Trade Liberalization, Infrastructure and Industrial Performance in Cameroon

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Summary:
Using pre-and post-reform industry-level panel and aggregate national infrastructure data, this paper examines the effects of infrastructure on industry productivity in Cameroon, controlling for trade variable and correcting for the likely endogeneity of infrastructure and other regressors. The empirical strategy involves, (i) estimation of production functions augmented by the infrastructure quantity and quality indicators and then derivation of industry-level productivity measures, (ii) accounting for output growth, and (iii) assessment of infrastructure impact on industry productivity growth. The results suggest that infrastructure stock index contributed to output growth and boosted productivity in both subperiods, but the post-reform effects were stronger. Infrastructure quality index significantly affected productivity growth only in the post-reform era. Interestingly, control trade variables appeared insignificant.

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1. Introduction

After achieving independence in 1960, Cameroon embarked on an industrialization strategy based on import substitution. This strategy was marked by the extensive use of quantitative restrictions and controls, high levels of tariffs, widespread rent-seeking activities, etc. However, Cameroon failed to industrialize using inward-looking strategies.[1] Various hypotheses have been advanced to explain Cameroon's industrial disappointing performance record. The poor performance of Cameroon industries during the last decades was mostly explained by inappropriate domestic policies e.g. the inward-orientation of the trade regime and the subsequent distortions due to industrial licenses.

Since the late 1980s and early 1990s, policies that reduced the openness to foreign trade have been largely reversed. The policy reform started in Cameroon in 1988 when the government accepted a stabilization program supported by an 18 month IMF standby agreement, followed one year latter with the adoption of a structural adjustment program financed through the World Bank and bilateral donors. Between 1990 and 1992, trade reform was marked by the elimination of non-tariff barriers. In 1993-94, trade reform gained momentum with (i) the consolidation of the existing regional trading arrangements i.e. the CEMAC-Communauté Economique et Monétaire de l'Afrique Centrale- member states succeeded in establishing a custom union and lowering drastically their external tariff,[2] and (ii) the devaluation of the CFA–Communauté Financière Africaine- franc by 50 percent against the French franc.

There are enormous advantages to trade e.g. the ability to use comparative advantage (as, for example, in producing very unskilled labor-intensive products), the removal of domestic monopoly positions and provision of competition for domestic producers, and learning from activities abroad (Kruger, 2009). More specifically, the potential benefits of trade reform include among others, (i) opportunities to access intermediate and capital goods embodying better technologies, (ii) stimulation of productive performance, better resource allocation, and exports, and (iii) access of local producers and consumers to less expensive and higher quality goods from abroad (Winter, 2004). However, many observers e.g. Noland and Pack (2003) and Milner (2006) among others, believe that domestic policies largely unrelated to trade such as institutions, macroeconomic management, education, health, infrastructure, etc. may now be the main obstacles to reap the benefits of trade reform in most developing economies.

Concerning specifically the inadequacy of infrastructure, the survival and competitiveness of domestic industries in most developing countries depend largely on the reliability and the degree of improvement of transport networks, electricity, gas, water and telecommunication. In this context, Krueger (1995) writes, '… an outer-oriented trade strategy cannot succeed unless development of infrastructures (ports, roads, railroads, electric power, communication), and a number of other policies are conducive to growth'. Indeed, the

[1] The inner-looking policies were successful for almost two decades. For instance, between 1961-79, the average annual sector-wide growth rate was 9.7 percent (Tybout et al., 1997). However, the Cameroonian industry closed the century with a mixed record. For instance, the contribution of the industrial sector to gross domestic product-GDP dropped from 24 in 1993 to 19.7 percent in 2000 (Ministère du Développement Industriel et Commercial, 2001). There were also among others major price distortions, the domination of industry by foreign and public interests, and the underdevelopment of the indigenous private sector.

[2] The CEMAC is composed of the following countries: Cameroon, Chad, Central African Republic, Congo Republic, Equatorial Guinea, Gabon, and Sao Tome & Principes.

infrastructures serve as intermediate inputs to production of industries. Therefore, changes in their quantity and quality possibly affect the profitability of industrial production (Fedderke and Bogetic, 2009).

