Trade reform and efficiency in Cameroon's manufacturing industries

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List of abbreviations

C.i.f.	Cost insurance freight
CD	Custom duty
CGE	Computable general equilibrium
CR	Computer Redevance
CSNC	Cameroonian Shipper National Council
CT	Complementary tax
DEA	Data envelopment analysis
EFD	Entry fiscal duty
FOB	Free on board
GPT	Generalized preferential tariff
GTP	General trade programme
IMP	Industrial Master Plan
IMTOT	Import turn-over tax
MLE	Maximum likelihood estimates
PIT	Production internal tax
QRs	Quantitative restrictions
RTS	Returns to scale
SAP	Structural adjustment programme
SFA	Stochastic frontier approach
STT	Standard time trend
TC	Technical change
TOT	Turn-over tax
Translog	Transcendental logarithmic
UDEAC	Union Douaniére des Etats de l'Afrique Centrale
UT	Unique tax

Abstract

Does trade reform generate gains in manufacturing firm-level technical efficiency? Pooling of pre and post trade reform data for Cameroon, and estimating a single stochastic production frontier for each industrial sector, yielded empirical results showing that the average technical efficiency increased in six of eight sectors following trade reform. The post trade reform firm-level technical efficiencies increased on average at an annual rate of 1.39%, while prior to trade reform they decreased on average at the annual rate of 0.76%. Before trade reform, the restricted trade regime coupled with macroeconomic and political instability negatively affected firm-level technical efficiency. Post trade reform potential determinants of firms' technical efficiency include export share and import penetration rate.

JEL classification: F13; E23; L6

Keywords: Trade reform; technical efficiency; manufacturing sector; Cameroon

1. Introduction

Owing to the widely accepted view that liberal, outward-oriented trade policies are superior to restrictive, inward-oriented policies, and because of the slow or even negative economic growth during the 1980s, Cameroon broke from its tradition of inward-looking development strategies to embark on a trade reform programme in July 1988. In this context, the protection of the import-competing industrial sector was reduced by drastically scaling down licensing requirements, progressively removing reference prices and reducing tariff rates on most products (Table 1). The initial impact of these changes on import-competing products was softened by a 50% nominal devaluation of the local currency (CFA franc) in January 1994.[1]

Table 1: Protection of Cameroon's manufacturing industries

Industry	Official tariff rates (%)[a]		Effective protection rates (%)		Import penetration rates (%)[b]		Export shares (%)[c]		Intra-industry trade index (%)[d]	
	Column key: (1) = 1985/86; (2) = 1994/95									
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Food products	90.00	36.80	78258.0	53.6	13.07	18.87	17.15	18.71	84.14	99.47
Beverage-tobacco	163.00	36.80	555.50	57.70	19.37	29.46	2.98	5.60	22.65	24.94
Textile & leather	95.00	19.30	1209.70	53.20	34.38	23.84	73.57	71.11	31.68	31.20
Wood & furniture	64.00	19.30	591.90	-2.60	07.58	02.23	15.05	25.94	03.80	12.46
Paper & printing	57.00	19.30	329.20	50.30	65.87	43.87	01.48	22.90	05.40	55.07
Chemical products	58.00	26.80	1322.30	74.10	29.77	34.44	24.64	38.52	87.08	91.21
Rubber products	102.00	26.80	4911.60	51.00	16.20	12.93	52.17	78.16	30.12	07.97
Building materials	98.50	16.80	16367.0	48.90	42.82	42.49	56.84	56.48	72.49	72.55
Electrical products	49.00	19.30	706.40	20.60	37.26	32.52	21.29	36.50	62.58	91.20
Transport material	73.00	16.80	717.60	38.70	29.32	30.71	18.10	46.68	69.51	67.23

Notes: a: Expressed as ad valorem rates.
b,c,d: Let X, M and Q represent exports, imports and domestic production, respectively. Then, the export share is X/Q. The import penetration rate is $M/(Q+M-X)$. The index of intra-industry trade is $1-|X-M|/(X+M)$. Effective protection figures are taken from Industrial Master Plan (IMP, 1989) and Kamgnia (1994). The exports and imports are deflated by the export and import price indexes in the manufacturing sector, while the GDP deflator in the Cameroon manufacturing sector deflates the outputs. All these deflators are taken from the World Bank World Tables, 1995.

The first four columns in Table 1 indicate that by 1994/95 Cameroon had reduced tariffs to uniformly low levels, and had considerably reduced the level of protection for most sectors. The last six columns indicate that these measures were accompanied by increases in import penetration rates in four of ten sectors, increases in export shares in eight of ten sectors, and increases in intra-industry trade index in seven of ten sectors. It is generally believed that this increase in competition (domestic and foreign) would make the Cameroon manufacturing sector more efficient in the production process. Indeed, by enhancing international competition and cross-border technology diffusion, trade reform boosts technical efficiency in manufacturing industries. Also, by enlarging markets, trade reform delivers gains in efficiency.[2] In attempting to evaluate the evidence that supports these views, this study assesses the impact of trade reform in changes in the Union Douaniére des Etats de l'Afrique Centrale (UDEAC)[3] on firm-level technical efficiency.

We follow a two-stage procedure. First, the parameters of the production function are estimated and firm-level technical efficiencies are derived. Second, the impact of the trade reform on the derived firm-level technical efficiencies is assessed. Given the argument that productivity might respond slowly to trade reform (Rodrick, 1992), and in order to make the effects of trade reform clearer, macroeconomic variables not related to trade, such as macroeconomic instability, political instability, etc., are also used to explain the technical efficiency changes. To keep the results from being plagued by the small industry-specific sample sizes, some sectors were pooled.[4] Also, both pre and post trade reform samples were pooled and a single production function was estimated. We also tested for changes in the regression coefficients between the two periods.

The paper is structured as follows. Section 2 gives the relationship between trade reform and firm-level efficiency, while Section 3 describes the trade policy reform in Cameroon. Section 4 presents the literature review, Section 5 presents the methodology, and Section 6 gives an overview of the Cameroon manufacturing sector. Data sources and definitions are discussed in Section 7, Section 8 presents the empirical results, and Section 9 gives the conclusions and policy implications of the findings.

2. Trade reform and firm-level efficiency

Most observers believe strongly that trade reform is beneficial. The channels through which trade reform could bring benefits are broadly these: improved resource allocation; access to better technologies, inputs and intermediate goods; an economy better able to take advantage of economies of scale and scope; greater domestic competition; availability of favourable growth externalities like the transfer of know-how; and "*a shake up of industry that may create a Shumpeterian environment especially conducive to growth"*.[5]

Greater attention has therefore been given to the role of market mechanisms in guiding the allocation of resources and providing incentives for cost discipline and efficiency improvement. Indeed, increased competition, or import discipline, is important in moving producers from inefficient positions toward potential efficiency, since an open economy is more likely to allocate resources in areas where it has a comparative advantage. A different trade reform argument has to do with the effects of foreign competition on the efficiency of domestic producers. It is possible that the challenge implied by foreign trade forces domestic industries to respond by adopting new technologies to improve efficiency. This process is generally achieved through increased investments embodying new technology and increased acquisition of skilled labour. Free trade also leads to a more economically rational market structure. Gains from liberalization also result from scale economies and economies of scope that arise in wider markets.[6] Nishimizu and Page (1991: 253) summarize this logic as follows:

> The existence of economic of scale . . . implies that a widening of a market through trade should lead to reduction in real production costs. In the context of an outward oriented development strategy, this argument is usually cast in terms of benefits of increased demand through export expansion . . .

