 (276)	100,0 (11)
Institutional environment								
Corruption +	67,0 (91)	33,3 (21)	43,5 (89)	36,9 (194)	9,7 (62)	15,5 (148)	41,7 (276)	6,3 (16)
Days for import	12,1 (30)	23,1 (12)	6,3 (26)	7,2 (54)	4,3 (21)	2,9 (97)	14,3 (21)	8,6 (13)
Days for export	6,4 (34)	12,2 (10)	4,5 (17)	4,6 (59)	2,6 (20)	1,7 (66)	12,4 (30)	4,8 (13)
Informal payments (% of sales)		8,5 (11)	5,4 (17)		0,1 (57)		2,2 (276)	0,0 (16)

Source. *World Bank*, ICA databases. + Percentage of firms mentioning the constraint as a major obstacle or a very severe constraint. Number of firms given in parentheses.

III. SFA and Adjusted efficiencies for environment

The first objective we pursue in this section is both to measure and explain firms' technical inefficiency through three g-categories of determinants reflecting organizational, economic and institutional factors. Following Coelli *et al* (1999)'s method, our second objective is to predict firm's production performance when all organizations share the most favorable empirical environment.

The stochastic frontier model that is estimated by the maximum likelihood method takes the following form:

$$Y_i = f(X_i, D, \beta) e^{V_i - U_i(Z_i, \delta)} \quad (1)$$

Yi is the output for the i-th firm and *Xi* a vector of inputs. *D* reflects country dummy variables capturing all sources of international heterogeneity. This heterogeneity is potentially correlated with factors reflecting the average firm technology as well as the quality of products or some other non observable invariant factors[2]. Labour (*L)* and capital (*K*) have been retained as inputs and f (.) is a suitable functional form. The stochastic frontier specification decomposes the total error term that we denote ε into two components: the usual random noise *V* and the asymmetric error term *U* (Z, δ), which depends on the inefficiency determinants, the so-called z-factors that affect the inefficiency distribution denoted *U* (see, Battese and Coelli 1995):

$$U_i = Z_i^{'} \delta + \eta_i \quad (2)$$

$Z_i^{'} = (1, z_{2i}, ..., z_{pi})$ is the vector of the p-1 variables (z_j) associated with the three categories of inefficiency determinants. η_i is a half normal variable $\left| N(0, \sigma_U^2) \right|$ and δ a (1xp) vector of parameters to estimate. These variables are assumed to be not correlated with the error components (U, V).

An important question to address when estimating the stochastic frontier model is the risk of endogenity of some of the business climate variables. Failing to control for it would mean that the error term and the regressors are correlated in a way implying biased coefficients. To tackle this problem, several methods can be used. A first method consists in using regional sector averages of the endogeneous variable (see Commander and Svejnar, 2008). The validity of this method is conditional upon the presence of poor and good

[2] The panel data associate both firms and countries. Country dummies are introduced to determine the heterogeneity that is not explained by technical inefficiency factors.

productive performers in each region. Moreover, if firms self-select into better climate locations for reasons we do not control for, we cannot distinguish the effect of the investment climate from the effect of location decisions. This self selection problem can be potentially restricted by limiting the calculation of the regional averages across firms to a specific category of small enterprisers. Indeed, these ones are very often family based and then, unlikely to choose their location by considering the quality of their external environment (see, Dollar et al, 2005)[3]. An other method, which is by far the best one, consists in resorting to the classical instrumental technique. Instruments have to be found, correlated with the specific z-factors but independent from the inefficiency component. Predicted values for the endogenous z-determinants, denoted $\hat{z}$, are introduced in the likelihood function to be maximized. Although the estimator is consistent, the bootstrapping procedure has to be used to provide correct standard errors[4] The procedure is as follows:

Step 1: The frontier is estimated by the maximum likelihood method (MLE) with instrumental variables ($\hat{z}$). Estimates of the two distribution variances are obtained ($\hat{\sigma}_v^2$ and $\hat{\sigma}_u^2$). The inefficiency components ($\hat{u}_i$) are estimated according to Jondrow *et al* (1980)'s method.

Step 2: For each bootstrap iteration b=1,…B, we generate a Gaussian random sample $\hat{v}_i^b \rightarrow N(0, \hat{\sigma}_v^2)$ according to its estimated characteristics in step 1[5].

Step 3: New bootstrapped samples for the endogenous variable are generated according to the equation: $Y_i^b = f(X_i, D, \hat{\beta})e^{\hat{v}_i^b - \hat{u}_i}$, where $\hat{\beta}$ are the estimated parameters of the technology obtained in step 1.

Step 4: Each bootstrapped sample is estimated by the MLE. The same experience is iterated (B = 500 times), allowing the calculation of the empirical parameters' standard errors.

Two technical efficiency measures are derived from the frontier model according to whether they are adjusted or not for the impact of the production environment. In so doing we determine the proportion of efficiency gains that could be observed under the hypothesis that all firms share some or the whole three dimension environment. Our method of adjustment is

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[3] Regional averages concerning characteristics of the external environment are also useful to complete firms missing information on non-behavioral z-factors.

[4] The estimated standard errors have to be corrected due to the use of $\hat{z}$ instead of the observed Z variables.

[5] The same method cannot be adopted for the u term as the Jondrow *et al* estimates do not provide perfect predictions of inefficiencies. This method does not provide estimates of u_i but the mean of the distribution from which u_i is generated (see Greene, 2008).

based on Coelli *et al's* (1999) although we refer not only to the best firm environment but also to a quantile to reduce the potential sensitivity of adjustments to measurement errors. The 95% quantile has been retained when the factor is favorable (e.g., access to an overdraft facility) and the 5% quantile when unfavorable (e.g., severe infrastructural constraints). Moreover, while Coelli et al. (1999) refer to the best relation combining all factors, our adjusted measures are made according to each of the g-category of the production environment. The method then allows predicting technical efficiency gains when, for example, in-house factors are modified, the other two g-categories being unchanged. The following formulas then apply: (3), (4), (5):

$$TE_i^a = \frac{Y_i}{f(X_i, D, \beta)e^{-U_i(Z_i^a,\delta)}} = e^{-U_i(Z_i^a,\delta)} \qquad (3)$$