If infrastructure matters, then the questions of (i) its impact on industrial performance, and (ii) its interactions with trade reform policies are relevant and legitimate. In this article, we use pre-reform (1986-94) and post-reform (1995-03) industry-level panel as well as aggregate national infrastructure data to investigate the relationship between industry-level total factor productivity-TFP and three types of infrastructure, namely electricity, transport, and telecommunication. Specifically, the problem is addressed in three steps. First, a flexible production function-translog augmented by the infrastructure stock and quality indicators was estimated on each subperiod separately and then on the pooled sample of pre-and post-reform periods. Second, the growth accounting framework was used to measure the contribution of synthetic indexes of infrastructure stock and quality to output growth. Finally, and in a regression framework, the impact of aggregate indexes of infrastructure stock and quality on industry productivity growth was assessed controlling for trade variables. Moreover, and in the context of Cameroon where there is not only an increased reliance of the private sector on the provision of public infrastructure services and also constraints on industrial performance due to infrastructure provision, the possibility of infrastructure endogeneity is a real issue. The potential endogeneity of infrastructure as well as other explanatory variables was addressed using the GMM-IV system estimator technique.

Our results are as follows. First, we find that the synthetic measure of infrastructure stock and output were positively associated in the pre-and post-reform periods, repectively. Over the entire period from 1986 to 2003 i.e. pooled sample, the coefficients on the indexes of infrastructure stock and infrastructure quality were negative, pointing to a negative contribution of infrastructure stock and quality to industrial output. Second, the output growth accounting findings suggest that the accumulation in infrastructure stocks was relevant in explaining both pre-and post-reform industrial output growth, with a stronger role in the latter subperiod, whereas only infrastructure quality contributed to post-reform output growth. Third, the aggreagte index of infrastructure stock boosted the pre-and post-reform productivity growth, but the post-reform effect tended to be stronger. A one standard deviation increase in aggregate index of infrastructure stock resulted in a pre-and post-reform productivity increase of 3.9 and 12.4 percentage points, respectively. Finally, the synthetic index of infrastructure quality had a significant positive effect only on post-reform industry productivity growth rates. A one standard deviation increase in the infrastructure quality index increased post-reform productivity growth by 8.9 percentage points and had essentially no effect before trade reform. Interestingly the control trade variables were insignificant.

The remainder of the article is laid out as follows. The next section presents the theoretical background. The third section presents the pre-and post-reform patterns of growth in Cameroon industrial activities. The fourth section presents the methodological framework. The fifth section presents the data sources and definitions including discussion of how we constructed the synthetic indexes of infrastructure stock and quality. The sixth section presents and analyzes the empirical results. The seventh section concludes and gives the policy implications of our findings.

2. Theoretical Background

As suggested in the neo-liberal view, trade liberalization is the route to improved industrial performance. The various transmission channels are the following, among others. First, trade liberalization allows domestic producers to achieve the economies of scale by taking advantage of market expansion. Second, through participation in foreign markets, trade liberalization enables local producers to absorb technologies and knowledge. Third, trade liberalization pressures producers to reduce X-inefficiency in order to cope with foreign competition. Last but not least, trade liberalization forces producers to refrain from rent-seeking behavior.[3] However, it is largely agreed that the degree to which local producers can take advantage of trade liberalization depends upon the country's characteristics e.g. the state of infrastructures. In fact, many liberalization programs are implemented in most developing countries facing infrastructure bottlenecks. In this context, the expected benefit of trade liberalization might be completely jeopardized.

The transport infrastructures (roads, railways, port and airport facilities) are important for transporting intermediate and final goods as well as for employees for commuting to work. Poor transport networks might lead to inappropriate incentive system and inefficient management such as unreliable supply of inputs and goods produced, waste of time on the road, etc. Increases in the provision of the services of public capital might be an important determinant of output growth (see Lynde and Richmond, 1993 and Fernald, 1999 among others). Indeed, an increase in the transport networks increases the quantity of transportation services and then to lower costs of production. In addition, efficiency in inputs utilization increases as well as the producers' productivity (Winston, 1990).

Coming to telecommunication infrastructure, when the state of telephone system is rudimentary, communications between firms are limited. The transaction costs of ordering, gathering information, searching for services are high (Roller and Waverman, 2001). Inadequate telecommunication services also lead to inappropriate incentive system and inefficient management such as hold of conversations that could be handled in moments over a working phone line. The results is the increase in X-inefficiency (Winston, 1998). As the telephone system improves, the costs of doing business fall and output might increase for individual firms in the different sectors of the economy. Thus, telephone infrastructures by lowering the fixed and variable costs on information acquisition provide significant benefits i.e. their presence allows productive units to produce better. Moreover, the ability to communicate at will increase the ability of producers to engage in new productive activities (Leff, 1984). In sum, telecommunications infrastructure provides facilities for communications and saves time, energy, labor, and capital by condensing the time and space required for production, consumption, market activities, government operations, educational and health services. So, by reducing inherent delays at various stages of production, the availability of communication allows for improved production efficiency.