Last but not least, arguments similar to those on the efficacy of international competition also apply to national competition. Ultimately, it is the force of competition—whether external or internal—that challenges firms and induces the response of technical change, innovation, and sustained effort to increase productive efficiency and reduce costs. It is often the case that this challenge–response mechanism is largely absent in economies in which non-market allocation of resources dominates in the form of planning or market regulation.

3. Trade policy reform in Cameroon

Since July 1988, the Government of Cameroon has been pursuing trade measures within the framework of a structural adjustment programme (SAP). There is no general understanding of what is meant by trade policy reform. For Papageorgiou et al. (1991: 13, 29) "*trade liberalization is defined as any act that would make the trade regime more neutral—nearer to a trade system free of government*". An episode of liberalization commences "*. . . at a point at which a significant policy change toward liberalization was implemented. It ends with a reversal or when no further policy trend in either direction is apparent*". Trade liberalization measures have a number of common features. They generally involve neutralizing incentives for exports and imports at low tariff levels through removal of import quotas and other quantitative restrictions (QRs) or their conversion into tariffs; removal or reduction of export taxes; subsequent reduction of the level and dispersion of import tariff rates; and compensatory devaluation of the local currency.

Concerning the relative relaxation of QRs on imports and exports, in 1989/90, for example, approximately 105 commodities did not require import licences and so were removed from QRs. In 1990/91, 22 products were classified in the free import category. In 1991/92, nearly all QRs had been removed. For exports, exit duties on all commodities except coffee, cocoa and cotton were removed. In sum, and within the SAP, there was simplification of the process of obtaining import as well as export licences and authorizations and the elimination of the twinning system. On the other hand, the labour market had been deregulated in order to allow firms more flexibility in responding to changing environment. Despite these measures, the Cameroonian economy is far from being an open economy, and this liberalization episode can be characterized as mostly institutional. Further liberalization took place in 1992/93 within a regional framework, i.e., the Regional Fiscal Reform Programme in the UDEAC zone.

Prior to the trade reform, there were four individual taxes on imports: the custom duty (CD), the imports turnover tax (IMTOT), the entry fiscal duty (EFD) and the complementary tax (CT). The custom duty was levied on the cost insurance freight (c.i.f.) value of the imported goods for local use, and was subject to a wide variation (5–20%) both across and within sectors. The import turnover tax was levied at 10% of the c.i.f. value inclusive of custom duty, entry fiscal duty and the complementary tax; it could be zero for some imported first necessity goods, but sometimes reached 72% of the c.i.f. value for some luxury imports. The entry fiscal duty was a tariff levied on the c.i.f. value of imports whatever the country of origin at rates between 15 and 70%. The complementary tax was levied on the c.i.f. value at the rate of 40%. At the regional level, and on the export side, there were two main taxes: the production internal tax (PIT) and the unique tax (UT). The fiscal regime permitted partial or total fiscal and custom exemptions, which were compensated for by the collection of a specific tax called the production internal tax. The enterprises registered to the system of unique tax were exempted from all export taxes and duties in the UDEAC member states; these enterprises paid only a tax called unique tax.

After trade liberalization, the custom duty and the entry fiscal duty were replaced by a custom duty, applicable to all Cameroonian imports, and according to the category of goods: first necessity goods, 5% of the c.i.f. value; equipment goods, 10%; intermediate goods, 20%; and current consumption goods, 30%. The import turnover tax and the complementary tax were replaced by the turnover tax (TOT), applicable to all Cameroonian imports as well as to all domestic production at three different rates: zero rate for exempted goods, a reduced rate of 5% and a normal rate of 12.5%. On the export side, and at the regional level, the production internal tax was abolished while the unique tax was replaced by a generalized preferential tariff (GPT), which is a proportion of the custom duty applicable to similar goods that do not conform to this particular tax system. The other different taxes remain unchanged, and their application depends on each UDEAC member state. At the level of Cameroon, the contribution to Cameroonian Shipper National Council (CSNC) and the computer charge (CR) are levied at rates of 0.3% and 1.5%, respectively. A tax on the control and inspection of agricultural products (cocoa, coffee, wood, palm oil and banana) is levied at the rate of 0.95% of the free on board (FOB) value of exports.

Finally, before the trade reform, quantitative restrictions (QRs) were regarded as the principal instrument of domestic protection. In this context, an annual general trade programme (GTP) classified goods by tariff line into four categories: "sensitive" goods, imported at very restrictive conditions; "twinned" goods, which required prior authorization to import a quantity of a specific good in proportion to the local purchase; "government-controlled" goods, which necessitated prior authorization to be imported; and "freely imported" goods. Since 1992/93, "sensitive" imported goods have been steadily transferred to "government-controlled" goods. Nowadays, import licences for "government-controlled" goods are almost automatically granted. However, the import of products that represent a danger to the environment or to the life of human beings and animals is still strictly forbidden. The period analysed in this paper covers the two liberalization episodes described above.

4. Literature review

The literature on economic efficiency change in developing countries offers a wide variety of possible causes. Recently a clear consensus emerged on the role of trade policy in increasing growth and efficiency. Until quite recently, however, much of what we knew was in terms of macroeconomic effects of trade reforms.[7]

There is now a small but growing empirical literature on the effects of trade liberalization at a desaggregated level. The hypothesis that opening up to international competition will induce increased efficiency in domestic industries is generally supported by the econometric results. It is in this connection that the results of Nishimizu and Robinson (1984) indicated that there are important links between trade policies and industrial productivity performance. Pack (1993) argued that the liberalization of the international trade regime is unlikely to be sufficient for successful development unless the technological ability of firms is increased to allow an elastic supply response. Using a panel of manufacturing firms in Côte d'Ivoire, Harrison (1994) measured changing profit margins and productivity following the 1985 trade reform. Tybout and Westbrook (1995) found that Mexico's trade liberalization generated productivity gains, more specifically that average costs fell in most industries owing to improvement in relative productivity. Gokcekus (1997) found that total factor productivity growth in the Turkish rubber industry was significantly higher following trade liberalization, with technological change as the major contributor to this growth. Krishna and Mitra (1998) used firm-level data from India and found strong evidence of an increase in competition and in the growth rate of productivity. By accounting for imperfect competition and non-constant returns, Kim (2000) found that trade liberalization improved performance, increased competition and promoted scale efficiency in Korean manufacturing.

There are unresolved questions about the approach used by most of these papers. They do not evaluate the range of manufacturing firms' productive efficiency change following the liberalization of the trade. Moreover, most of the studies are oriented toward the analysis of the effects of trade reform on welfare, market structure as reflected in a price-marginal cost mark up, and scale efficiency. This paper separates itself from the previous studies by assessing inputs and plant-specific measures of deviations from the production frontier, and the pre and post reform approach. Moreover, this study attempts to separate the effects of trade reform from the effects of macro determinants of industrial productive efficiency such as institutional instability, political instability and macroeconomic instability. Njikam (2003) uses a stochastic frontier production function approach to evaluate and compare pre and post trade reform measures of productive efficiency in the UDEAC zone. This plant-level evidence confirmed the positive relationship between trade reform and productive efficiency even though the potential effects of trade reform on firm-specific efficiencies are ambiguous. However, the study is at the level of one industrial sector, e.g., the electrical industry, and therefore ignores the effects of trade reforms on the whole manufacturing sector.

