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

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Production frontiers and inefficiency determinants are estimated by using stochastic 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 (e.g. managerial organization, economic environment, institutions) by using principal component analyses. 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. 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. For this analysis, domestic and international levels are considered, respectively. When focusing on domestic benchmarks, the contribution of organizational factors prevails for all countries. The role of institutions proves dominant for three countries (Egypt, India, and Ecuador) when we refer to international simulations.

I- Introduction

Competitiveness can be a "dangerous obsession" for nations; but in the context of the world economy it is a paramount constraint for the survival of firms (see Krugman, 1994). Beyond the impact of macroeconomic policy, especially the exchange rate instrument that modifies domestic relative prices, the competitiveness of firms depends on the productive performance, which is influenced by producers' behavior as well as their external environment. Based on a standardized questionnaire, World Bank surveys on the Investment Climate Assessment (ICA) have encouraged the emergence of empirical literature on this issue. Recent papers by Dollar *et al* (2005, 2006) or by Eifert *et al* (2007) fall into this category.

The present study relies on the empirical exploration of firms' data for textile manufacturing in eight developing countries in the early 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 international panel. We make use of the technical inefficiency concept and appraise the respective importance of economic, institutional and in-house organizational determinants on firms' productivity levels. Four reasons underlie the interest for textile manufacturing. (i) First of all, it is one of the most important manufacturing sectors in the developing countries studied. For example, production and transformation of fibers account for more than one third of the added value or formal employment in Morocco and Egypt, encompassing several hundreds of firms. (ii) Secondly, 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 over thirty years (1974-2005). New competitive pressures resulted from this evolution with world prices tending to fall in terms of

US dollars. To face this price erosion, firms' productivity has to increase to preserve profitability. (iii) Thirdly, the heterogeneity of products is also rather less than in other sectors, although in some middle income economies product differentiation forms a strategy of upgrading to respond to competition from low labor cost emerging countries. (iv) Lastly, and related to the previous argument, technology differs somewhat across firms and countries, but heterogeneity is rather less than in more sophisticated sectors.

This paper focuses on the measurement and explanation of technical inefficiencies or relative firms' productivity levels. World Bank Investment Climate (ICA) surveys possess valuable characteristics including the use of a standard questionnaire providing homogeneous data on firms' production, investment and employment decisions. ICA surveys also cover various factors dependent upon public regulation, governance, and access to finance or infrastructural services. First of all, the "one-step" formulation of stochastic production frontiers (SFA) is adopted by considering three categories of inefficiency determinants (e.g. economic, institutional and in-house organizational factors). In-house organizational factors are found to be important. Entrepreneurship matters more than external economic factors which are captured by a limited number of variables reflecting access to financing, the quality of public services or the size of the city where firms are located. The role of institutions is more ambiguous. On the one hand, they have a limited effect over firms or domestic geography but, on the other hand, they have a strong impact on the determination of productivity differences between countries, especially when *Doing Business* information complements ICA data. Secondly, stochastic frontier models and inefficiency determinants are used to predict potential productivity gains if firms operate in a homogeneous context (e.g. the most favorable environment). These predictions are based on the adjusted efficiency measures as proposed by Coelli et al (1999). These adjustments are made in respect of the most favorable production context. 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 the empirical results. Section 5 concludes by summing up the main results.

II- The sector-based ICA data

At firms' level, productivity depends on a wide range of factors. For convenience, the information from World Bank ICA surveys can be regrouped into three categories, hereafter called g- categories.

The external economic environment. The quality of roads, transport, 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.

Although the causality between these variables is subject to debate, 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 trade restrictions. ICA surveys incorporate several items addressing these points.

To determine the level of competition, the size of the city as measured by the number of inhabitants potentially matters. A "quiet life" and managerial inefficiency are likely as well as a non-optimal scale of production when firms evolve in areas with a limited population. 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 leads to copying among producers. 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.

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 bureaux 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. In the 2005 issue, the *World Development Report* showed that a national law can be applied differently within a country. The time taken to transfer property title in Brazil varies between 15 days in Brasilia and 65 days in Salvador. 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 the number of calendar days, the number of procedures and the cost required to complete various types of business transactions. These procedures may be in relation to starting or closing a business, dealing with licences 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.