Last but nor least, if the state of power infrastructures (electricity and water) is poor, the costs and production techniques are directly affected. Indeed, a poor electricity supply imposes huge costs on the firm arising from idle workers, materials spoilage, lost output, damage to equipment and restart costs. Similarly, the power outages are one of the major factors in low capacity utilization in industries of most developing economies. Also, in a context of lack and high utility prices, etc. firms most produce their own power by buying

[3] For a compact elaboration on this issue see Baldwind and Nicoud (2006), and Legrain (2006) among others.

generators, thus the increase in the costs of production. Indeed, frequent power cuts and voltage fluctuations have tangible output consequences since they force industrial establishments to undertake extra investments in generators in order to avoid production losses as well as damage to machinery and equipment. Such extra investments raise industrial costs and make it difficult for domestic industries facing strong competition following trade liberalization to compete in price with their foreign counterparts (Lee and Anas, 1996). In sum, power generation shortages carry the risk of disorganization of industrial production.

3. Pre-and Post-reform Trends in Cameroon Industries

The patterns of growth across individual industries before and after trade reform are illustrated in Table 1. During the pre-reform period (1986-94) output growth varied drastically across industries. The production grew most rapidly i.e. at two digits per year in six industries, namely fishing, other food, textile-weaving , paper-printing, miscellaneous, and restaurants-hotels. Ten industries experienced moderate output growth, with the production increasing in the range of 0.4-7.8 percent per annum. The remaining industries experienced decreasing production, with the more decline (12.5 percent per year) occurring in the agricultural production for industry and exports sector. During the period following immediately trade reform (1995-03) the figures in Table 1 show that two industries e.g. forestry-logging, and mining-quarrying experienced declining output of respectively 1.5 and 0.04 percent per year. The remaining industries under investigation experienced increasing production, with wood-furniture, and real-estate and business services industries registering the highest output growth rate of nearly 10.6 percent per annum. Coming to the impact of trade reform, the figures in Table 1 indicate that 22 of 29 industries experienced improvement in output following trade reform while the remaining industries experienced output drop.

As far as employment is concerned, the figures in Table 1 indicate that two industries e.g. agricultural crop production, and miscellaneous experienced increasing employment before trade reform, with the former being the more important industry in terms of labor used. The remaining 27 industries experienced decreasing employment. Indeed, in the context of domestic industrial development through import substitution, the artificially cheap capital goods imports encouraged the use of capital-intensive means of production. That, in turn, led to very low or even negative rates of growth of employment in most industries. After trade reform, four industries experienced declining employment. The remaining 25 industries experienced improvement in their labor force with the dramatic increase of nearly 20 percent per annum occurring in transport-storage-communication industry. Relative to the pre-reform era, the period following immediately trade reform was marked by an improvement in employment of all industries. The exception was in the agricultural crop production industry where the post-reform employment growth was still positive but lower than the pre-reform level.

Concerning the labor productivity measured as the value added per capita, the figures in Table 1 indicate the following facts. During the 1986-94 pre-reform period, one industry (agricultural crop production) experienced negative labor productivity growth. The remaining industries experienced positive labor productivity growth with the (i) breeding-hunting, (ii) flour-vegetable, (iii) processing of agriculture products, (iv) textile-weaving, and (v) restaurants-hotels industries leading. During the 1995-03 post-reform period, the labor productivity grew in 13 industries with the dramatic increase of nearly 47.4 percent per annum occurring in the chemical industry. The remaining industries experienced declining labor productivity gains with the metal-machinery-equipment, and transport-storage-communication sectors experiencing the worst drop. Finally, and regarding the effect of trade reform, the evidence in Table 1 indicates that following trade liberalization, labor productivity improved only in four industries and deteriorated in the remaining 25 industries.

Concerning the degree of integration into the world economy, Table 2 reports the changes from 1986 to 2003 in export share, import penetration rate, and effective rate of assistance. Between 1986 and 2003 the import penetration rate improved in 11 industries. The most integrated industries into the international trade were agricultural crop production, forestry-logging, mining-quarrying, beverage-tobacco, shoes-leather, and rubber-plastic. In these industries the import penetration rate increased by more than 50 percent between 1986 and 2003. The remaining industries recorded declining import penetration rate, with agricultural production for industry and exports, fishing, other food, textile-weaving, wood-furniture, paper-printing, and miscellaneous industries recording the dramatic decline of more than 50 percent.

Concerning the outward-orientation, the figures in Table 2 once again indicate diversity of experiences across industries. Between 1986 and 2003, 14 of 29 industries experienced an increase in export share, with building materials, rubber-plastic, and shoes-leather industries leading. The rest of industries recorded a decline in export share. The decline of more than 50% occurred in the fishing, other food, paper-printing, transport equipment, and miscellaneous industries.