where z_i^a is the adjusted vector of inefficiency determinants. The adjustment of the z_j variable depends on the sign of the δ_j coefficient. If δ_j <0, the z_j variable has a positive impact on efficiency. Then, firms' performances are adjusted according to the environment given by the upper quantile of this variable. In the opposite case (δ_j >0), adjustment is made by the lower quantile[6]:

$$\begin{aligned} z_{ji}^a &= \max(z_{ji}, q_{z_j}^{(1-\alpha)}) \text{ if } \delta_j < 0 \\ z_{ji}^a &= \min(z_{ji}, q_{z_j}^{(\alpha)}) \text{ if } \delta_j > 0 \end{aligned} \qquad (4)$$

where $q_{z_j}^{(\alpha)}$ is the α-quantile of the variable z_j. Coelli et al (1999) report the following adjusted inefficiency measure:

$$TE = E(\exp(-U_i^c) \mid \varepsilon_i) = \left\{\exp\left[-\mu_i^a + 0.5\sigma_*^2\right]\right\}.\left\{\Phi\left[\frac{\mu_i^a}{\sigma_*} - \sigma_*\right] / \Phi\left[\frac{\mu_i^a}{\sigma_*}\right]\right\} \qquad (5)$$

where $\Phi(.)$ denotes the distribution function of the standard Gaussian random variable. $\mu_i^a = (1-\gamma)Z'^a_i\delta - \gamma\varepsilon_i$; $\sigma_*^2 = \gamma(1-\gamma)(\sigma_u^2 + \sigma_v^2)$, $\gamma = \sigma_u^2/(\sigma_u^2 + \sigma_v^2)$. Z'^a_i is the adjusted vector of systematic influences on technical inefficiencies (4). By replacing the adjusted vector Z'^a_i by the firm observed vector Z'_i in (5), unadjusted inefficiency measures are obtained, the ratio of the adjusted to unadjusted measures providing the impact of the environments.

IV. Empirical results

[6] For firms evolving in an environment beyond (below) the upper (lower) quantile, adjusted and non-adjusted efficiencies measures are the same.

We comment upon the stochastic frontier estimations and then simulate the productivity gains that would result from the possibility for firms to evolve in most favorable environments we observe in the sample.

A. Stochastic frontiers with technical inefficiency determinants

The empirical work relates to 899 firms from the eight countries, allowing the estimation of a standard production frontier (e.g. without the z-factors). When inefficiency determinants are incorporated, according to the specifications of the model, the sample size varies from 840 to 821 firms. The loss of observations results from missing variables. Attrition can be a source of a selection bias affecting the shape of production technology and/or the influence of the z-factors on technical inefficiencies. The potentiality of a bias justifies the use of Heckman's procedure[7], and the introduction of the inverse Mills ratio in the models. The sample on which simulations of section IV are based includes 821 firms. By country, the number of enterprises is given in parentheses: Ecuador (11), South Africa (16), Sri-Lanka (55), Egypt (88), Brazil (90), Morocco (144), India (155), and Pakistan (262).

Table 3 provides the regression results of the "one step" stochastic frontier. The Cobb Douglas functional form is assumed to describe the production technology[8]. To check the heterogeneity of technology across countries, fixed effects are present in the specification of the production function. Statistically significant these effects are not reported in the table[9]. Country fixed effects have not been incorporated among the z-factors as we may expect that they are correlated with the county-distributions of efficiencies. The three columns differ by the way the inverse Mills ratio is introduced as an extra explanatory variable. The parameter associated to this extra regressor being not statistically different from zero there is no evidence of selection bias. The sum of input elasticities does not reject constant returns to scale. The labor coefficient is about 0.66 and reflects what is generally found in the literature for the relative contribution of wages in value- added, between 60% and 70%**.** As can be seen

[7] The estimation results of Heckman's first step selection provide a high percentage of correct predictions (Appendix 1).

[8] The use of a more flexible technology such as the translogarithmic one did not reveal any significant variation. The coefficients of the interaction terms proved non statistically significant and those of the primary inputs very close to the Cobb-Douglas coefficients. The Spearman Rank correlation between the two efficiency distributions is 0.98.

[9] Although textile products benefit a stronger homogeneity than other manufacturing goods, we alternatively tried to test heterogeneity according to the main firm product line but with a major inconvenience, the loss of a good deal of observations.

through the γ parameter, the standard error of the inefficiency component (σ_u) is significant and does not reject the relevance of the stochastic frontier model (SFA) against the alternative classical production function hypothesis where the error term would be the classical random disturbance. The conclusion we draw from the breakdown of this error is that about 30% of the total variance of the error can be attributed to firms' technical inefficiency[10].

For the impact of inefficiency determinants, we have controlled for the potential endogeneity bias according to the different methods we referred to. Standard errors have been bootstrapped by using the semi parametric method as discussed in section III. Appendix 2 reports the first step results for the three instrumented variables. In Table 3, predicted variables are signaled as follows (+). Perceptions depicting the external environments (e.g. electricity supply constraint, severity of the corruption phenomenon…) have been replaced by average firms' regional information to be as close as possible to the identification of the supply problem (++) limiting the risk of endogeneity.

[10] This percentage is calculated as follows : $\sigma_u^2/(\sigma_u^2+\sigma_v^2)$

Table 3 Stochastic frontiers incorporating individual z-factors

	Value-added (Model 1)	Value-added (Model 2)	Value-added (Model 3)
Production function			
Log (labor)	0.66	0.66	0.67
	(0.05)***	(0.05)***	(0.05)***
Log (capital)	0.32	0.32	0.33
	(0.02)***	(0.02)***	(0.02)***
Inverse Mills ratio		0.08	-0.38
		(0.56)	(0.70)
Inefficiency determinants			
Size	0.09	0.095	0.17
	(0.13)	(0.13)	(0.17)
Foreign ownership (% of capital)	-0.03	-0.03	-0.03
	(0.03)	(0.03)	(0.04)
Export (% of sales)	-0.001	-0.001	-0.001
	(0.002)	(0.003)	(0.003)
Overdraft facility+	-1.01	-1.01	-1.09
	(0.30)***	(0.33)***	(0.36)***
Electricity constraint ++	0.19	0.19	0.21
	(0.09)**	(0.09)**	(0.09)**
Education (% workforce, more than 12 years)	-0.01	-0.01	-0.01
	(0.008)	(0.008)	(0.01)
Financing constraint +	0.04	0.04	0.03
	(0.08)	(0.08)	(0.09)
Internet services +	-0.93	-0.93	-1.09
	(0.44)**	(0.44)**	(0.50)**
Manager’s experience (years, in the sector)	-0.02	-0.02	-0.02
	(0.008)***	(0.008)***	(0.009)***
Agglomeration (from large to small cities)	0.14	0.13	0.12
	(0.07)*	(0.08)*	(0.08)
Corruption ++	-0.07	-0.07	-0.05
	(0.08)	(0.08)	(0.08)
Inverse Mills ratio			-1.68
			(1.82)
Constant	0.74	0.73	0.78
	(0.50)	(0.50)	(0.52)
Observations	832	832	832
σ_u^2	0.34	0.34	0.29
σ_v^2	0.73	0.73	0.77
γ	0.32	0.32	0.27
	(0.13)***	(0.14)***	(0.16)**
Log Likelihood	- 1146.7	-1146.7	-1146.2