Managerial know-how. 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. 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. In some large economies, such as China and India, the World Bank's Investment Climate surveys found that garment manufacturers are more productive when telecommunication services are better. The availability of these services relates to the exogenous economic environment. But a regular use of a Website is more focused on the demand side, revealing firms' ability to achieve quick and cheap interaction with customers and suppliers. Foreign companies can be seen as an additional source of know-how connected with good practice 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 1. We regroup them into the three above-mentioned g-categories; the number of firms being given in parentheses under the variable. On average, South African firms are both large and open, as shown by the export sales ratio or the participation of foreigners in the ownership. The opposite situation is observed 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 in 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 the production in small enterprises. 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 and conflicts sometimes with information about overdraft facilities. In Morocco, although 67% of the 148 respondent firms benefit from these 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 (43.0 %). 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 1 Main variables reflecting organizational, economic and institutional environments: country means (observations in parentheses)

Countries	Brazil	Ecuador	Egypt	India	Sri Lanka	Morocco	Pakistan	South Africa
Organizational environment								
Size	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 (% of workforce)	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)
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 access 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 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 favourable environment.

The stochastic frontier model 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 the heterogeneity of the production technology across countries[1]. 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 $|N(0, \sigma_U^2)|$ and δ a (1xp) vector of parameters to estimate. These variables are assumed to be not correlated with the error components (U, V).

The model is estimated by the maximum likelihood method. An endogeneity problem may arise from some variables, inefficient producers justifying a low technical efficiency by the poor quality of power supply or the acuteness of public corruption. To address this issue, a first method consists in using regional sector averages of the endogeneous variable (see Commander and Svejnar, 2008). The validity of this method depends upon both, the presence of poor and good productive performers in each region and a suitable correlation between the regional average and the endogeneous variable[2]. An alternative method is 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. The procedure is as follows:

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

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

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: Gaussian random sample are generated for the $\hat{v}^* \rightarrow N(0, \hat{\sigma}_v^2)$ vector according to its estimated characteristics in step 1. The same method cannot be adopted for the u term as the Jondrow *et al* estimates do not provide perfect predictions of inefficiencies[3].
Step 3: New bootstrapped samples for the endogenous variable are generated according to the equation: $Y_i^* = \hat{Y}_i + (v_i^* - \hat{u}_i)$, where $\hat{Y}_i$ are the predicted values and $\hat{u}_i$, the inefficiency components estimated in step 1.
Step 4: Each bootstrapped sample is estimated by the MLE. The same experience is iterated 500 times allowing the calculation of the empirical parameters' standard errors.

Two efficiency measures are derived from the frontier model according to whether they are adjusted or not in respect of production in the most favorable environment. Our method of adjustment is based on Coelli *et al's* (1999) but is different on two points. First of all, the reference environment is defined by the 95% quantile when the factor is favorable (e.g., access to an overdraft facility) and the 5% quantile in the opposite case (e.g., severe infrastructural constraints). The choice of a quantile avoids the sensitivity to outliers. Secondly, while Coelli et al. (1999) refer to a linear combination of all factors, our adjusted measures are made according to each of the three above- mentioned g-categories of the production environment respectively. For example, efficiency predictions with good organizational factors are obtained keeping the other two categories unchanged. The following formulas then apply: (3), (4), (5)

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

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[4]:

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

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

[3] Jondrow *et al*'s method does not provide estimates of u_i but the mean of the distribution from which u_i is generated (see Greene, 2008).
[4] For firms evolving in an environment beyond (below) the upper (lower) quantile, adjusted and non-adjusted efficiencies measures are the same.

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

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

We comment upon the stochastic frontier estimations and then simulate the production performance resulting from the possibility for firms to evolve in most favourable environments.

SFA models with technical inefficiency determinants

Investment Climate surveys rely on large random samples of firms that reflect the true sector-based population of each country. Combining firms and countries has some advantages. First of all, statistical inference can be carried out on average country distributions of inefficiency, reducing the variance of the residual term we would observe in a *pure* cross-sectional analysis. Secondly, through the set of country-dummies, we check the time invariant heterogeneity common to all firms. The empirical work relates to eight developing countries with a total of 899 firms 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. These can be the source of a selection bias affecting the shape of production technology and/or the z-factors influencing technical inefficiency. The potentiality of a bias justifies the use of Heckman's procedure[5], and the introduction of the inverse Mills ratio in the models. The sample on which simulations of sub-section 4.2 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 2 provides the regression results of the "one step" frontier. The Cobb Douglas functional form is assumed to describe the production technology[6]. To check the heterogeneity of technology between countries, fixed effects are present in the specification of the production function. These effects are statistically significant but not reported in the table.