Coming finally to the effective protection movements, the results in Table 2 indicate that 18 of 29 industries experienced increase in effective rate of assistance between 1986 and 2003. The dramatic increase (more than 50 percent) occurred in the fishing, flour-vegetable, processing of agricultural products, other food, textile-weaving, paper-printing, basic metal, miscellaneous, and restaurants-hotels industries. The remaining industries recorded a contraction in effective rate of assistance between 1986 and 2003.

Table 1. Output, employment and labor productivity growth (%) before and after trade reform in Cameroon industries

Industry	Output			Employment			Labor productivity		
	Pre-reform	Post-reform	Improvement (+) or drop (-)	Pre-reform	Post-reform	Improvement (+) or drop (-)	Pre-reform	Post-reform	Improvement (+) or drop (-)
Agricultural crop production	2.55	6.03	+	80.79	4.82	-	-42.91	0.62	+
Agricultural production for industry and exports	-12.55	3.67	+	-27.2	7.64	+	23.53	-5.57	-
Breeding and hunting	-2.06	5.22	+	-37.05	2.33	+	50.05	3.22	-
Fishing	20.9	6.69	-	-38.66	10.69	+	114.12	-2.52	-
Forestry and logging	0.58	-1.49	-	-23.7	8.72	+	32.19	-8.1	-
Mining and quarrying	-4.8	-0.04	+	-30.82	11.08	+	35.19	-9.97	-
Production of flour and vegetable	1.08	4.96	+	-34.99	3.24	+	67.83	2.15	-
Processing of agriculture products	0.41	7.87	+	-22.23	6.07	+	40.9	0.63	-
Other food	29.83	5.72	-	-20.74	11.94	+	59.37	-5.64	-
Beverage and tobacco	-6.22	5.88	+	-26.3	-5.98	+	25.84	10.76	-
Textile and weaving	10.34	3.61	-	-23.1	5.32	+	54.58	-1.3	-
Shoes and leather	-6.65	1.22	+	-23.00	5.19	+	27.86	-7.36	-
Wood and furniture	3.92	10.57	+	-21.54	10.28	+	30.58	-1.02	-
Paper and printing	17.67	9.06	-	-8.63	12.1	+	25.83	-7.61	-
Chemical products	1.11	4.26	+	-15.92	-15.95	-	19.78	47.37	+
Rubber and plastic24.06	-1.98	4.00	+	-2.89	-0.02	+	4.06	11.55	+
Building materials	-1.13	8.36	+	-18.54	-12.18	+	16.32	24.06	+
Basic metal	1.89	3.98	+	-21.82	9.09	+	38.08	-2.82	-
Metal, machinery and equipment	-7.08	5.41	+	-22.86	12.95	+	26.2	-11.39	-
Transport equipment	7.84	0.41	-	-14.93	0.07	+	39.55	4.36	-
Miscellaneous	24.67	8.13	-	4.9	7.77	+	25.72	2.11	-
Electricity, gas and water	0.18	4.43	+	-13.37	3.35	+	13.23	-0.95	-
Construction	-1.2	7.51	+	-29.61	7.78	+	25.74	-0.89	-
Whole sale and retail trade	2.35	6.17	+	-29.94	11.36	+	45.43	-5.26	-
Restaurants and hotels	25.28	6.85	-	-26.26	9.16	+	63.19	-1.92	-
Transport, storage and communication	-3.23	7.4	+	-22.15	20.21	+	25.16	-11.89	-
Financial institution	4.54	3.87	-	-24.49	0.51	+	40.54	2.12	-
Real-estate and business services	-2.69	10.59	+	-30.65	6.17	+	17.64	4.18	-
Services to collectivities	1.2	6.27	+	-23.76	2.76	+	34.67	2.65	-

Source: Author’s calculations using annual industrial survey data of the National Institute of Statistics.
Note: All growth rates are calculated by a regression of that variable on a constant trend.