In recent years the use of frontier models has become increasingly widespread for a variety of reasons. First, the notion of a frontier is consistent with the underlying economic theory of optimizing behaviour. Second, deviations from a frontier have a natural interpretation as a measure of the efficiency with which production units pursue their behavioural objectives. Since the pioneer work of Farrell (1957), several approaches have come up in frontier production estimation: deterministic as well as stochastic. In the data envelopment analysis (DEA) approach no restrictive assumptions about technology have to be made, except about convexity. Although the main attraction of the DEA approach is its potential for handling multiple input/multiple output technologies, its main shortcoming is that the efficiency of a micro unit is measured relative to the efficiency of all micro units. The stochastic frontier approach (SFA), also called composed error model, of Aigner et al. (1977) and Meeusen and van den Broeck (1977) takes into account the possibility that a firm’s performance may be affected by factors entirely outside its control (such as poor machine performance, bad weather, input supply breakdowns, luck, etc.) as well as factors under its control (inefficiency). Hence, the asymmetric component of the error term permits random variation of the frontier across firms while a one-sided component captures the effects of inefficiency. There exist three categories of the SFA. The first is the regular panel data model with time-varying technical (in)efficiency. The second is an extension of the first; it introduces some plant and production characteristics variables, i.e., type of production process, fuel type, regions, locations, etc., with the idea that these variables are used as controls instead of regular inputs. Finally, in the third category, technical (in)efficiency is explained by variables other than the regular inputs (see Reifschneider and Rodney,1991). Given the purpose of our study, the first category is chosen.

5. Methodology

According to Collier et al. (1997: 349–50):

> There are three ways of evaluating the impact of liberalization on economic performance: (1) CGE modeling, it has the virtue of allowing systematic evaluation of alternative scenarios; (2) cross-section analysis, it involves comparing the experience of countries that have undergone liberalization with those that have not and (3) time-series analysis; depending upon the availability of data this is potentially the most fruitful; this is essentially a "before and after" methodology, that is it tracks the series concerned up to liberalization and after liberalization...".

The last of these approaches is used in our analysis. More specifically, the stochastic frontier production approach is adopted. To avoid strong a priori restrictions on the technology, a flexible functional form, i.e., translog, is adopted. I apply the standard time trend (STT) model as a form of benchmark model for technical change (see Cotfas, 1997). If variables are in logarithmic form, the production technology of the Cameroonian manufacturing plants is represented by:

$$lny_{it} = \alpha_0 + \sum_{j=1}^{6} \alpha_{jt}\, lnx_{jit} + \alpha_t t + 1/2\{\sum_j \sum_k \beta_{jk}\, lnx_{jit}\, lnx_{kit} + \alpha_{tt} t^2\} + \Sigma \beta_{jt}\, lnx_{jit}\, t - u + v \qquad (1)$$

where y and x_j (j = 1, ..., n) are the respective output and inputs measured in logarithms, α and β are unknown parameters, t is the time trend representing the rate of technical change or shift in the production function over time, u is a firm-specific technical efficiency variable that follows a half-normal distribution, and v is a disturbance term that follows a full normal distribution. The elasticities of output with respect to inputs are calculated as follows:

$$\eta_j = \frac{\partial y}{\partial x_j} . \frac{x_j}{y} = \frac{\partial lny}{\partial lnx_j} = \alpha_j + \sum_k \beta_{jk}\, lnx_{kit} + \beta_{jt}\, t \qquad (2)$$

with j = L_1, L_2, L_3, K, M and E, where L_1 stands for foreigners and senior executives, L_2 for middle executives, L_3 for workers and unskilled workers, K for capital, M for materials, and E for energy. The input elasticities vary over time and across plants. Returns to scale (RTS), i.e., the elasticity of scale are evaluated from the sum of the input elasticities $RTS = \sum \eta_j$ as, where η_j is defined as in Equation 2. Technical change (TC) is specified as follows:

$$TC = \frac{\partial y}{\partial t} = \alpha_t + \alpha_{tt} t + \sum_j \beta_{jt} lnx_{jt} \quad (3)$$

In Equation 3, TC consists of two parts: the pure TC component $\alpha_t + \alpha_{tt} t$ which is invariant across plants, and the non-neutral component $\sum_j \beta_{jt} lnx_{jt}$, which varies across plants and over time. Individual firm-specific measures of technical efficiency are more important from a policy viewpoint. Also, such disagregated measures facilitate straightforward comparison distribution of u_i given ε_{it} as follows:

$$E(u_i / \varepsilon_{it}) = -[\sigma \frac{f(\frac{\varepsilon_{it}\lambda}{\sigma})}{1 - F(\frac{\varepsilon_{it}\lambda}{\sigma})} - \frac{\varepsilon_{it}\lambda}{\sigma}] \quad (4)$$

where $\sigma^2 = \sigma_u^2 \sigma_v^2 / T\sigma^2$, $\sigma^2 = \sigma_v^2 / T + \sigma_u^2$, $\lambda = \sigma_v^2 / T\sigma_u^2$ and f(.) and F(.) are density and distribution functions of N(o,1), respectively.

To identify the effects of trade reform and macroeconomic variables on firm-level technical efficiency, the following is estimated on pre and post trade liberalization firm-level technical efficiencies.

$$lnTE_{it} = \beta_0 + \sum_j \beta_j Z_{jt} + w_{it} \quad (5)$$

where $lnTE_{it}$ is the natural logarithm of firm-level technical efficiencies. Z_{jt} is the set of trade liberalization variables such as the import and export tariff rates, the export share, the import penetration rate, and the set of business environment variables such as political and macroeconomic instability.[1] β are the parameters to be estimated and w_{it} is the residual term assumed to be iid. To solve for the endogeneity problem we estimated Equation 5 using the fixed-effects method where each variable in each sector is measured as a deviation from its mean over time. To evaluate the relative importance of the independent variables in explaining the level of firm-level technical efficiency, the standardized coefficient approach is also applied.

6. Overview of Cameroon's manufacturing sector

According to the national account classification, the Cameroon manufacturing sector consists of various subsectors. The pre and post trade reform industrial surveys show that the manufacturing sector is relatively diversified and employs a considerable portion of the labour force (Table 2).