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

[6] The mean technical efficiency measures that are reported in Table 4 are obtained under a hypothesis of Cobb-Douglas technology. 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 invariant 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.

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 0.67 and reflects the contribution we generally find in the literature for the relative contribution of wages in added value, between 60 % and 70%. The standard error of the inefficiency component (σ_u) is significant and does not reject the relevance of the SFA against the alternative production function hypothesis where the error is the classical random disturbance term. About 30% of the total variance of the error can be explained by firms' technical inefficiency[7].

For the impact of inefficiency determinants, the potential endogeneity bias has been checked by using th*e instrumental variable* technique. Standard errors have been bootstrapped according to the semi parametric method we discussed in section III. Appendix 2 reports the first step results for the three instrumented variables. In Table 2, we refer to predicted variables by (+). Perception depicting the external environment (e.g. electricity supply constraint, severity of the corruption phenomenon…) has been replaced by firms' regional capacities according to firms' size (++).

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

Table 2 Stochastic frontiers incorporating individual z-factors

	Added value (1)	Added value (2)	Added value (3)
Production function			
Log (labor)	0.666	0.669	0.669
	(0.048)***	(0.048)***	(0.047)***
Log (capital)	0.321	0.322	0.322
	(0.022)***	(0.022)***	(0.022)***
Inverse Mills ratio		-0.402	-0.324
		(0.541)	(1.060)
Constant	2.653	2.655	2.647
	(0.304)***	(0.337)***	(0.400)***
Inefficiency determinants			
Size	0.103	0.089	0.116
	(0.109)	(0.110)	(0.108)
Foreign ownership (% of capital)	-0.029	-0.027	-0.029
	(0.054)	(0.051)	(0.052)
Export (% of sales)	-0.001	-0.001	-0.001
	(0.004)	(0.004)	(0.004)
Overdraft facility+	-1.002	-1.006	-1.007
	(0.304)***	(0.308)***	(0.309)***
Electricity constraint ++	0.181	0.189	0.189
	(0.076)**	(0.075)**	(0.080)**
Education (%, workforce)	-0.009	-0.009	-0.010
	(0.009)	(0.009)	(0.008)
Access to financing constraint +	0.065	0.059	0.061
	(0.064)	(0.067)	(0.065)
Internet services +	-0.955	-0.977	-0.996
	(0.415)**	(0.420)**	(0.442)**
Manager's experience	-0.021	-0.021	-0.022
	(0.008)***	(0.008)***	(0.008)***
Agglomeration	0.133	0.135	0.132
	(0.070)*	(0.067)*	(0.069)*
Corruption ++	-0.077	-0.077	-0.075
	(0.063)	(0.062)	(0.063)
Constant	0.691	0.724	0.715
	(0.462)	(0.478)	(0.558)
Inverse Mills ratio			-0.294
			(1.310)
Observations	840	840	840
σ_u	0.56	0.57	0.56
	(0.204)	(0.199)	(0.212)
σ_v	0.86	0.86	0.86
	(0.061)	(0.067)	(0.075)
Wald chi2	822.62	829.71	806.66
Prob > chi2	0.00	0.00	0.00

N.B: Bootstrapped standard errors with 500 replications in parentheses, *significant at 10%; ** 5%; *** 1%. Regressions include country dummies 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

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 grouping as characterized by population size positively matters at a 90% level of confidence. Two in-house-organizational factors provide an explanation. Top managers' experience, as measured by the number of years at the head of firms, points to a "learning by doing" effect. Internet services are also statistically significant, highlighting 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)[8]. As variables can be inter-correlated, previous results do not necessarily mean the absence of any correlation with 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 has the additional and valuable advantage of encapsulating the impact of all inefficiency determinants in three indicators based on earlier defined g-categories (e.g., economic, institutional and in-house organizational 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 *($PCIND^g$)* 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[9].