Table 2. Trade orientation in Cameroon industries, 1986 and 2003

Industry	Export share			Import penetration rate			Effective rate of assistance		
	1986	2003	% change	1986	2003	% change	1986	2003	% change
Agricultural crop production	0.003	0.016	444.67	0.004	0.012	195.00	0.111	0.131	17.52
Agricultural production for industry and exports	0.264	0.81	207.269	0.049	0.002	-95.122	0.167	0.114	-31.585
Breeding and hunting	0.007	0.004	-44.615	0.007	0.004	-40.299	0.133	0.131	-1.132
Fishing	0.051	0.001	-97.633	0.391	0.0001	-99.974	0.042	0.139	229.314
Forestry and logging	0.101	0.235	132.182	0.0001	0.006	5800.00	0.093	0.111	19.281
Mining and quarrying	0.476	0.967	103.107	0.025	0.948	3755.285	0.137	0.103	-24.843
Production of flour and vegetable	0.0001	0.0002	100.00	0.159	0.178	12.35	0.08	0.127	58.032
Processing of agriculture products	0.079	0.254	219.27	0.023	0.129	464.912	0.08	0.135	68.035
Other food	0.169	0.006	-96.393	0.561	0.052	-90.71	0.04	0.133	235.443
Beverage and tobacco	0.008	0.023	175.61	0.029	0.064	123.776	0.141	0.137	-2.488
Textile and weaving	0.033	0.113	248.308	0.16	0.03	-80.952	0.065	0.122	85.78
Shoes and leather	0.0002	0.014	6900.00	0.071	0.158	123.338	0.147	0.117	-20.774
Wood and furniture	0.018	0.523	2870.46	0.029	0.001	-95.105	0.118	0.152	28.874
Paper and printing	0.077	0.013	-83.333	0.769	0.225	-70.769	0.046	0.149	224.106
Chemical products	0.037	0.203	445.308	0.329	0.421	27.911	0.122	0.163	33.58
Rubber and plastic24.06	0.007	0.591	8218.31	0.261	0.506	93.91	0.111	0.15	35.682
Building materials	0.012	0.163	1247.934	0.293	0.224	-23.798	0.164	0.142	-13.589
Basic metal	0.235	0.367	56.29	0.323	0.475	47.137	0.071	0.119	66.387
Metal, machinery and equipment	0.263	0.176	-32.902	0.778	0.826	6.264	0.143	0.099	-31.006
Transport equipment	1.105	0.033	-97.041	1.011	0.87	-13.979	0.113	0.101	-10.424
Miscellaneous	0.048	0.004	-92.678	0.436	0.028	-93.549	0.036	0.147	304.683
Electricity, gas and water	Na	Na	Na	Na	Na	Na	0.104	0.122	17.78
Construction	Na	Na	Na	Na	Na	Na	0.209	0.134	-35.937
Whole sale and retail trade	Na	Na	Na	Na	Na	Na	0.117	0.145	23.956
Restaurants and hotels	Na	Na	Na	Na	Na	Na	0.053	0.141	167.904
Transport, storage and communication	Na	Na	Na	Na	Na	Na	0.123	0.146	18.485
Financial institution	Na	Na	Na	Na	Na	Na	0.116	0.126	8.341
Real-estate and business services	Na	Na	Na	Na	Na	Na	0.157	0.138	-12.117
Services to collectivities	Na	Na	Na	Na	Na	Na	0.111	0.131	17.993

Source: Author’s calculations using annual industrial survey data of the National Institute of Statistics. Na implies not avaialble.

4. Methodological Framework

To evaluate whether public infrastructure matters in the trade liberalization-productivity nexus, we use the following production function augmented by public infrastructures,

(1) $$Y = F(K, L, M, G_s, G_q)$$

The production function (1) assumes that public infrastructure may enhance the industries' production. If we assume that the functional form chosen for production is a Cobb-Douglas in a logarithmic form so that the input coefficients represent input elasticities,[4] the estimating equation for industry i at period t is given by,

(2) $$Y_{it} = \beta_0 + \beta_1 L_{it} + \beta_2 K_{it} + \beta_3 M_{it} + \delta_1 G_{st} + \delta_2 G_{qt} + \mu_{it} + \nu_{it}$$

where Y_{it} is output, L_{it}, K_{it}, and M_{it} are respectively labor, capital, and raw materials expenditures inputs, while G_{st} and G_{qt} are the stock and quality of infrastructure at period t.

To overcome the problem of multicollinearity that arises when estimating with a large number of infrastructure indicators, the first step in our approach consists in developing, using principal component analysis, an aggregate index of infrastructure stock and an aggregate index of infrastructure quality. The second step in our approach consists in testing the stationarity of the series used in equation (2). In the case of pooled cross-sectional and time-series data, we use the Im-Peseran-Shin (1997) method which allows us to test the unit root hypothesis for all the individuals of the sample at the same time. If the results lead to the rejection of the unit root hypothesis, then we test for co-integration of the series i.e. test of the stationarity of the residuals of the regression using the same method. Indeed, the production function can be interpreted as a long-term co-integration relation if the unit root tests performed on the residuals show that these residuals are stationary while the dependent and independent variables are integrated of order one, I(1).[5] Also, we address the likely endogeneity of infrastructure as well as that of other regressors using the GMM-IV system estimator technique of Arellano and Bover (1995) and Blundell and Bond (1998). We used both lagged levels and lagged differences of the regressors as instruments.