Table 2: Pre and post trade reform structure of Cameroon's manufacturing industries

Industry	Number of firms				Total employment			
	Pre-reform		Post-reform		Pre-reform		Post-reform	
	Number	Share (%)	Number	Share (%)	Number	Share (%)	Number	Share (%)
Food products	185	44.79	52	28.89	20,490	31.38	24,526	46.21
Beverage and tobacco	13	3.15	10	5.56	8,359	12.80	2,797	05.27
Textiles	36	8.72	07	3.89	5,182	07.94	3,511	06.62
Wood and furniture	68	16.46	35	19.44	9,316	14.27	7,957	14.99
Paper and printing	24	5.81	21	11.67	2,053	03.14	1,716	03.23
Chemical products	20	4.84	19	10.56	2,278	03.49	2,428	04.57
Rubber and plastics	15	3.63	11	6.11	11,265	17.25	6,935	13.07
Building materials	07	1.69	05	2.78	826	01.26	653	01.23
Basic metallurgy	03	0.73	03	1.67	1,364	02.09	1,080	02.03
Electrical products	33	7.99	11	6.11	2,806	04.30	735	01.38
Transport materials	06	1.45	03	1.67	754	01.15	200	0.38
Miscellaneous	03	0.73	03	1.67	611	0.94	536	01.01
Total manufacturing	413	100.0	180	100.0	65,304	100.0	53,074	100.00

The pre-trade reform figures in Table 2 show that Cameroon manufacturing consisted of 413 firms. The dominant sectors in terms of the number of firms were "food", "wood and furniture", "textiles and leather", and "electrical products", with the share of the number of firms varying between 8% and 45%. After trade liberalization Cameroon's manufacturing sector consisted of 180 firms. The dominant sectors were "food", "wood and furniture", "paper and printing", and "chemical", with the number of firms representing 10.5% to 29% of the total. Relative to the pre trade reform sample, the post trade reform figures show a dramatic drop—nearly 56.42% of firms in total manufacturing. Trade reform was disastrous for sectors such as "textiles", "electrical", "transport materials", and "wood and furniture". With a respective drop in the number of firms of nearly 80.56%, 66.67%, 50% and 48.53%, the reform almost led to the disappearance of these sectors.

In terms of employment, the pre trade reform figures in Table 2 show that the dominant sectors were "food", followed by "rubber and plastic", "wood and furniture", and "beverage and tobacco". After the trade reform, the dominant sectors were still "food", "wood and furniture", and then "rubber and plastics". Relative to the pre trade reform situation, the post trade reform total labour force declined by nearly 18.73%. This situation masks a disparate trend across sectors, however. Some sectors, such as "food" and "chemical", reinforced their labour force, while there was dramatic drop of 73.81%, 73.47% and 66.54%, respectively, in "electrical products", "transport materials", and "beverage and tobacco".

In terms of protection and trade flows, between 1985/86 and 1994/95 there were dramatic changes in the tariff rates of manufactures (refer to Table 1). By 1994/95, and for all manufacturing sectors, there had been a fall of nearly 54 to 83%. The effective protection rate figures are also of interest since they summarize all of the product market forces that drive a wedge between domestic and world prices. By 1994/95 the dramatic drop in effective protection rates is situated between 84.72 and 100.44% for all the sectors. The considerable cuts in protection levels led to dramatic changes in import penetration rates, export shares and intra-industry trade indexes.

The import penetration rates and export shares are also of interest because they reveal how important foreign producers and consumers are to domestic suppliers. The most striking changes in export/output ratios over both sample periods are those of the "paper and printing", "transport materials", "beverage and tobacco", "wood and furniture", and "electrical products" sectors.[9] From the pre to post trade reform period, these ratios rose from 1.5% to 22.9% for "paper and printing", 18.1% to 46.68% for "transport materials", 2.98% to 5.6% for "beverage and tobacco", 15.05% to 25.94% for "wood and furniture", and 21.29% to 36.5% for "electrical products". Among the ten industrial sectors in the sample, only two, "textile and leather" and "building materials", registered declining export shares over this period; another two, "chemical" and "rubber and plastics", experienced nearly 50% change, while "food processing" registered a slight increase of about 9.1% of its export share. The norm thus appears to have been one of increasing openness. Some of these changes no doubt reflect recent efforts to liberalize Cameroon's economy.

As far as import penetration is concerned, the most striking changes from the pre to post reform period are related to "food processing", "beverage and tobacco", "chemical products", and "transport materials". Over both sample periods, the import penetration rates increased from 13.1% to 18.87%, 19.37% to 29.46%, 29.77% to 34.44% and 29.32% to 30.71%, respectively, for the "food processing", "beverage and tobacco", "chemical products", and "transport material" industries. The other six remaining industries witnessed declining import penetration rates. In the Cameroon trade reform context therefore, exports and imports are not encouraged to rise together in all industrial sectors.

Also of interest is the degree of openness in the sense of intra-industry trade. From the before to after trade reform period, the intra-industry trade figures in Table 1 exhibited dramatic increases ranging from 45.73 to 919.81% for the "electrical products", "wood and furniture", and "paper and printing" industries. Five other sectors, "building materials", "transport materials", "chemical products", "beverage and tobacco", and "food", registered mild increases ranging from 0.083% to 18.22% in intra-industry trade index. However, the "textile and leather" and "rubber and plastics" industries registered decreases of 1.52% and 73.54%, respectively.

To see whether the various trade exposure measures tell a coherent story, we calculated the correlation between their levels and changes. These are reported in Table 3. Several patterns are worth noting. First, as theory would suggest, relatively large reductions in official tariffs are associated with relatively large increases in import penetration. In the Cameroonian manufacturing context, this correlation is statistically significant. This pattern also extends to effective protection, and the correlation is also significant. Second, output expansion is associated with higher rates of export expansion and relatively lower initial openness measured by the 1985/86 official tariffs, effective protection and import penetration rates. Third, the results in Table 2 show strong negative association between output growth and intra-industry trade index. Looking across sectors, changes in official tariffs are associated with changes in effective protection, but this association is statistically weak. Fourth, changes in tariffs and effective protection very closely correlate with sector-specific changes in import penetration and export rates. Indeed, large variations in effective protection rate are robustly correlated with variations in export shares. Finally, large changes in import penetration are associated with large reductions in initial import penetration rates.

Table 3: Cross-industry rank correlation between levels and changes in trade exposure measures of Cameroon's manufacturing industries

	GR	OTR	ERP	MPR	XS	ITI	DOTR	DERP	DXS	DMPR	DITI
GR	1										
OTR	-0.235*	1									
ERP	-0.145	0.091	1								
MPR	-0.103	-0.334*	-0.304*	1							
XS	0.074	0.098	-0.054	-0.004	1						
ITI	-0.682*	-0.173	0.468**	-0.641*	0.149	1					
DOTR	-0.034	-0.564*	0.296**	-0.039	-0.464*	0.335**	1				
DERP	-0.113	0.092	-0.387*	0.634*	-0.485*	-0.382*	0.031	1			
DXS	0.315**	-0.302*	-0.193	0.733*	-0.451*	-0.465*	0.139	0.779*	1		
DMPR	-0.774*	0.541*	0.477**	-0.160	-0.235*	0.581*	0.135	0.129	-0.262	1	
DITI	0.451**	-0.369*	-0.164	0.652*	-0.475*	-0.542*	0.176	0.673*	0.962*	-0.395*	1

Key: GR = growth in industry-wide gross output; OTR = 1985/86 official tariff rates; ERP = 1985/86 effective rates of protection; MPR = 1985/86 import penetration rates; ITI = 1985/86 intra-industry trade index; XS = 1985/86 export shares. DOTR is change in official tariff rate between 1985/86 and 1994/95. DXS and DMPR are, respectively, changes in export share and import penetration rate between 1985/86 and 1994/95. DERP is the change in effective protection between 1985/86 and 1994/95, while DITI is the variation in intra-industry trade index between 1985/86 and 1994/95.

* Significant at the 5% level.