N.B: Bootstrapped standard errors with 500 replications in parentheses, *significant at 10%; ** 5%; *** 1%. Regressions include country fixed effects in the production function. **PS: ++,** average regional mean according to firm size; **+,** predicted variables. Regressions for instrumentation of the endogenous variables are provided in Appendix 2. All the external constraints of the environment have been calculated from answers: major obstacle, very severe obstacle.

The possibility for firms to benefit from overdraft facilities proves strongly correlated with relative productivity. Loans and overdrafts potentially mean fewer risks of disruption in the supply of raw materials and intermediary consumption, better ability to finance working capital and new investments. The empirical model also displays the significant impact of electricity constraints. The role of this factor has been evidenced in several studies including in Dollar *et al*. (2006). The influence of the agglomeration positively matters at a 90% level of confidence. In the enterprise survey, this variable being coded from large to small cities, the impact is consistent with hypotheses of agglomeration economies and/or firm selection hypotheses. Two in-house-organizational factors provide a statistically significant explanation of relative productivities. Top managers' experience, as measured by the number of years at the head of firms, points to a "learning by doing" effect while internet services highlight dynamic behavior in stimulating innovation and efficiently managing new information technologies.

Several firms' characteristics in ICA surveys do not prove relevant, including most variables reflecting firms' or regional perceptions concerning the institutional environment. These variables can be correlated with per capita GDP levels and then with country fixed effects. Firm size as well as the ownership structure or the export ratios are not correlated with firms' inefficiency. The non-significance remains when instrumentation is used, when we leave out the export ratio or foreign participation (see Commander and Svejnar, 2008)[11]. As variables of the models can be inter-correlated, previous results do not necessarily mean the absence of any correlation with technical inefficiency. By restricting the specification to a subset of indicators the omitted variable bias potentially arises (see Bastos and Nasir, 2004). An alternative method is the use of the Principal Component Analysis (PCA). This method encapsulates the impact of all inefficiency or z-determinants in each of the three indicators based on earlier defined g-categories (e.g., external economic environment, institutional environment, organizational know-how and in-house organization factors). The *principal components* (p_j) are orthogonal linear combinations of the original variables. A weighted average of these combinations is used to construct an aggregate indicator ($PCIND^g$)

[11] In this working paper, Commander and Svejnar refer to the 2005 and 2002 Business Environment and Enterprise Performance Surveys (BEEPS), collected by the European Bank for Reconstruction and Development (EBRD) and the World Bank. Firms are from a wide range of sectors in 26 transition countries.

where p_j^g is the principal component specific to each of the *g*-categories of variables and λ_j^g, the j-th eigenvalue of the covariance matrix[12].

$$PCIND^g = \frac{\lambda_1^g}{\sum_{j=1}^{M_g} \lambda_j^g} p_1^g + ... + \frac{\lambda_{Mg}^g}{\sum_{j=1}^{M_g} \lambda_j^g} p_{Mg}^g \quad (6)$$

For the institutional environment, ICA surveys suffer from being based on firms' perceptions which may be affected by a subjective assessment of institutions, including the difficulty for entrepreneurs to have a common reference of what an appropriate situation is. Therefore, the institutional $PCIND^g$ index has been calculated by adding specific country information provided by expert assessments of the World Bank's *Doing Business*. For the studied sector, Figure 1 displays how average efficiency distributions correlate with some institutional features. Note that the list of countries is more extended than the eight countries this paper deals with. Additional distributions relate to countries for which the information for technical efficiency calculation is available while ICA databases provide poor information for the analysis of the z-determinants. The use of the *Doing business* allows remedying this empirical problem, but only for the national institutional context that we matched with average country distributions. Some variables prove to be highly correlated with the productive performance as determined by the stochastic frontier without z-determinants[13]. The regression slopes mean that transaction costs potentially handicap production performance at all phases of firms' lifetime (e.g., starting a business, hiring and firing workers, obtaining credit, making contracts, winding up a business…).

For each of the three g-categories of factors, the different principal components that we consider for $PCIND^g$ explain at least 70% of the data variation. Appendix 3 reports the PCA indicators as well as the variables we used for their construction. In carrying out these PCA, previous treatments for variables suspected to be endogeneous have been used.