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

For the institutional environment, ICA surveys suffer from being based on firms' perceptions which may be affected by a subjective assessment of institutions. Therefore, the institutional $PCIND^g$ index has been calculated by incorporating specific additional country information provided by expert assessments obtained from the World Bank's *Doing Business*. Figure 1 suggests that some variables of *Doing Business* are highly correlated with average efficiency distributions between countries as defined by a standard stochastic frontier without

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8 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.

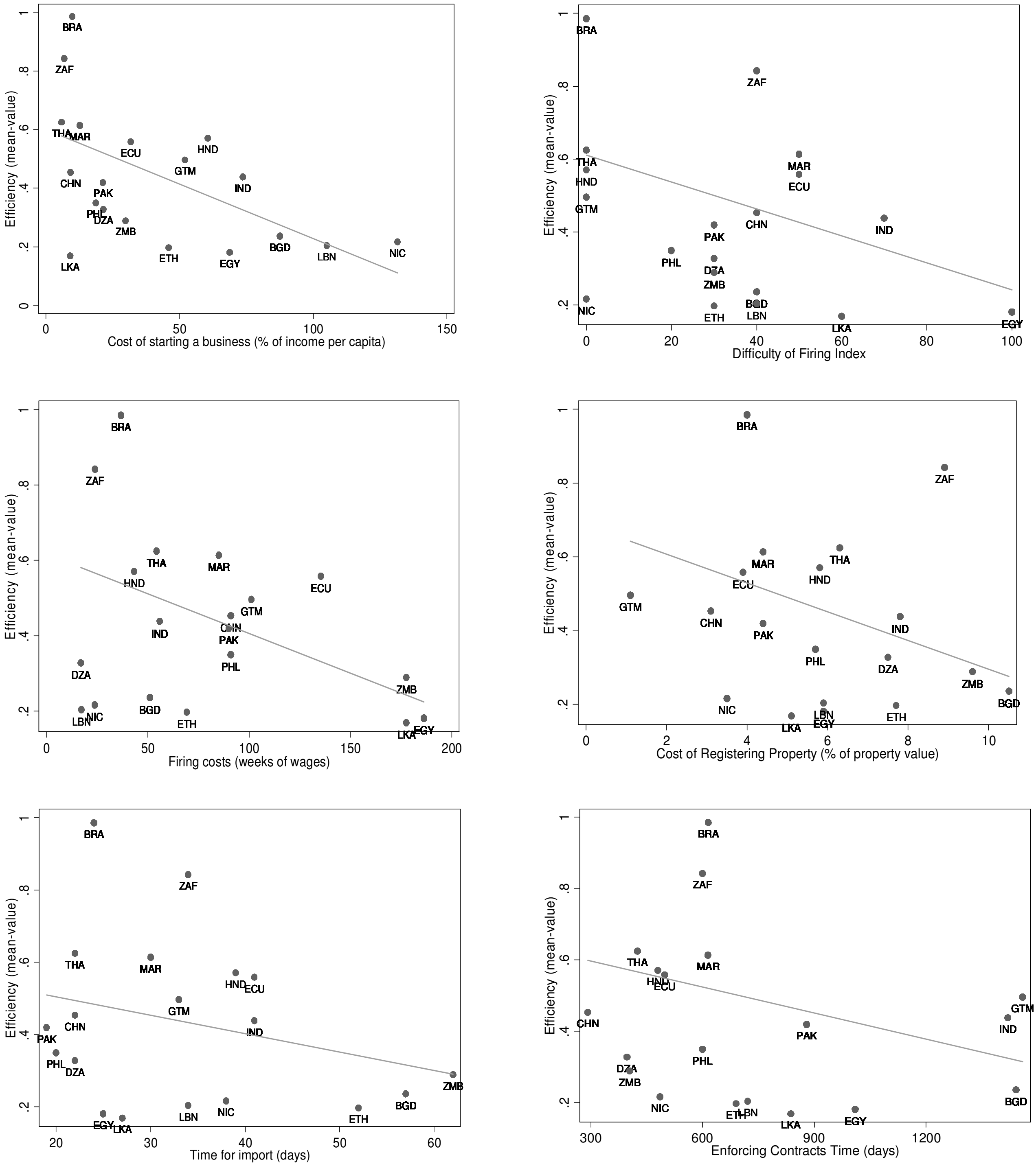
9 The λ_j^g are usually presented in descending order. In a first step, and for each *g*-group of factors, we select the M_g number of principal components accounting for at least 70% of the cumulative variance. In a second step, we construct a weighted average, with weights being proportional to the 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.

z-determinants[10]. 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, variables that were previously suspected to be endogeneous have been instrumented.