** significant at the 10% level.

7. Data source and definitions

The firm level panel data for the present study are from the Direction de la Statistique et de la Comptabilité National (DSCN), which is instructed to gather annual information on all industrial firms. Though the coverage of the industrial sector is incomplete (informal firms are excluded), the sample covers large, medium-size and small-size formal manufacturing firms over the pre trade reform (1988/89–1991/92) and the post trade reform (1994/95–1997/98) periods. For each industrial sector the sample firms represent approximately 75% of total output. Therefore, in terms of size, the data set well represents the population. For each firm and year, we observe the usual data on production, labour, intermediate consumption/materials, investment, inventories, and energy (water, electricity, and fuel), as well as industry codes and plant identity codes that allow us to track establishments over time and to get an idea on the exit and entry of firms in each sector.

The variables are defined as follows: Output is the constant 1989/1990 value of the observed production per year. The manufacturing output price index is used as deflator. Therefore, the real revenue is used to measure the output. The data on the types of labour in terms of both numbers and earnings are available. In order to take into account variations in labour quality and effort, however, the labour input is measured by the wage paid to each category of employees. Indeed, the Cameroon labour market is characterized by a lack of real job opportunities. Therefore, workers often accept employment that does not really reflect their true level of qualification. Because of this disguised unemployment, the marginal revenue productivity is considered in payments to factors. Thus, W_1 is the 1989/1990 constant wage paid to foreigners and engineers per year, W_2 is the 1989/1990 constant wage of middle executives per year, and W_3 is the 1989/1990 constant wage of workers and temporary workers per year. The consumer price index is used as deflator of wages.

The capital variable is obtained from the balance sheet of the different plants, and covers machinery and equipment. Following Ahluwalia (1991) and Harrison (1994), we derive the gross capital stock estimates at constant prices using the perpetual inventory method. This requires data on (a) the gross capital stock for a benchmark year and (b) the gross investment for all the years. Fortunately, data on gross investment at current prices were available for each year and for each firm. Thus, the real capital stock in period t is defined as follows: $K_{it} = (1 - d) K_{i,t-1} + I_t$. As a benchmark we used 1988/89 capital stock for each firm and then added real investment while accounting for depreciation. Real investment is computed by deflating investment at current prices by the wholesale price index for machinery and machine tools. Raw material is not proportional to output, and is therefore included in the analysis; it is measured in volume, using the price index of raw materials in each industrial sector as deflator. It is worth noting that energy at constant prices is obtained by first deflating the data on fuel, water and electricity by their respective deflators and then aggregating the data at constant prices to obtain each firm level consumption of energy.

The trade reform variables (export shares (XS), import penetration rates (MPR), export tariff rate (XTR) and import tariff rate (MTR)) are sector-specific indexes. For the macroeconomic variables, macroeconomic instability is measured by the black market premium (BMP), while a dummy variable (DPINS) taking the value of zero in the years of political instability and one otherwise is used to capture the political instability effect.[10] The summary statistics of variables are presented in Appendix Table A1.

8. Analysis of empirical results

As indicated in the introduction, we established the link between trade reform and firm-level technical efficiency using a two-stage procedure. In the first stage the production frontier parameters are estimated and firm-level technical efficiencies are derived. In the second stage regressing the derived firm-level technical efficiencies on trade policy and macroeconomic variables assesses the impact of trade reform and macroeconomic variables.

Assessment of technical efficiency scores

The paper first considered estimation of parameters of a stochastic frontier production for each sector on pooled pre and post trade reform data[11] and the derivation of firm-level technical efficiencies. Second, the choice between the Cobb–Douglas and the translog functional forms was made using the conventional F test, which compares the restricted and unrestricted residual sums of squares. The test results given in Table 4 are insignificant in all sectors, implying that the Cobb–Douglas form was best supported by the data.

Table 4: F tests on the restriction of the coefficients of Cameroon's manufacturing production function

Industry	Calculated F statistic	Critical F statistic	Decision
Food products	1.4805	$F_{0.05}(28, 172)=1.52$ $F_{0.01}(28, 172)=1.79$	Cobb–Douglas accepted
Textiles	2.0981	$F_{0.05}(28, 20)=2.04$ $F_{0.01}(28, 20)=2.77$	Cobb–Douglas accepted
Wood, paper, printing	1.5315	$F_{0.05}(28, 180)=1.52$ $F_{0.01}(28, 180)=1.79$	Cobb–Douglas accepted
Chemical products	1.4778	$F_{0.05}(28, 80)=1.60$ $F_{0.01}(28, 80)=1.94$	Cobb–Douglas accepted
Rubber and plastics	1.4838	$F_{0.05}(28, 32)=1.82$ $F_{0.01}(28, 32)=2.34$	Cobb–Douglas accepted
Electrical products	1.4062	$F_{0.05}(28, 148)=1.54$ $F_{0.01}(28, 148)=1.83$	Cobb–Douglas accepted

Third, given that the pre and post trade reform data were pooled, we used the dummy variable approach and the F test to check for the stability of coefficients (intercept as well as slope coefficients; the dummy variable entered the regression models in additive and multiplicative ways) over time. The test results reported in Table 5 show that in all sectors there was no reason to reject the null hypothesis (H_0) of the stability of models. Moreover, the fact that the Durbin–Watson statistic is close to two in all sectors suggests that there was no specification error in the pooled regression models.

Table 5: F tests on the pooling of pre and post trade reform samples in Cameroon's manufacturing industries

Industry	Calculated F statistic	Critical F statistic	Decision	Durbin–Watson
Food products	1.6343	$F_{0.05}(7,94)=2.05$ $F_{0.01}(7,94)=2.73$	H_0 (stability) accepted	2.0774
Textiles	3.0656	$F_{0.05}(7,42)=2.24$ $F_{0.01}(7,42)=3.10$	H_0 (stability) accepted	1.8598
Wood, paper, printing	1.2149	$F_{0.05}(7,202)=2.05$ $F_{0.01}(7,202)=2.73$	H_0 (stability) accepted	1.7736
Chemical products	2.3223	$F_{0.05}(7,102)=2.1$ $F_{0.01}(7,102)=2.82$	H_0 (stability) accepted	1.467
Rubber and plastics	2.0388	$F_{0.05}(7,54)=2.18$ $F_{0.01}(7,54)=2.98$	H_0 (stability) accepted	1.5615
Electrical products	1.6861	$F_{0.05}(7,170)=2.05$ $F_{0.01}(7,170)=2.73$	H_0 (stability) accepted	1.6621

The maximum likelihood estimates (MLE) of the stochastic frontier model with panel data are reported in Appendix Table A2. In all sectors the output elasticity with respect to each input has the expected positive sign. Materials have the largest output elasticity, followed by workers and temporary workers, energy, and then foreigners and engineers. The returns to scale are not further from one, suggesting constant returns to scale. The overall rate of technical change is negative and insignificant (except in "rubber and plastic" and "electrical" sectors) in all sectors. Pre and post trade liberalization firm-level technical efficiencies were estimated using Equation 4, and the summary statistics are given in Table 6.

For the eight manufacturing sectors, and from pre- to post-reform periods, the average technical efficiency score varied from 64% to 95% and from 74% to 96%, respectively. This implies that the manufacturing sectors were operating before trade reform at 36% to 5% below capacity, and after the trade reform at 26% to 4% below capacity. In the post-reform period, and relative to the pre-reform period, the "food" and "electrical products" sectors experienced negative average technical efficiency growth of -6.28% and -5.83%, respectively. On the other hand, six sectors experienced rapid positive average technical efficiency growth in the post-reform period, with the "chemical" sector leading (+16.22%), followed by "wood and furniture" (+15.8%), "textiles" (+12.81%), and "beverage and tobacco" (+12.55%). These results imply that on average the firms in six of eight industries became technically efficient following the trade reform, while the reform negatively affected average technical efficiency in two of the eight industries.