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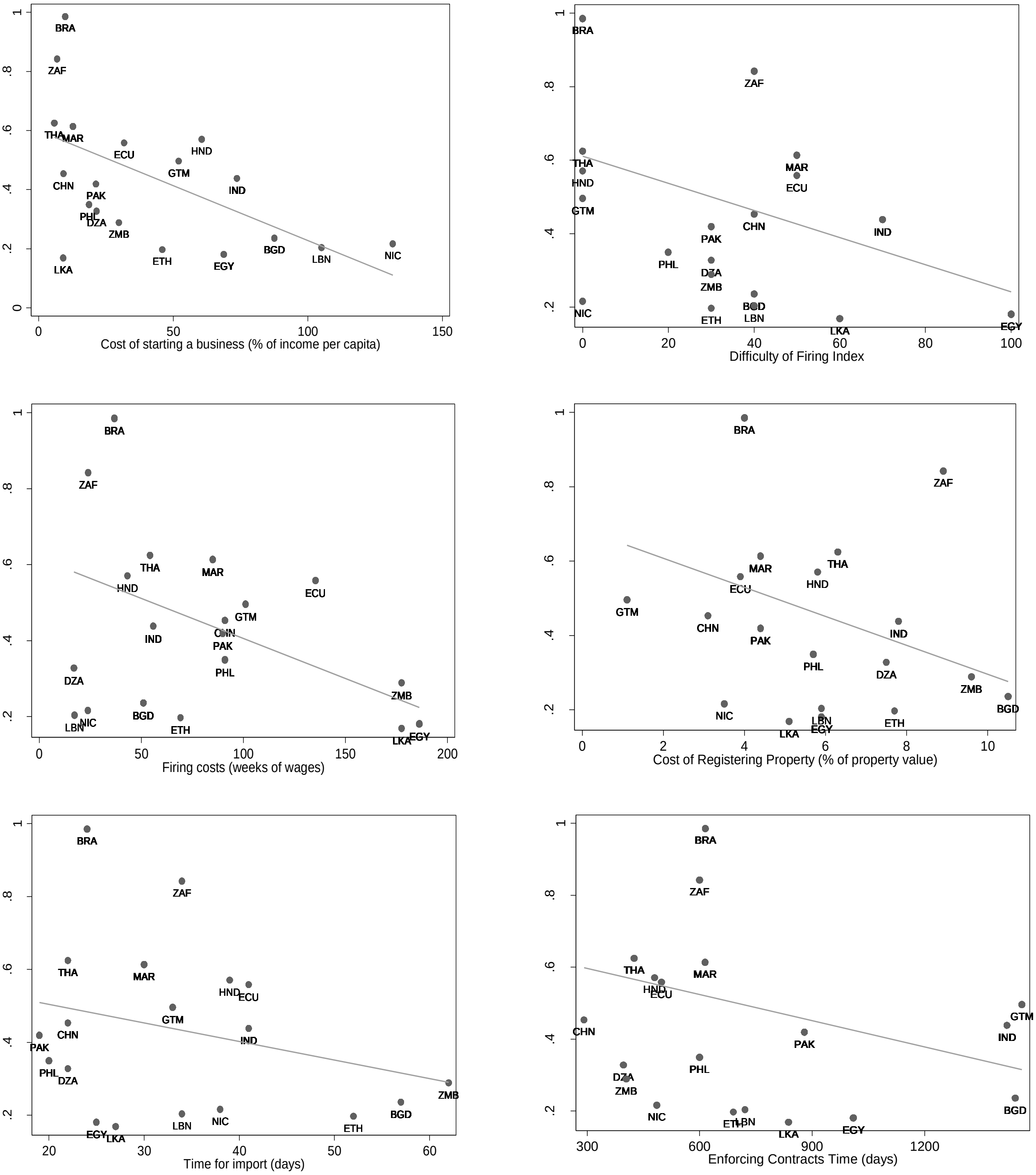
[12] The λ_j^g are usually presented in descending order. In a first step, and for each *g*-group of factors, we select the M_g number of principal components accounting for at least 70% of the cumulative variance. In a second step, we construct a weighted average, with weights being proportional to the contribution of each component to the explanation of the total variance. For the calculation of $PCIND^g$, all the variables have been standardized in order to present them in the same unit of measurement.

[13] Figure 1 refers to a larger sample of countries than the eight studied. The initial sample restriction was made because of the incompleteness of some country-based data that did not permit an estimation of the frontier with z-factors.

Figure 1 - Technical efficiency means and a selection of the main *Doing Business* variables



Nota Bene: Each graph plots the indicated governance indicator of the World Bank's *Doing Business* (horizontal axis) against the country mean efficiency scores in textile (vertical axis). The following sample of countries is considered: Algeria, Bangladesh, Brazil, China, Ecuador, Egypt, Ethiopia, Guatemala, Honduras, India, Lebanon, Morocco, Nicaragua, Pakistan, Philippines, South Africa, Sri-Lanka, Thailand and Zambia.

Table 4 Stochastic frontiers with principal components indices: z-determinant regrouped into three broad categories of factors.

	Value-added (Model 4)	**Value-added (Model 5)**	**Value-added (Model 6)**
Production function			
Log (labor)	0.66	0.65	0.65
	(0.04)***	(0.03)***	(0.03)***
Log (capital)	0.32	0.31	0.31
	(0.02)***	(0.02)***	(0.02)***
Inverse Mills ratio	-0.20	-2.20	-0.51
	(1.56)	(2.35)	(0.61)
Inefficiency determinants (PCINDs)			
Managerial know-how(in-house organization)	-0.85	-0.64	-0.65
	(0.34)***	(0.15)***	(0.13)***
Economic environment	0.21	0.16	0.16
	(0.07)***	(0.05)***	(0.05)***
Institutional environment		0.57	0.38
		(0.22)***	(0.16)**
Inverse Mills ratio	0.17	-2.53	
	(1.792)	(2.50)	
Constant	0.36	1.45	0.95
	(0.42)	(0.39)	(0.41)
	(0.588)	(0.607)**	(0.426)***
Observations	813	813	813
σ_u^2	0.39	0.55	0.48
	(0.20)	(0.17)	(0.19)
σ_v^2	0.72	0.55	0.60
	(0.068)	(0.10)	(0.10)
γ	0.35	0.50	0.45
	(0.12)	(0.09)	(0.10)
Log Likelihood	-1124.8	-1121.4	-1123.0

Bootstrapped standard errors with 500 replications in parentheses. Coefficients are significant at: *, 10%; **, 5%; ***, 1%. Regressions incorporate country fixed effects at the level of the production technology. For the institutional environment, the *PCIND* results from the combination of the *Doing Business* information and ICA variables reflecting corruption. For more details see: Appendix 3.

Table 4 shows the "one step" frontier estimates with the aggregate information *(PCINDs)*. Correct *MLE* standard errors of coefficients have been bootstrapped by using the semi-parametric procedure (see section III). Except for model 6, but with a negligible impact on the coefficients of Cobb Douglas technology, the sample selection bias is rejected. Again, the hypothesis of the frontier proves statistically relevant with an efficiency term (σ_u) accounting for about 30% of the variance of the total error term. In comparison with previous regressions where individual z-factors were considered, the coefficient of the production technology is marginally modified. Moreover, all *PCINDs* are significant at the 99% level. Variables being standardized through the principal component analysis, coefficients relating to $PCIND^g$ have the same unit of measurement simplifying the interpretation of relative impacts. Two or three $PCIND^g$ are considered in the regression results, according to whether the role of institutions is considered or not. The expected positive signs are found for the severity of the constraints underlying the institutional factors and the external economic environment, highest constraints increasing firms' inefficiency. On the contrary, a negative sign is obtained for the $PCIND^g$ reflecting the positive correlation between the quality of in-house managerial environment and efficiency. The magnitude of the coefficients suggests that in-house organizational impact is the most influential, followed by the role of institutions. Contribution of the economic environment is less, mainly composed of appreciations based on infrastructure and financial services.