[10] 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 (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 3 Stochastic frontiers with principal components indices for the z-determinants

	Added-value (1)	Added value (2)	Added value (3)
Production function			
Log (labor)	0.679	0.670	0.671
	(0.038)***	(0.033)***	(0.034)***
Log (capital)	0.314	0.312	0.312
	(0.020)***	(0.018)***	(0.018)***
Constant	2.616	2.900	2.817
	(0.316)***	(0.328)***	(0.314)***
Inverse Mills ratio	-0.576	-2.221	-1.274
	(1.558)	(2.345)	(0.613)**
Inefficiency determinants *(PCINDs)*			
Organizational environment	-0.873	-0.616	-0.628
	(0.341)***	(0.153)***	(0.132)***
Economic environment	0.206	0.146	0.148
	(0.074)***	(0.049)***	(0.047)***
Institutional environment		0.549	0.419
		(0.217)***	(0.164)***
Constant	0.190	1.340	1.024
	(0.588)	(0.607)**	(0.426)***
Inverse Mills ratio	0.974	-1.422	
	(1.792)	(2.503)	
Observations	821	821	821
σ_u	0.62	0.72	0.69
	(0.204)	(0.174)	(0.185)
σ_v	0.85	0.75	0.77
	(0.068)	(0.103)	(0.097)
Wald chi2	1582.63	1573.59	1547.98
Prob > chi2	0.00	0.00	0.00

Bootstrapped standard errors with 500 replications in parentheses. Coefficients are significant at: *, 10%; **, 5%; ***, 1%. Regressions include country dummies 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 3 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). Country-fixed effects are not reported in this table but are introduced in the production technology. The sample selection bias has been tested on both the frontier and the z-factors through the inverse Mills ratio. Except for regression (3), but with a weak impact on the coefficients, the 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 incorporated, 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*[8] have the same unit of measurement simplifying their interpretation. 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 intra-organizational impact is the most influential, followed by the role of institutions. The economic environment, mainly composed of appreciations based on "hard infrastructure", is much less relevant.

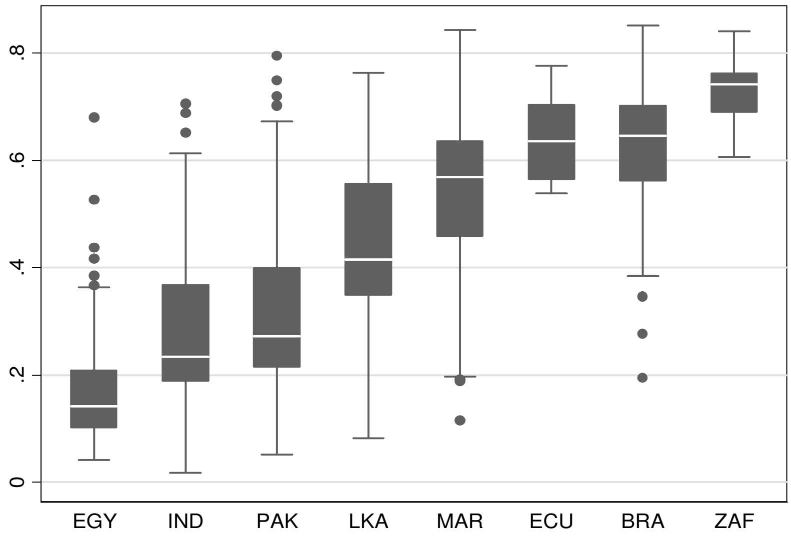
Figure 2 and Table 4, which are established from regression (3) of Table 3, show that the South African (ZAF) textile manufacturing sector is the most technically efficient one within the sample with a low standard deviation, suggesting homogeneity of efficiency over a small number of firms which are 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 13% with respect to South Africa. Morocco ranks fourth with a gap of 25%. It is worth noticing that the two large Asian countries, i.e. India and Pakistan, are well below *best practice*. These two countries account for about 50% of the number of firms underlying this empirical work. Textile manufacturing in Egypt is by far the least productive of the eight countries with an average firms' productivity level three times less than in ZAF.