The third step in our approach consists in accounting for output growth before and after trade reform. To derive the growth accounting, the standard procedure is to divide output growth into components attributable to changes in the factors of production. To see how, we re-write equation (2) in growth rates,

(3) $$\frac{dY_{it}}{Y_{it}} = \beta_1 \frac{dL_{it}}{L_{it}} + \beta_2 \frac{dK_{it}}{K_{it}} + \beta_3 \frac{dM_{it}}{M_{it}} + \delta_1 \frac{dG_{st}}{G_{st}} + \delta_2 \frac{dG_{qt}}{G_{qt}} + \frac{d\mu_{it}}{\mu_{it}}$$

where β_1, β_2, β_3, δ_1, and δ_2 are the output elasticities of labor, capital, materials, index of infrastructure quantity, and index of infrastructure quality, respectively, and $\frac{d\mu_{it}}{\mu_{it}}$ is the rate of change of TFP. Equivalently, equation (3) can be written as follows,

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[4] The choice between the Cobb-Douglas and the translog functional forms will be made using the conventional F test that compares the restricted and unrestricted residual sums of squares.

[5] Mitra et al. (2002) followed the same approach, but rather used the Levin and Lin (1993) approach. It seems that the Im-Pesaran-Shin method provides more robust results for relatively small samples as compared with performing a separate unit root test for each individual time series.

(4) $$r_Y = \beta_1 r_L + \beta_2 r_K + \beta_3 r_M + \delta_1 r_{Gs} + \delta_2 r_{Gq} + r_{TFP}$$

where r_Y is the growth of output, r_L, r_K, r_{Gs}, r_{Gq}, and r_{TFP} are respectively, the growth rates of labor, capital, synthetic index of infrastructure stock, aggregate index of infrastructure quality, and of TFP. The equation (4) simply states that the growth rate of output is equal to the sum of the growth rate of labor weighted by β_1, growth rate of capital weighted by β_2, growth rate of raw materials expenditures weighted by β_3, growth rate of the stock of infrastructure weighted by δ_1, growth rate of the quality of infrastructure weighted by δ_2, and growth rate of TFP.

The pre-and post-reform growth accounting consists in assessing, (i) the contribution of labor to growth, which is given by the ratio of labor growth weighted by the corresponding factor income to output growth rate, (ii) the contribution of capital to growth, which is given by the ratio of capital growth weighted by the corresponding factor income to output growth rate, (iii) the contribution of raw materials expenditures to growth, which is given by the ratio of raw materials expenditures growth weighted by the corresponding factor income to output growth rate, (iv) the contribution of stock of infrastructure to growth, which is given by the ratio of stock of infrastructure growth weighted by the corresponding factor income to output growth rate, (v) the contribution of infrastructure quality to growth, which is given by the ratio of infrastructure quality growth weighted by the corresponding factor income to output growth rate, and (vi) the contribution of productivity growth to growth as the ratio of TFP growth (r_{TFP}) to output growth rate. From equation (4) the TFP growth can be computed for each industrial sector as follows,

(5) $$r_{TFP} = r_Y - (\beta_1 r_L + \beta_2 r_K + \beta_3 r_M + \delta_1 r_{Gs} + \delta_2 r_{Gq})$$

It is important to note that a relative industry productivity measure comparable across years is obtained by simply subtracting the productivity of an industry with mean output and inputs in a base year (1986 for the pre-liberalization period and 1995 for the post-liberalization period) from each individual industry's productivity as follows,

(6) $$TFP_{it} = y_{it} - \hat{\beta}_1 l_{it} - \hat{\beta}_2 k_{it} - \hat{\beta}_3 m_{it} - \hat{\delta}_1 G_s - \hat{\delta}_2 G_q - (y_r - \hat{y}_r)$$

where $y_r = \bar{y}_{it}$, $\hat{y}_r = \hat{\beta}_1 \bar{l}_{it} + \hat{\beta}_2 \bar{k}_{it} + \hat{\beta}_3 \overline{m}_{it} + \hat{\beta}_4 \overline{G}_s + \hat{\beta}_5 \overline{G}_q$, and the bar over a variable indicates the mean over all industries in the base year. Therefore, y_r is the mean log output of industries in the pre- and post-liberalization base years, 1986 and 1995 respectively, and $\hat{y}_r$ is the predicted mean log output in 1986 and 1995.[6]

We finally assess the role of infrastructure in the TFP movements across the trade regimes i.e. we focus on the role of the stock and quality of infrastructure in explaining the performance of Cameroonian industrial sectors before and after trade reform. Our estimation is based on an equation in which TFP growth of each industry is supposed to depend on the stock and quality of infrastructures. To make the effects of infrastructures clearer we control for trade liberalization variables e.g. export share (XS), import penetration rate (MPR), and effective rate of assistance (ERA). Indeed, we assume that the effects of liberalization depend on sectoral export shares i.e. sectors with high and increasing share of exports are more likely to benefit from the dynamic effects of trade. We capture the intensity of import competition in