Figure 2 and Table 5, which are both established from model 4 of Table 4, show that the South African (ZAF) textile manufacturing sector is the most technically efficient with a low standard deviation, suggesting homogeneity of efficiency over a small number of firms which are larger than those of the other countries (Table 1). In Brazil as well as in Ecuador, enterprises are also quite efficient with an average productivity gap of about 10% with respect to South Africa. Morocco ranks fourth with a gap of less than 20%. It is worth noticing that Asian countries, i.e. India, Pakistan and Sri Lanka, are significantly below the *best practice*. These three countries account for 57% of the number of firms underlying this empirical work. Textile manufacturing in Pakistan is by far the least productive of the eight countries with an average firms' productivity level two times less than in ZAF.

Table 5   Technical efficiencies: summary statistics (model 4)

Country	Mean	Median	Standard deviation	Coefficient of variation	Number of firms
Brazil (BRA)	.705	.730	.116	.165	90
Ecuador(ECU)	.688	.675	.077	.112	11
Egypt (EGY)	.571	.561	.152	.266	88
India (IND)	.576	.574	.156	.272	155
Sri Lanka (LKA)	.472	.447	.152	.323	55
Morocco (MAR)	.640	.659	.130	.203	144
Pakistan (PAK)	.396	.353	.152	.383	262
South Africa (ZAF)	.786	.796	.045	.066	16

N.B: efficiencies resulting from model 4, Table 4. The percentage of coefficient of variation is obtained by considering at the country level both the standard deviation and the mean. Technical efficiencies are potentially distributed from zero (fully inefficient) to one (the best practice).

If we look at what happens when the quality of institutions is taken into account, including the way the rules are defined and enforced, empirical results are then significantly modified (see Table 6 and Figure 3). In other words, some technical efficiency distributions are strongly affected by extensive regulations and weaknesses of public administrations; this is the case in India and Pakistan, but above all, in Egypt.

Table 6   Technical efficiencies: summary statistics (model 6)

Country	Mean	Median	Standard deviation	Coefficient of variation	Number of firms
Brazil (BRA)	.627	.646	.125	.199	90
Ecuador(ECU)	.642	.636	.073	.114	11
Egypt (EGY)	.191	.160	.120	.628	88
India (IND)	.290	.244	.150	.517	155
Sri Lanka (LKA)	.449	.423	.153	.341	55
Morocco (MAR)	.549	.577	.139	.253	144
Pakistan (PAK)	.317	.274	.150	.473	262
South Africa (ZAF)	.728	.740	.058	.080	16

N.B: efficiencies resulting from model 6, Table 4. The percentage of coefficient of variation is obtained by considering at the country level both the standard deviation and the mean. Technical efficiencies are potentially distributed from zero (fully inefficient) to one (the best practice).

-IV Robustness and adjustments of efficincies for the best environments

The robustness of econometric results conditions the quality of the statistical inference. Previous empirical analyses cared about endogeneity which was addressed by using different instrumentation methods. We also paid attention to the challenge of the attrition bias resulting from the variation of the sample size according to the specification of the stochastic frontier when technical inefficiency determinants are introduced in the model. Some additional statistical tests are implemented here. Our intention is to strengthen the statistical relevance of the simulations proposed at the end of the section where we assess the gains that could result from the possibility for all firms to evolve in the best empirical environments.

What do robustness tests suggest?

First, the endogeneity problem potentially remains if weak instruments have been used, enhancing biased estimation of parameters. This may occur because of correlations of the error term with the efficiency determinants or inputs[14]. To test the robustness to endogeneity a *post mortem* procedure has been carried out. For each suspected variable, both the instrumental (predicted) variable and its associated residuals have been jointly introduced in the frontier models, the significance of residuals coefficients reflecting the persistence of the endogenity bias. For the three models of table 3, the Chi-square test rejects the endogeneity suspicion (table7).

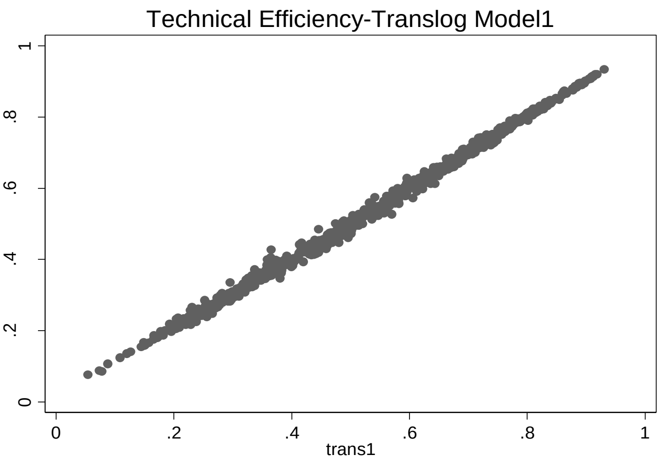
Table 7 Endogeneity test Results : Chi Square test Statistic

	Cobb Douglas		Translog	
	Statistic	P-value	Statistic	P-value
Model 1	4.75	0.19	3.69	0.297
Model 2	4.43	0.218	4.42	0.219
Model 3	5.02	0.170	4.37	0.225

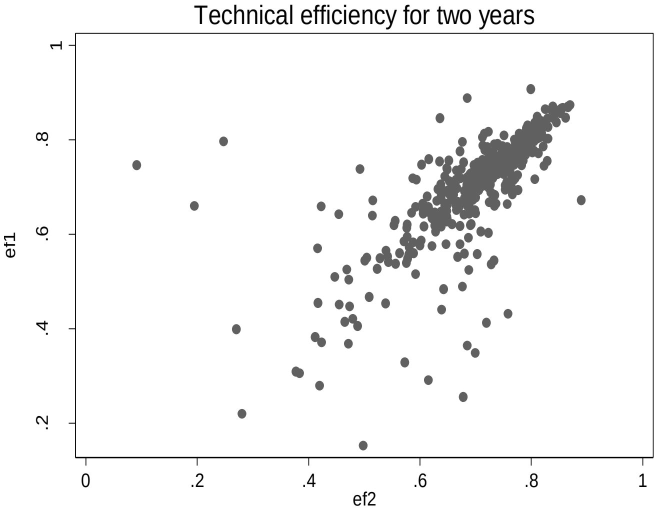
[14] We didn't refer to the latter possibility for practical reasons. Indeed, usual methods to address input endogeneity require a time dimension. If this one is absent from our sample (), input coefficients proved close to those we find in the applied literature, giving the intuition that the bias, if any, can be considered as negligible.