Table 4 Summary statistics about technical efficiencies

Countries	**Mean**	**Median**	**Standard deviation**	**Coefficient of variation**	**Number of firms**
South-Africa (ZAF)	0,73	0,74	0,06	8%	16
Brazil (BRA)	0,63	0,65	0,12	19%	90
Ecuador (ECU)	0,64	0,64	0,07	10.9%	11
Morocco (MAR)	0,54	0,57	0,14	25.9%	144
Sri-Lanka (LKA)	0,45	0,41	0,15	33.3%	55
Pakistan (PAK)	0,32	0,27	0,15	46.9%	262
India (IND)	0,28	0,23	0,15	53.6%	155
Egypt (EGY)	0,18	0,14	0,11	61.1%	88

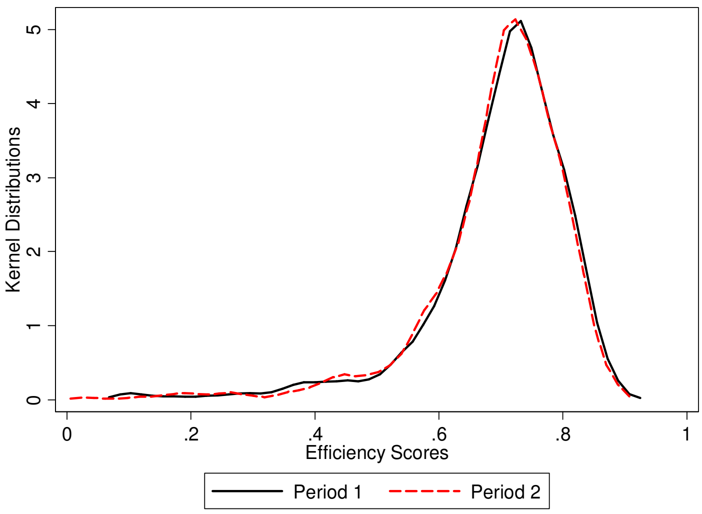
N.B.From regression (3), Table 3; the percentage of coefficient of variation is obtained by considering at the country level both the standard deviation and the mean.

Figure 2 International distribution of efficiency measures



One question that deserves particular attention for both the robustness of our analysis and the relevance of the relative productivity simulations carried out in 4.2, is to ascertain whether the results are sensitive or not for a specific year. In respect of production technology, ICA databases contain the data for the year surveyed and one or two previous years. Unfortunately, this is not the case for the inefficiency determinants as respondents only characterize the current year. Therefore, although some countries were surveyed twice, the "one step" frontier model cannot be estimated under the conventional time-series-cross-sectional panel data form. In a cross sectional analysis, strong assumptions underlie the breakdown of the composed error model in its *U* and *V* terms. The stability of efficiency distribution as determined by the application of the standard Aigner *et al* (1977)'s specification of the stochastic frontier model (e.g., without the z-factors), was tested for two subsequent years.

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



Efficiency measures being estimated rather than observed, the non-parametric kernel estimates of efficiency density were used. Kernel distribution reported in graph 1 shows that the two distributions overlap. More formally, the Li (1996) statistics[11] (0.009176), with p-values of 0.496 does not reject the equality of the two empirical distributions.