Table 6. Pre(1) and post(2) trade reform summary statistics (%) of firm-level technical efficiencies in Cameroon's manufacturing industries

Industry	Average		Standard Dev.		Minimum		Maximum	
	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
Food products	79.29	74.31	13.79	13.63	39.53	45.97	99.16	99.15
Beverage and tobacco	75.09	85.16	19.53	12.11	23.89	60.02	99.23	99.64
Textiles	67.70	76.37	19.64	13.84	21.80	43.27	99.90	99.34
Wood and furniture	64.66	74.87	18.88	19.57	11.76	29.40	99.32	99.62
Paper and printing	75.43	77.52	19.08	16.38	33.35	35.94	99.52	99.99
Chemical products	64.11	74.51	19.98	20.34	36.89	32.88	99.89	99.96
Rubber and plastic	95.38	96.64	3.67	2.83	84.88	88.35	99.03	99.34
Electrical products	81.01	76.29	15.20	18.66	41.64	24.61	99.38	99.14
Total manufacturing	75.46	78.59	18.84	17.47	11.46	29.40	99.90	99.99

Because of differences between the pre and post trade reform average technical efficiencies, we tested the null hypothesis (H_0) of equal pre and post trade reform average technical efficiencies. For that, the following test was used, $T = (ATE_2 - ATE_1)/(\sqrt{\sigma_1^2/n_1 + \sigma_2^2/n_2})$, where ATE_1 and ATE_2 are pre and post trade reform average technical efficiencies, σ_1 and σ_2 are the standard deviations, and n_1 and n_2 are pre and post trade reform sample sizes, respectively. The calculated t-values are given in Table 7.

Table 7: T tests on the differences between pre and post trade reform average technical efficiency in Cameroon's manufacturing industries

Industry	Absolute t-value	p-value
Food products	1.8995**	0.0606
Beverage and tobacco	3.0138*	0.0034
Textiles	1.9247**	0.0596
Wood and furniture	2.8094*	0.0060
Paper and printing	0.5861	0.5592
Chemical products	2.7869*	0.0064
Rubber and plastic	1.6032	0.1136
Electrical products	1.6248***	0.1081
Total manufacturing	2.4545*	0.0143

*, **, *** significant at the 1%, 5%, and 10% level respectively.

From Table 7 we see that when we compare the pre and post trade reform results, the null hypothesis (H_0) is rejected in all sectors (except "rubber and plastic" and "paper and printing"). This implies that the drop in average technical efficiency in "food" and "electrical" and the increase in average technical efficiency following the trade reform were significant at the 1% level in four of eight industries. The pre and post trade reform behaviour of firm-level technical efficiencies can be seen from Table 8.

Table 8: Pre and post trade reform firm-level technical efficiency growth in Cameroon's manufacturing industries

Industry	Pre trade liberalization	Post trade liberalization
Food products	0.55%	-3.95%
Beverage and tobacco	-2.53%	5.46%
Textiles	-1.34%	2.79%
Wood and furniture	-3.87%	3.26%
Paper and printing	0.39%-	3.01%
Chemical products	-1.55%	2.16%
Rubber and plastic	0.85%	0.63%
Electrical products	1.44%	-2.26%
Average	-0.76%	1.39%

Prior to trade reform and on average, the annual growth rate for the entire manufacturing sector shows that firm-level technical efficiency was falling at 0.76%, with "wood and furniture" (-3.87% annual growth rate) and "beverage and tobacco" (-2.53% annual growth rate) having the worst records. In the post trade reform period, the firm-level technical efficiency increased on average at an annual rate of 1.39%, with the "beverage and tobacco" (5.46% annual growth rate), "wood and furniture" (3.26%), and "paper and printing" (3.01%) industries leading. However, the "food" and "electrical products" sectors experienced negative growth (-3.95% and -2.26% annual growth rate, respectively).

In terms of frequency distribution, the pre and post trade reform firm-level technical efficiencies are reported in Table 9. We assumed that when technical efficiency is located between 0 and 25% firms are considered as technically inefficient, between 25 and 50% firms are less technically efficient, between 50 and 75% firms are technically efficient, and between 75 and 100% firms are considered as very technically efficient.

Table 9: Frequency distribution of pre(1) and post(2) trade reform firm-level technical efficiency in Cameroon's manufacturing industries

Technical efficiency level (%)	Number of firms		Percentage	
	(1)	(2)	(1)	(2)
00.00–25.00	05	01	0.95	0.31
26.00–50.00	51	20	9.66	6.25
51.00–75.00	180	103	34.09	32.19
76.00–100.00	292	196	55.30	61.25
Total	528	320	100.00	100.00

The results in Table 9 show that there were wide variations in the level of technical efficiency across the sample firms (figures 1 and 2), and that the reform of the trade regime led to considerable improvements in firms' ability to operate near the production frontier.

Figure 1: Pre-trade reform distribution of sample firms by their technical efficiencies

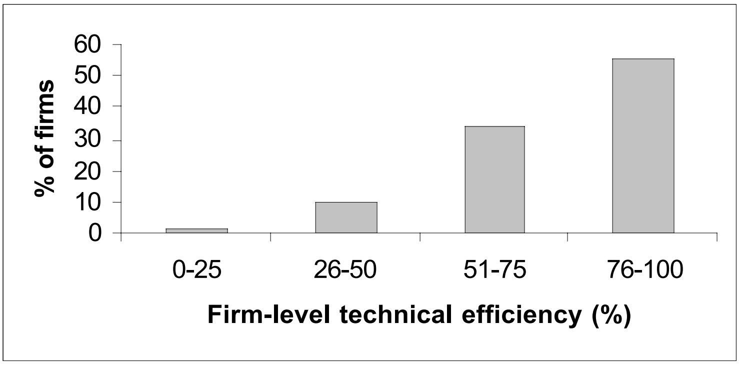
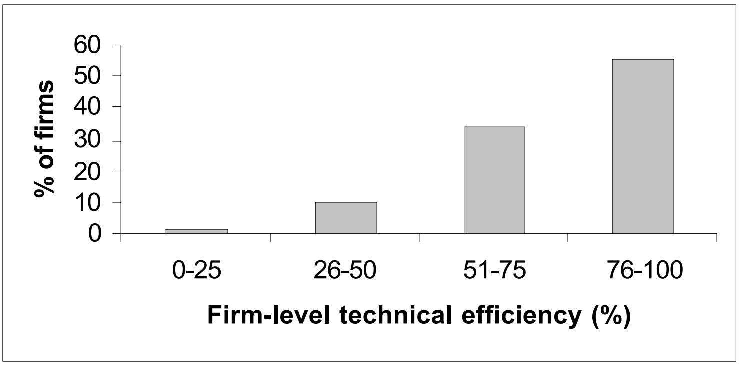


Figure 2: Post-trade reform distribution of sample firms by their technical efficiencies



Trade reform and technical efficiency

We now look at the patterns of association between the trade related variables, the macroeconomic variables and the firm-level technical efficiencies. The results of estimating Equation 5 using the Tobit, fixed-effects and standardized estimates methods are given in Table 10. All the variables (except the dummies, of course) are expressed in logarithmic form.