Second, the sensitivity of the results can be analyzed in relation with some hypotheses about the functional form of the technology or the u-term reflecting the asymmetric inefficiency term. There is no agreement as regard the shape of the statistical distribution of the U-term (half normal, normal truncated, exponential). The will to shed light on the explanatory factors of technical inefficiencies constraints the choice of the truncated-normal distribution which does not presume a concentration of firms around efficient observations. As regards the functional form of the technology, the homogenous Cobb-Douglas function is very standard but restricts the elasticity of substitution between capital and labor to unity and assumes that the returns to scale are fixed. The translog function is more flexible. As it imposes no homogeneity restrictions, it allows for convenient treatment of economies of scale and for the optimal scale to be determined. Moreover it permits the investigation of non homotheticity, large and small firms potentially using inputs in different proportions. As the chart 1 suggests, efficiency scores are highly correlated whatever the specification of the production frontier (Cobb-Douglas, translog).

Chart 1 Sensitivity to the functional form technology

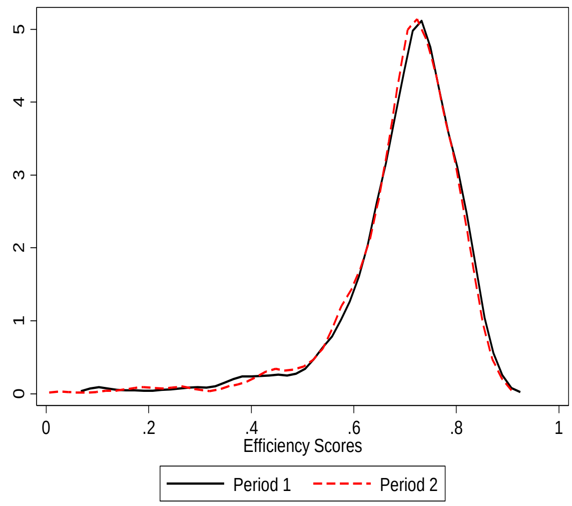


Third, the whole empirical analysis relies on a non standard panel data where firms and countries are pooled over a single period of time. In a pure cross sectional analysis, strong assumptions underlie the breakdown of the error term in its two components (*U, V)*. The empirical difficulty we face to get a time dimension proceeds from the lack of information about inefficiency effects which are only available for the surveying year while information about the production technology is provided for a two to three year period. To test the stability of efficiency distributions the standard Aigner *et al* (1977)'s specification (e.g., the stochastic frontier model without the z-factors) has been considered for two subsequent years.



The correlation of technical efficiency measures over the two years is quite good and gives the intuition of the equality of the distributions. This conclusion is not rejected when using a formal statistical test. Indeed, the non-parametric kernel estimates of efficiency density suggest that the two distributions are not different, the Li (1996) statistics[15] (0.009176) being not significant with p-values of 0.496.

Graph 1 - Kernel distribution of technical efficiency for two subsequent years:



[15] This statistics follows a standard normal variable, see details in the appendix of the Russel and Kumar's (2002) in the American Economic Review, june 2002

Adjusting technical efficiencies for the differences of the production environment

Producing in the most efficient environments provides new technical efficiencies that are reported in table 8 by considering both, the national and the international environments as well as the two definitions of the best environment previously defined (section 3). Adjustments aer made according to the specification of model 6, the best environment being considered for each of the three g-categories. The results that we obtained can be illustrated by looking at what happens for Egyptian enterprises. Adjustment for the quality of in-house organization proves the most significant one when the domestic environment is considered. The percentage gain of average technical efficiency, which is measured as follows:

$$\frac{Eff^{\,ajust} - Eff}{Eff} \text{ x } 100,$$

provides an improvement of 42%, average efficiency level arising from 0.19 to 0.27. The impact of the two other dimensions proves marginal, effective and hypothetical best environmental contexts being close. In other words, economic and institutional variables are quite homogenous across all domestic firms. Moving to the most efficient international scenarios greatly modifies the conclusions. The prevailing impact is then attached to institutions, average efficiencies more than doubling (from 0.19 to 0.39). Only for organizational factors do technical efficiency scores reveal sensitivity to the way best environments are defined.

Table 8 Adjusted Efficiency Scores to the best environment (Mean value)

Efficiency scores are distributed between 0 and 1

Countries	Non adjusted average efficiencies	Average efficiency scores											
		Best Domestic Environment						*Best International Environment*					
		In-house-org		*Economic*		*Institutions*		*In-house Org*		*Economic*		*Institutions*	
		(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Brazil (BRA)	.63	.71	.76	.67	.68	.64	.65	.69	.76	.67	.69	.63	.65
Ecuador(ECU)	.64	.70	.70	.67	.67	.65	.65	.67	.75	.66	.68	.69	.71
Egypt (EGY)	.19	.27	.29	.21	.21	.20	.20	.30	.42	.20	.22	.39	.41
India (IND)	.29	.39	.46	.32	.33	.30	.30	.39	.52	.32	.34	.47	.49
Sri Lanka (LKA)	.45	.55	.63	.49	.50	.46	.46	.61	.71	.50	.52	.48	.50
Morocco (MAR)	.55	.66	.76	.56	.57	.56	.56	.68	.76	.56	.58	.58	.60
Pakistan (PAK)	.32	.41	.58	.34	.38	.33	.33	.53	.65	.36	.38	.38	.40
South Africa (ZAF)	.73	.79	.79	.75	.75	.73	.73	.75	.80	.74	.75	.73	.73

(1) Measure with respect to the quantile of the 5% most efficient firm environment; (2) Measure with respect to the most efficient firm environment. Non-adjusted average efficiencies come from Table 5.