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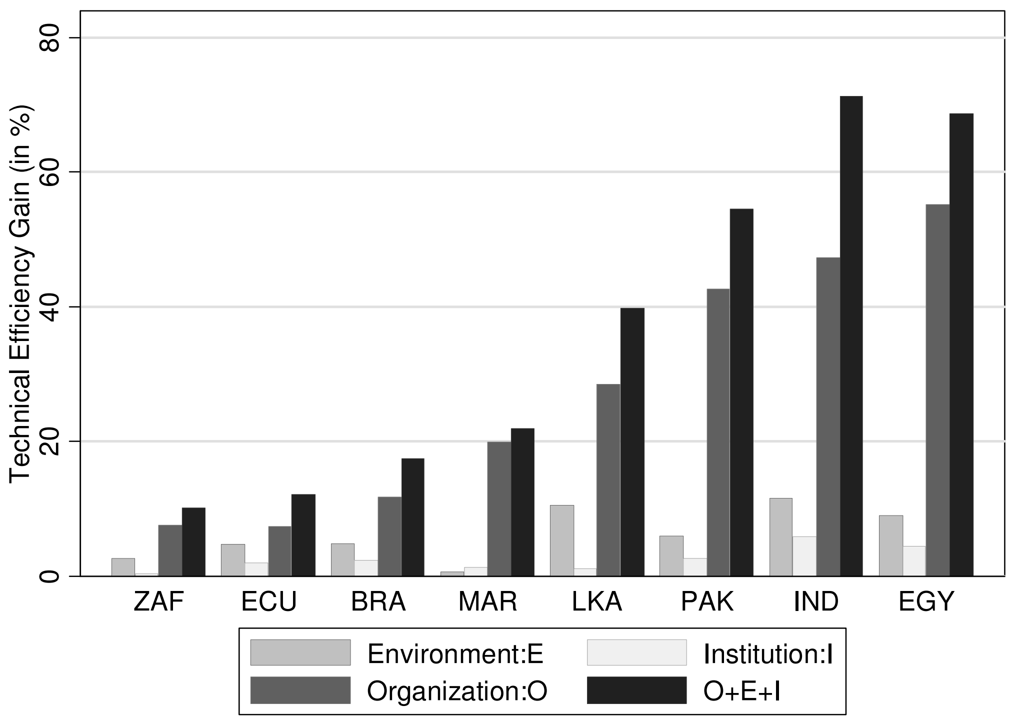
4.2. Technical efficiency adjusted for a common productive environment

Technical efficiency is predicted by placing all firms in the 5% most favorable environment to obtain adjusted efficiency measures (see section III). Simulations were successively carried out with respect to the domestic and the international environment. In each case, the three g-categories of efficiency determinants are considered separately. In other words, the firms' environment benchmark is liable to vary from one category to another. Although the international scenario is likely to be speculative (e.g. public institutions and their effectiveness only modify slowly), these simulations demonstrate where producers and governments need to promote efforts in order to improve firms' productivity levels[12].

Figure 3 Adjusted efficiency for the best domestic environment



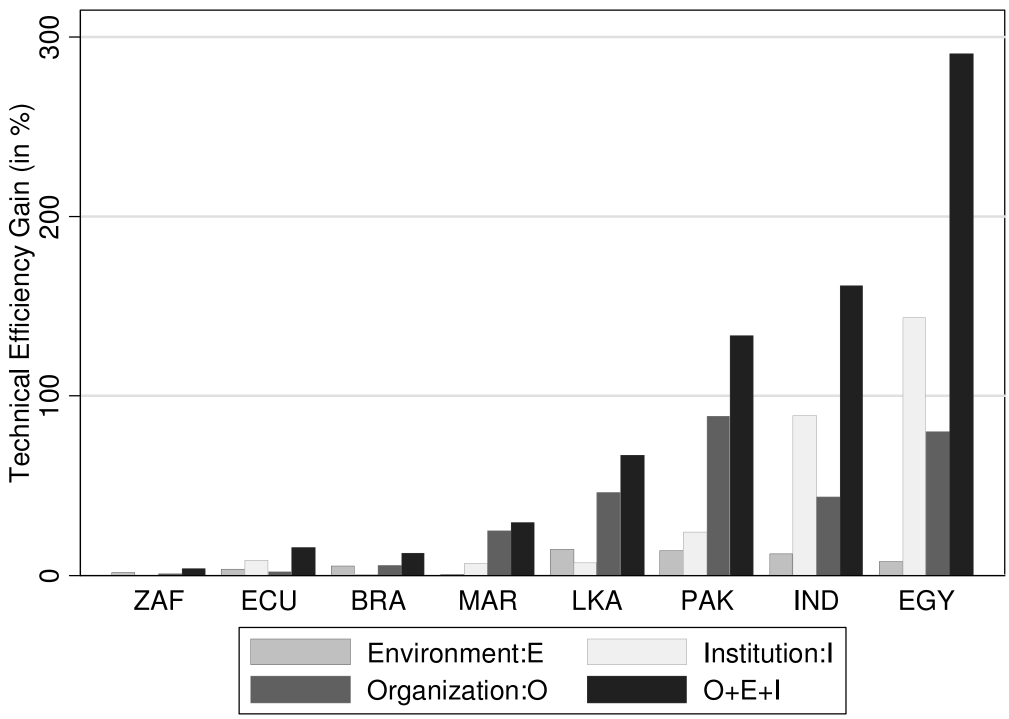
In the domestic framework, total productive efficiency gains range from less than 10% in South Africa to about 70% in Egypt (Figure 3). These marked differences reflect statistical dispersion, which tends to be more pronounced in the lowest *per capita* GDP countries. If we look at the decomposition of these gains, the in-house organizational source is systematically