The before-trade-reform results presented in Table 10 show quite a good fit. The macroeconomic and political instability of the early 1990s appears to have affected negatively and significantly the firm-level technical efficiency. The import and export tariff rates have an unexpected positive effect, and only the effect of the import tariff rate is significant at the 5% level. The import penetration rate is positive and significant at the 5% level in explaining firm-level technical efficiency. This implies that prior to trade reform the increase in domestic competition as reflected by the penetration of imports was conducive to improvements in technical efficiency. In terms of the relative importance of exogenous variables, the export tariff rate plays an important role in explaining firm-level technical efficiency scores. Macroeconomic instability, as reflected by the black market premium, which is a good proxy for the degree of external sector distortions, and political instability appear to be the main impediments to increased firm-level technical efficiency scores.

Table 10: Trade regime and macroeconomic determinants of firm-level technical efficiency in Cameroon's manufacturing industries

				Pre trade reform					
	Tobit			Fixed-effects			Standardized		
Variables	Coeff.	t-value	p-value	Coeff.	t-value	p-value	Coeff.	t-value	p-value.
Constant	5.4518	2.04	0.042	-	-	-	-	-	-
Log(MTR)	0.0416	1.92	0.056	0.0399	2.05	0.041	-0.038	-1.28	0.202
Log(XTR)	0.0085	0.52	0.600	0.0108	0.66	0.506	0.135	2.11	0.035
Log(XS)	0.0073	-0.52	0.559	0.0067	-0.53	0.600	0.0219	0.43	0.668
Log(MPR)	0.0392	2.06	0.04	0.0372	2.06	0.040	0.0733	0.99	0.322
Log(BMP)	-2.461	-1.50	0.133	-2.688	-1.66	0.097	-0.186	-1.92	0.056
DPINS	-0.047	-1.16	0.247	-0.056	-1.78	0.075	-0.264	-2.00	0.046
R^2(adjusted)	0.735	-	-	0.4334			0.4085	-	-
No. of Observations	528		528			528			

				Post trade reform					
		Tobit			Fixed-effects			Standardized	
Variables	Coeff.	t-value	p-value	Coeff.	t-value	p-value	Coeff.	t-value	p-value.
Constant	4.505	1.50	0.135	-	-	-	-	-	-
Log(MTR)	-0.044	-2.01	0.0389	-0.143	-2.76	0.015	0.0816	3.28	0.001
Log(XTR)	-0.026	-1.73	0.084	-0.319	-2.22	0.027	0.14.5	2.35	0.019
Log(XS)	0.4731	3.85	0.000	0.4165	4.003	0.000	0.2823	3.511	0.000
Log(MPR)	0.5081	2.85	0.001	0.4902	3.8165	0.000	0.2279	4.481	0.000
Log(BMP)	-0.031	-0.05	0.962	-0.057	-0.09	0.931	0.0026	0.07	0.943
R^2(adjusted)	0.6025	-	-	0.4048	-	-	0.6334	-	-
No. of Observations	320			320			320		

The after-trade-reform results reported in Table 10 also show good fit. The import and export tariff rates now have the expected negative sign and are significant. Therefore, the firm-level technical efficiency and the import and export tariff rates vary in opposite directions—a decrease in tariff leads to an increase in technical efficiency. The computation of standardized coefficients, however, shows that in spite of having the expected sign and being significant, the import and export tariff rates are relatively less important than export share and the import penetration rate, but more important than the black market premium in explaining firm-level technical efficiency scores. The export share appears to have a significant positive effect on technical efficiency. This implies that the export-led growth hypothesis is credible in Cameroon's manufacturing sector after the trade reform—exports drive firm-level technical efficiency. In terms of magnitude, this result shows, for example, that an increase of export share by 10 percentage points will increase logarithmic firms' technical efficiency by nearly 4.7%. The import penetration rate is also positive and significant at the 1% level in explaining firm-level technical efficiency. Thus, the domestic competition as reflected by the penetration of imports had a strong positive role in driving the technical efficiency. For example, an increase of 10 percentage points in imports as a share of domestic sales will increase firm-level technical efficiency by about 5%. In terms of the relative importance, the standardized coefficient for the import penetration rate is 0.2279, less than that for the export share variable (0.2823).

9. Conclusion

This paper used firm-level balanced panel data to assess the effects of trade reform on firm-specific technical efficiencies in Cameroon manufacturing. The pre trade reform sample, which covered the four-year period from 1988/89 to 1991/92, and the post trade reform sample, which covered 1994/95–1997/98, were pooled and a single Cobb–Douglas stochastic production frontier was estimated for each industrial sector. The pooling test showed that the coefficients (intercept and slope coefficients) were stable over both sample periods.

The empirical results suggested that the trade reform provided an enabling environment for improving firm-level technical efficiency. Indeed, relative to the pre-reform scores, the post-reform average technical efficiency increased in six of eight industries and in total manufacturing. The pre-reform firm-specific technical efficiencies decreased on average at the annual rate of 0.76%, while the post-reform firm-specific technical efficiencies increased on average at an annual rate of 1.4%. Coming to the question of correlation, the Tobit and fixed-effects results showed that prior to trade liberalization the macroeconomic instability and the political instability of the early 1990s, coupled with a restricted trade regime, negatively affected firm-level technical efficiency. After trade reform, the potential determinants of firms' technical efficiency were the export share and the import penetration rate. Indeed, and as expected, the export-to-gross output ratio had a significant positive effect at the 1% level. The effect of import penetration rate on technical efficiency was positive and significant at the 1% level. Finally, the import and export tariff rates associated negatively and significantly with firm-level technical efficiencies.

Given the previous findings, and in order to improve the firm-level technical efficiency, the extent of the trade reform should be substantial, especially in the industrial sectors that are still not outward oriented. Therefore, measures to foster exports are welcome. Also, in order for the output to respond to the domestic competition related to the trade reform, the actual imports as a share of domestic sales should be increased in most industrial sectors. Finally, it is important to have a business-friendly environment, e.g., by reducing macroeconomic and political instability.

Notes

1. In this context, Rodrik (1992: 95) noted, "The standard prescription to a country undergoing trade liberalization is to devaluate the currency so as to offset any adverse effect the reform may have on the balance of payment".

2. For more developments in this sense see, among others, Havrylysbyn (1990) and Dornbusch (1995).

3. UDEAC is composed of the following countries: Equatorial Guinea, Congo, Chad, Cameroon, Gabon and the Central African Republic. The Treaty of Brazzaville formed it in 1964.

4. Indeed, the "food" and "beverage and tobacco" sectors were pooled to form the "food processing" sector. Also, the "wood and furniture" and "paper and printing" were pooled into one sector.

5. For more developments in this sense see Nishimizu and Page (1991), Falvey and Dong Kim (1992), and Pack (1993), among others.

6. Of course markets in protected economies are narrow, and the lack of competition from the rest of the world fosters oligopoly and inefficiency.

7. Some of the best known are: Krueger (1978), Papageorgiou et al. (1991), Dollar (1992), Greenaway (1994), Shafaeddin (1995), and Krueger et al. (2000).