When the domestic frame is considered, technical efficiency gains are quite limited for South African firms, which prove to be homogenous while, on the contrary, gains are potentially important for Egypt. As regards Moroccan firms, the in-house environment accounts for about 90% of the potential improvement of average efficiency level while for the other countries it exceeds 70%. Therefore, improving the productive performance is first an outcome of the entrepreneurship. The economic environment ranks second, except for Morocco where it is outperformed by the role of institutions. Within this empirical frame, we don't find that modifying institutions would enhance a noticeable impact. When moving from the existing to the best domestic institutional environment, technical efficiency does not improve more than 10%. There is of course a logical explanation in this result. *Doing Business* information, which prevails in the calculation of the institutional PCA, gives a nationwide picture of this environment with no variation across regions. In this respect the international perspective increases the variance.

Indeed, adjusting efficiencies to the best international conditions changes the story. Institutions rank first for three countries with adjusted predictions enhancing strong efficiency gains. Under the influence of these variables, average efficiency more than doubles in Egypt. Although adjustments for India are less spectacular, the average performance would improve of about 60%. While in Egypt, the improvement of institutions overrides the other factors, it is not the case for Pakistan, Sri-Lanka and Morocco, where organizational factors are the most prominent determinants. Once again, the role of the economic environment proves negligible except for Sri-Lanka. Finally, and in accordance with the limitation underlying the "best practice" principle, adjustments prove to be of limited interest for South Africa, Brazil and Ecuador, where firms already benefit from the most productive environment within the empirical sample[16].

[16] The same exercise was carried out with no significant variations with the translog specification of the stochastic frontier. Results can be provided upon request.

V. Conclusion

Productive performance and its determinants have been studied for textile manufacturing by considering the "one step" stochastic frontier method. In the eight developing countries studied average firms' efficiency broadly reflects international per capita GDP differences. South Africa, Brazil, and to some extent Ecuador, define the *best empirical practice*. On the contrary, Egypt, India and Pakistan are poor productive performers with a high dispersion of efficiency across firms. The variance of firms' inefficiency depends on some factors connected with in-house organization, but also on external components such as the economic and institutional environment.

We find that the most influential inefficiency determinants are connected with access to an overdraft facility, but also with some infrastructural services such as power supply and access to modern technology or the Internet that affect the quality of knowledge about market conditions. Among the organizational variables, the experience of the top manager proves significant in accordance with a "learning by doing" effect. Competition also matters through the stimulating impact of the agglomeration effect. As inefficiency determinants are correlated, principal component analyses have been used to aggregate information through several indices encapsulating three broad categories of factors: managerial know-how (e.g. in-house organizational efficiency), external economic environment, and institutions.

Empirical results have shown that firm's productivity level is significantly influenced by these three broad categories of factors. Both managerial know-how and the institutional environment are by far the most influential components. These results have been extended by simulations where we predict the productivity gains that could be obtained if firms had the opportunity of evolving in a more favorable environment. At the domestic level, nation-based simulations suggest that in-house organizational determinants prevail. For the eight country-sector based studied, the relative contribution of this component exceeds 70% of the total cumulated productivity gains. Simulations in the international environment display much more important productivity gains. In this framework, institutions prevail for three countries: Egypt, India and Ecuador. In Egypt, firm productivity level would double. The role of the external environment including "hard infrastructure" is much less important. Productive performance may thus be increased by stimulating managerial efficiency and the driving mission of the State in the definition and application of efficient rules.

Appendix 1 - Probit results for the sample selection bias (Inverse Mills Ratio)

	Model for the frontier with the individual z-determinants	**Model for the frontier with the PCIND indices as z-determinants**
Firm Size (permanent employment)	-0.053	-0.199
	(0.082)	(0.089)**
Legal status of the firm	-0.686	-0.337
	(0.321)**	(0.215)
Individual firm	-0.570	-0.148
	(0.204)***	(0.283)
Family firm	-0.361	-0.352
	(0.170)**	(0.195)*
Constant	2.013	2.703
	(0.399)***	(0.365)***
Observations	899	899
% of correct prediction	69.30	77.09

N.B. The two models refer to the same sample of observations but differ by the endogeneous dichotomous variable. The construction of the PCINDs requires more information about a larger number of variables. Therefore the percentage of non respondent firms is different. Standard errors in parentheses; * significant at 10%; ** significant at 5%; *** significant at 1%. The regressions include countries dummies.

Appendix 2 - Regressions for instrumentation of endogenous variables

	Overdraft facility	Access to the financial Constraint	Access to internet
Size	-0.014 (0.018)	0.025 (0.060)	-0.020 (0.015)
Foreign ownership (% of capital)	-0.001 (0.001)	-0.001 (0.002)	0.000 (0.001)
Export (% of sales)	0.001 (0.000)	-0.001 (0.001)	0.001 (0.000)**
Overdraft facilities ++	0.978 (0.044)***	0.025 (0.133)	0.002 (0.041)
Electricity constraint ++	0.006 (0.014)	0.004 (0.041)	0.003 (0.011)
Education (% of workforce)	0.005 (0.001)***	-0.002 (0.003)	0.002 (0.001)**
Access to financial constraint ++	-0.002 (0.012)	1.012 (0.040)***	0.008 (0.013)
Access to internet ++	-0.002 (0.045)	-0.002 (0.114)	0.991 (0.037)***
Experience of top manager	0.001 (0.001)	-0.005 (0.004)	-0.001 (0.001)
Agglomeration	-0.002 (0.014)	0.007 (0.039)	0.001 (0.012)
Corruption constraint ++	-0.003 (0.013)	-0.003 (0.044)	-0.001 (0.011)
Constant	0.214 (0.227)	0.727 (0.534)	-0.048 (0.149)
Observations	1031	1001	1023
R-squared	0.55	0.48	0.49

Robust standard errors in parentheses
* Significant at 10%; ** significant at 5%; *** significant at 1%. Regressions include country dummies
PS: ++ Regional mean by firm size**.**