[11] This statistics follows a standard normal variable

[12] The same exercise was carried out with no significant variation with the translog specification. Results can be provided upon request.

the most important one. For Moroccan firms, this environment accounts for about 90% of the 23% average expected productivity gains. For the eight countries, the relative contribution of this g-category exceeds 70% of the total cumulated productivity improvement. The economic environment ranks second, except for Morocco where it is outperformed by the role of institutions. We don't find that modifying the institutions would enhance a noticeable impact. When moving from the existing to the best domestic institutional environment, productive efficiency does not improve more than 10%. There is of course a logical dimension in this result. *Doing Business* information only gives a nationwide picture of the institutional environment. On this point, our results then somewhat differ from those displayed by Dollar *et al* (2006) in their analysis of the relationship between regional institutions and exports. The international perspective has the advantage of increasing the variance of all variables including institutions.

Figure 4 Projection of the best international environment



Adjusting efficiencies to the most favorable international conditions changes the story (Figure 4). Institutions rank first for three countries with adjusted predictions enhancing strong efficiency gains. For Egypt, the productivity level is multiplied by nearly 4 and the quality of institutions accounts for about 50% of this improvement. Although simulations for India are less spectacular, the average productivity level would more than double. For this country, the relative contribution of institutions represents more than half the total of cumulative gains. In Egypt and India, the quality of institutions then overrides everything else. This is not the case for Pakistan, Sri-Lanka and Morocco, where the most prominent factors are those proceeding from the organizational factors. Once again, the role of the economic environment proves negligible except for Sri-Lanka. Finally, simulations are of limited interest for South Africa, Brazil and Ecuador, where most firms belong to the most favorable environment.

IV - 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 "best practice". On the contrary, Egypt, India and Pakistan are poor productive performers with a high dispersion of efficiency in 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 financing, especially through overdraft facilities, 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 countries 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, Ecuador). In Egypt, the productivity level would be multiplied by nearly 4, the quality of institutions accounting for about 50% of this improvement. 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 (0.082)	-0.199 (0.089)**
Legal status of the firm	-0.686 (0.321)**	-0.337 (0.215)
Individual firm	-0.570 (0.204)***	-0.148 (0.283)
Family firm	-0.361 (0.170)**	-0.352 (0.195)*
Constant	2.013 (0.399)***	2.703 (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

Institutions

Eigenvectors														
Variables	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Corruption constraint++	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
_3	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
_4	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
_6	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
_9	-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
_11	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
_12	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
_19	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
_20	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
_21	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
_22	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
_23	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
_24	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
_26	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
_28	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) number of procedures, (2) time (days), (3) cost (%of income per cap), (4) min capital (% of income per cap); **Hiring and Firing workers**: (5) difficulty of hiring index, (6) difficulty of firing index, (7) rigidity of employment index, (8) non wage labor cost, (9) cost of firing (weeks of salaries); **Registering property**: (10) number of procedures, (11) time (days), (12) cost of property value; Obtaining **credit**: (13) legal rights, (14) depth of credit information index; **Protecting investors**: (15); **Paying taxes**: (16) total tax payable (% benefits); **Trading across borders**: (19) time for import, (20) cost to import, (US dollars per container); **Making contracts**: (21) number of procedures, (22) time (days) and (23) costs (% of income per capita); **Winding up a business**: (24) time (years), (25) cost (%); **Dealing with licenses**: (26) number of procedures and (28) 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

In house organisation

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

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	Eigenvalue	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 selection bias

In a first regression a Probit model is estimated as follows: $h_i = W_i\theta + \omega_i$ (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 $\phi(.)$ 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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