[6] We drawed heavily from Aw et al. (2001) who used the same approach, but rather at the firm level.

each sector by the import penetration rate[7]. In the absence of continuous data on the industry-level effective rate of protection, we follow Chand et al. (1998) and use the effective rate of assistance, which is conceptually analogous to the measure of effective rate of protection. The effective rate of assistance takes account of the value added by giving assistance (tariff, quotas, subsidies, etc) on both outputs and intermediate inputs of each of the industries over time.

In addition to potential endogeneity of infrastructure, the endogeneity of the previous trade policy variables could be an issue.[8] Instrumental variable estimation is a way to address this issue. However, in the context of Cameroon we do not have good instruments, e.g. political economy determinants of trade policy. To circumvent the endogeneity problem of trade policy, we also use the GMM-IV system estimator, which combines the first-difference model (instrumented with lagged levels of the regressors) with its original version in levels (instrumented with lagged differences of the regressors). Also, productivity growth in some industries may be higher than in others due to factors that we do not fully capture. We therefore allow for exogenous differences in productivity growth rates across industries by including industry-specific effects α_j in the specification. We also control for macroeconomic shocks common to all industries by including time effects α_t in the regression. To address the issue of whether TFP grows differently as well as whether the stock and quality of infrastructure affect TFP growth differently before and after trade reform, the productivity gains equation is estimated in two forms e.g. restricted and unrestricted. The unrestricted equation takes the following form,

$$\Delta \ln TFP_{it} = \beta_0 + \alpha_j + \alpha_t + \gamma_0 Dum + \beta_1 \ln X_{it} + \gamma (Dum * \ln X_{it}) + \nu_{it} \quad (6)$$

where D_{um} is a trade reform dummy variable equal to 1 for pre-reform observations and the columns of X matrix are trade and infrastructure variables. Here Δ indicates a one-year difference. The error term ν_{it} is iid.

5. Data Definitions and Sources

The industry-level data for the present study are from the annual industrial surveys available at the Cameroon National Institute of Statistics-NIS, which gathers data on all industries on an annual basis The data consist of annual observations during the import-substitution era (1986-94) and immediately after trade reform (1995-03) for a sample of 29 industrial sectors. The output and inputs variables are as follows. For each industrial sector, output is measured as the sector gross domestic output in 1986 constant prices. The gross output deflator in the different industrial sectors is used as deflator. The quantity of labor input is given by sector employment data. The capital stock is calculated using the perpetual inventory method i.e. $K_t = (1-\delta)K_{t-1} + I_t$ with I_t standing for the industry-level investment series. We assume a depreciation rate (δ) of 4 percent per year. The initial capital stock (K_0) is calculated using the approach of Hall and Jones (1999) i.e. $K_0 = (K/Y)_0 = (I/Y)/g_I + \delta$ where g_I is the growth rate of gross investment (I) over the next three years during the pre-and post-

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7 The import competition puts pressure on domestic producers, forcing them to increase their productive efficiency or to exit. On the other hand, if import penetration is overwhelming, the domestic firms may not be able to face the competition and therefore experience a decline in productivity . See among others Amiti and Konings (2007) for further elaborations.

8 For instance, the government authorities may change trade policy in response to pressures by industries experiencing less productivity growth, thus generating simultaneity between trade policy at time t and productivity growth from t-1 to t (Fernandes, 2003).

reform periods, respectively, and δ is the depreciation rate.[9] Raw materials expenditures are not proportional to output, and are therefore included in the analysis. They are measured in 1986 constant price using the price indexes of raw materials in the industrial sector as deflator.

Concerning the infrastructure variables, the aggregate index of infrastructure stock is built using data from, (i) telecommunication sector e.g. number of main telephone lines per 1,000 population, (ii) power sector e.g. electricity generating capacity in MW per 1,000 population, and (iii) transportation sector e.g. length of the road network in km per square km of land area. The first component of the three stock variables accounts for 89 percent of their overall variance.[10] Specifically, the correlation between the first principal component and main telephone lines is 0.59; its correlation with power generating capacity is 0.56; and its correlation with the length of the road network is 0.39. All three infrastructure stocks enter the first principal component with different weights, $G_s = 0.8992\ln(Z_1) + 0.6911\ln(Z_2) + 0.463\ln(Z_3)$ where G_s is the synthetic index of infrastructure stock, Z_1 is the number of main telephone lines (per 1,000 population), Z_2 is the electricity generating capacity (in GW per 1,000 population), and Z_3 is the total road length normalized by the surface area of the country (in km per square km).