Appendix 3 - Principal Components Analyses

Eigenvectors														
Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
_1++	0,22	0,04	-0,12	-0,47	0,09	0,71	0,31	0,01	0,26	0,06	-0,13	0,08	-0,10	0,04
_2	0,39	0,06	0,03	0,03	-0,08	0,05	0,08	-0,28	-0,55	-0,11	-0,38	-0,43	-0,01	0,26
_3	0,06	0,44	0,29	-0,05	-0,04	0,05	-0,14	-0,51	-0,07	-0,31	0,15	0,54	-0,08	0,07
_4	0,21	0,39	0,07	0,23	-0,10	-0,15	-0,09	0,20	0,31	0,22	-0,49	0,04	-0,35	0,19
_5	-0,02	0,44	0,25	-0,08	-0,04	-0,23	0,46	0,33	0,18	-0,16	0,03	-0,08	0,41	0,12
_6	0,34	-0,06	0,34	-0,30	-0,17	0,00	-0,20	0,08	0,00	-0,07	0,19	-0,23	0,37	-0,04
_7	0,32	-0,20	0,25	0,09	-0,04	-0,15	-0,01	-0,41	0,57	0,13	0,16	-0,28	-0,14	-0,14
_8	0,34	-0,21	0,26	0,11	0,10	-0,05	0,12	0,09	-0,21	0,36	-0,28	0,48	0,25	-0,41
_9	0,10	-0,09	0,23	0,16	0,88	0,05	-0,11	0,11	0,04	-0,20	0,01	-0,05	0,00	0,24
_10	0,26	0,19	-0,46	-0,17	0,08	-0,06	-0,61	0,06	0,14	0,09	-0,05	0,08	0,36	0,08
_11	0,39	0,00	-0,19	0,02	-0,05	-0,09	0,00	0,33	-0,02	-0,61	0,06	0,02	-0,34	-0,44
_12	0,36	-0,21	-0,05	-0,03	-0,14	-0,14	0,12	0,23	-0,14	0,19	0,46	0,27	-0,24	0,56
_13	0,22	0,03	-0,41	0,59	-0,02	0,16	0,31	-0,21	0,13	-0,11	0,14	0,06	0,37	0,05
_14	0,04	0,41	0,17	0,32	-0,01	0,43	-0,18	0,21	-0,20	0,31	0,40	-0,23	-0,11	-0,23
__15	0,10	0,33	-0,29	-0,30	0,36	-0,39	0,28	-0,23	-0,16	0,31	0,20	-0,12	-0,14	-0,24

N.B: ++ Regional average by firm size: **Starting a business**: (1) Corruption constraint: number of procedures, (2) cost (% of income per cap), (3) min capital (% of income per cap); **Hiring and Firing worker**: (4) difficulty of firing index, (5) cost of firing (weeks of salaries); **Registering property**: (6) time (days), (7) cost of property value; **Trading across borders**: (8) time for import, (9) cost to import, (us dollar per container); **Enforcing contracts**: (10) number of procedures, (11) time (days) and (12) costs (% of income per capita); **Closing a business**: (13) time (years); **Dealing with licenses**: (14) number of procedures and (15) cost (% of income per capita)

PCA			
Components	Eigenvalues	Proportions	Cumulative
1	5,65	0,38	0,38
2	3,71	0,25	0,62
3	1,29	0,09	0,71
4	1,15	0,08	0,79
5	1,03	0,07	0,86
6	0,75	0,05	0,91
7	0,42	0,03	0,93
8	0,33	0,02	0,96
9	0,24	0,02	0,97
10	0,15	0,01	0,98
11	0,08	0,01	0,99
12	0,07	0,00	0,99
13	0,07	0,00	1,00
14	0,03	0,00	1,00
15	0,01	0,00	1,00

***Principal Component Index (PCIND[9])*: Managerial know-how and in-house organization**

Eigenvectors								
Variables	1	2	3	4	5	6	7	8
1- Formal training	0,44	0,09	-0,03	-0,45	0,25	0,20	0,61	0,34
2- Education (% of workforce)	0,34	-0,14	0,54	0,40	-0,10	-0,44	0,41	-0,22
3- Access to internet+	0,49	0,15	-0,09	-0,35	-0,08	0,07	-0,22	-0,74
4- Education of top manager	0,26	-0,60	0,16	0,23	0,50	0,43	-0,27	-0,01
5- Experience of top manager	0,05	0,75	0,37	0,31	0,24	0,36	-0,12	0,03
6- Foreign ownership (% of capital)	0,22	0,18	-0,62	0,37	0,48	-0,41	0,00	-0,01
7- Export (% of sales)	0,29	-0,03	-0,37	0,46	-0,57	0,46	0,17	0,06
8- Overdraft facilities+	0,50	0,05	0,13	-0,09	-0,24	-0,28	-0,55	0,54

+ predicted variables (Regressions in Appendix 2)

PCA			
Components	Eigenvalues	Proportions	Cumulative
1	2,23	0,28	0,28
2	1,07	0,13	0,41
3	1,02	0,13	0,54
4	1,00	0,12	0,66
5	0,88	0,11	0,77
6	0,76	0,10	0,87
7	0,55	0,07	0,94
8	0,49	0,06	1,00

***Principal Component Index (PCIND[9])*: External economic environment**

Eigenvectors					
Variables	1	2	3	4	5
1- Agglomeration	0,13	0,69	0,70	0,05	0,10
2- Electricity constraint++	0,56	0,20	-0,20	0,10	-0,77
3- Telecom constraint++	0,56	0,06	-0,28	0,53	0,57
4- Transport constraint++	0,55	-0,15	0,07	-0,78	0,24
5- Access to financial constraint+	0,23	-0,67	0,62	0,31	-0,13

++ Regional mean averages by firm size; + predicted variables (see Appendix 2)

PCA			
Components	Eigenvalues	Proportion	Cumulative
1	1,98	0,40	0,40
2	1,11	0,22	0,62
3	0,87	0,17	0,79
4	0,55	0,11	0,90
5	0,48	0,10	1,00

Appendix 4 - Heckman's sample selectivity correction

In a first regression a Probit model is estimated as follows:

$$h_i = W_i\theta + \omega_i \qquad (7)$$

h_i is a dummy variable which takes the value 1 when the firm gives the full information on all the variables needed for the "one step" method, and 0 if we only have partial information. W_i is the vector of firm characteristics, with some of them underlying the attrition of the initial sample and θ the parameters to be estimated while ω_i is the usual random error term. The variables retained and the estimation results are reported in Appendix 1. The measurement of Heckman's selection bias is obtained after the estimation of the Probit model according to: $\rho_i = \frac{\phi(W_i\theta)}{\Phi(W_i\theta)}$ (8), where $\phi(.) \text{and} \Phi(.)$ refer to the normal probability and the normal cumulative distribution, respectively. The factor correction is the inverse Mills ratio denoted ρ_i. As we don't know where the potential bias arises, this factor has been potentially introduced in the production technology (1) and/or in the inefficiency determinants (2).

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