8. Edwards (1998) points out that factors such as institutions, political instability and macroeconomic instability might be important determinants of total factor productivity growth as well. Concerning political instability, and according to Barro (1996), societies subject to a greater degree of political upheaval are more volatile and tend to discourage investment in innovation and productivity enhancements. Fischer (1993) among others argued that greater macroeconomic instability-and in particular higher inflation—tends to affect economic performance negatively.

9. In the "transport material" sector this can be partly due to the important phenomenon of re-exportation of imported "spare parts".

10. From 1990/91 to 1992/93 Cameroon went through serious political instability with the operations *villes mortes*, *pieds morts*, etc., i.e., campaign of widespread non-violent pro-democracy protest, including significant labour strikes.

11. Using a single production frontier for all the firms would not be appropriate because the firms do not use same inputs and do not produce the same outputs.

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Appendix

stics of pre(1) and post(2) trade reform variables in Cameroon's manufacturing sector

Food processing							Textiles and leather							
an	Standard deviation		Minimum		Maximum		Mean		Standard deviation		Minimum		Maximum	
(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)	(1)	(2)
5274.9	14096.0	8454.2	91.82	35.33	105200	46000.0	4599.40	5644.00	7625.20	7115.10	32.710	2.220	27750.00	48700.0
212.00	720.06	372.25	2.00	3.374	4651.0	2043.0	238.25	390.53	401.19	476.15	1.584	4.969	1466. 00	1208.0
92.22	406.05	146.58	1.782	0.8974	2786.0	594.3	65.87	206.18	115.29	293.48	2.871	2.945	527.40	836.6
219.39	623.38	311.08	6.238	3.817	3397.0	1052.0	447.64	477.75	687.76	620.82	13.470	2.025	2489.00	1717.0
13902.0	21515.0	26627.0	155.00	206.10	127700.0	119500.0	6791.70	7762.00	10076.00	21913.00	79.680	628.100	31170.0	59170.
3609.10	3253.3	7298.9	11.60	7.291	19930.0	50350.0	3983.30	7535.50	11651.00	13285.00	6.132	1.594	68370.01	51160.0
315.87	584.93	600.25	6.417	1.845	4909.0	3775.0	291.24	630.97	519.55	915.86	1.273	1.262	1925.0	2818.00
84.00	124.00	84.00	124.00	84.00	124.0	84.0	36.00	20.00	36.00	20.00	36.000	20.000	36.000	20.00
Wood, paper, printing							Chemical products							
1498.20	1347.40	1360.20	22.37	11.84	6652.00	5858.00	6680.90	8372.00	18825.0	22822.0	125.40	451.80	91100.0	93970.
76.965	69.423	80.771	0.8081	0.8589	273.00	359.30	272.45	226.31	530.10	464.71	1.089	3.96	2596.00	2023.0
22.288	24.952	25.767	1.089	1.282	147.80	159.40	78.22	70.32	181.42	174.78	1.782	1.043	827.00	673.0
78.496	152.25	84.615	3.168	2.638	790.20	457.10	115.06	85.79	136.99	112.35	7.327	5.725	526.60	438.5
1823.90	1434.30	2017.90	7.928	4.772	6578.00	9652.00	7222.00	10744.0	19944.0	29046.0	58.49	453.80	84450.0	108100
782.30	563.33	905.86	3.675	6.071	2917.00	4869.00	4637.60	7683.50	13136.0	25099.0	47.74	131.4	61680.0	125400
118.53	172.46	135.78	1.083	1.101	1074.00	481.10	214.78	371.41	581.14	932.72	3.814	8.627	3465.00	3969.
88.00	128.00	88.00	128.00	88.00	126.00	88.00	68.00	48.00	68.00	48.00	68.00	48.00	68.00	48.
Rubber and plastics							Electrical products							
2127.60	1079.10	3334.70	39.54	61.44	3998.00	4120.11	593.45	374.37	664.76	538.60	8.71	31.21	3904.00	2287.0
97.20	192.92	165.74	1.58	2.56	923.10	514.50	35.92	23.50	46.48	23.95	1.19	1.60	227.70	135.1
102.20	144.07	233.52	1.49	0.89	486.60	760.60	15.02	9.54	15.61	12.57	1.19	1.17	75.66	49.4
174.51	550.78	346.73	4.65	3.96	1974.00	1146.00	45.32	37.99	47.76	65.85	2.02	1.60	208.90	297.7
9915.90	18718.0	21180.0	48.00	425.80	62400.0	61980.0	729.10	768.95	807.40	861.50	8.14	31.07	3528.00	2869.0
1143.90	618.83	1633.4	24.43	15.66	1908.00	5924.00	402.05	227.50	609.61	307.07	5.00	3.69	3680.00	1273.0
138.44	178.32	248.72	1.25	10.49	675.00	1008.00	18.80	18.04	22.39	29.34	1.08	2.14	109.40	137.4
28.00	40.00	28.00	40.00	28.00	40.00	28.00	132.00	52.00	132.00	52.00	132.00	52.00	132.00	52.0

Table A2: Maximum likelihood estimates of stochastic production frontier with panel data in Cameroon's manufacturing sector

F	ood processing			Textiles and leather			Wood, paper-printing		
Variables	Coefficient	t-value	p-value	Coefficient	t-value	p-value	Coefficient	t-value	p-value
Constant	2.5978	11.53	0.0000	2.3479	3.397	0.0007	2.1641	8.75	0.0000
$Log(W_1)$	0.1838	3.053	0.0023	0.0892	1.476	0.1401	0.1001	2.5	0.01241
$Log(W_2)$	0.0900	2.257	0.0240	0.0897	1.173	0.1504	0.1488	2.844	0.0045
$Log(W_3)$	0.1055	2.11	0.0348	0.4871	1.226	0.1404	0.1898	3.261	0.0011
Log(K)	0.0148	0.369	0.7118	0.0046	2.0551	0.0521	0.1205	5.047	0.0000
Log(M)	0.4746	17.134	0.0000	0.3231	2.102	0.0611	0.3159	9.249	0.0000
Log(E)	0.1319	2.383	0.01719	0.2208	2.9031	0.0000	0.1845	4.656	0.0000
Time	-0.0199	-0.712	0.4762	-0.0340	-0.4712	0.4225	-0.0175	-0.807	0.4198
No. observations	208			56			216		

	Chemical products			Rubber and plastics			Electrical products		
Variables	Coefficient	t-value	p-value	Coefficient	t-value	p-value	Coefficient	t-value	p-value
Constant	2.655	10.889	0.0000	2.1456	5.488	0.0000	2.1679	8.427	0.0000
$Log(W_1)$	0.1800	4.126	0.0000	0.1132	1.113	0.2656	0.0592	0.782	0.4342
$Log(W_2)$	0.1981	4.422	0.0000	0.0992	1.664	0.0960	0.0464	0.674	0.5004
$Log(W_3)$	0.2347	1.927	0.0540	0.1976	1.515	0.1298	0.2716	3.842	0.0001
Log(K)	0.0009	0.034	0.9732	0.0665	1.197	0.2311	0.0038	1.083	0.3311
Log(M)	0.3252	6.865	0.0000	0.4930	5.745	0.0000	0.5857	17.9500	0.0000
Log(E)	0.1759	3.072	0.0021	0.1706	2.143	0.0321	0.0189	0.3370	0.7362
Time	-0.0315	-1.933	0.0532	-0.0500	-0.887	0.3751	-0.0461	-2.115	0.0344
No. observations	116			68			184		

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