In a similar fashion the aggregate index of the quality of infrastructure services is built by applying the principal component analysis to three indicators of quality in, (i) services of telecommunication e.g. waiting list for telephone main lines which can be considered as an indicator of the quality of telecommunication network given that a large waiting list implies that the country invests less in telecommunication infrastructure, (ii) power e.g. percentage of transmission and distribution losses in the production of electricity, and (iii) transport e.g. share of paved roads in total roads. The first principal component of theses indicators of infrastructure quality captures approximately 68 percent of their total variation, and it shows a high correlation with each of the three individual quality indicators i.e. 0.67 for telecommunication, 0.69 for power, and 0.25 for transport. The synthetic index is expressed as, $G_q = 0.6011\ln(Q_1) + 0.278\ln(Q_2) + 0.1557\ln(Q_3)$ where G_q is the synthetic index of infrastructure quality, Q_1 is the measure of waiting list of main lines telephone installation, Q_2 is the share of power output net of transmission and distribution losses in total output, and Q_3 is the share of paved roads in total roads.

Finally, the liberalization variables are defined as follows. Export intensity is the ratio of exports to gross output. Import penetration rate is the ratio of imports to domestic sales (output plus imports minus exports). Effective rate of assistance is measured as a percentage of value-added in each industrial sector. The summary statistics of all variables are presented in appendix Table A.

[9] The capital output ratio K/Y is assumed to be constant at the steady state, implying that the rates of changes in capital and output are equal.
[10] Before applying principal component analysis, and in order to abstract from units of measurement, the underlying variables are standardized.

6. Empirical Evidences

6.1. Panel data estimates of the production function of Cameroon's industries

As stated a preliminary step in our approach consisted in testing the stationary of the series used in the production function. The results of these tests using the Im-Pesaran-Shin method are reported in appendix Table B. These results led to the rejection of the unit root hypothesis, except in a few cases e.g. materials and aggregate index of infrastructure quality. This allowed us to test for the co-integration of the series in the second step. But, before testing for co-integration the choice between the Cobb-Douglas and the Translog functional forms was made using the conventional F test that compares the restricted and unrestricted sums of squares residuals. The computed F-statistic is given by, $F_{r,n-k} = [(SSR_r - SSR_u)/r]/(SSR_u/n-k)$ where SSR_r, SSR_u, r, n and k stand for sum of squared residuals in the restricted specification (Cobb-Douglas) and unrestricted specification (Translog), number of restrictions, number of observations and number of estimated parameters respectively. The computed F scores were respectively 15.24 for the pre-reform sample, 4.57 for the post-reform sample, and 14.768 for the pooled pre-and post-reform sample. These statistics are higher than the 5 percent critical value of 1.69, implying that the Translog form was best supported by the pre, post, and pooled sample data.[11] The production technology of the Cameroon industries is then represented by,

(7) $$\ln y_{it} = \beta_0 + \sum_{i=1}^{n} \beta_i \ln x_{it} + \tfrac{1}{2}\sum_{i}^{n}\sum_{j}^{n} \beta_{ij} \ln x_{it} \ln x_{jt}$$

where x_{it} (x_1, x_2, …, x_n) denotes a vector of inputs. The unit root tests performed on the residuals of the production functions results reported in appendix Table C indicate that these residuals are stationary, while the dependent and explanatory variables are I(1). The before, after, and pooled production functions can therefore be interpreted as long-run con-integration relations. Also, the Sargan test failed to reject the null in all cases lending support to the models. Likewise, the presence of second order serial correlation was rejected in all equations.

However, the estimates of the translog production functions in appendix Table C do not convey any direct economic interpretation. Therefore, the output elasticities with respect to different inputs were derived using the following equation,

(8) $$\eta_j = \frac{\partial y}{\partial x_j}.\frac{x_j}{y} = \frac{\partial lny}{\partial lnx_j} = \alpha_j + \sum_k \beta_{jk} lnx_{kit}$$

with j = K, L, M, G_s, and G_q, where K stands for capital, L for labour, M for raw materials expenditures, G_s for aggregate index of the stock of infrastructure, and G_q for the aggregate index of the quality of infrastructure. The returns to scale (RTS), i.e., the elasticity of scale is evaluated from the sum of the input elasticities i.e. $RTS = \sum \eta_j$, where η_j is defined as in equation 8. The OLS, fixed-effects, and GMM-IV calculated elasticity measures for the pre, post, and pooled samples are reported in Table 3. The estimated GMM-IV production function coefficients differ substantially from the OLS and fixed-effects, implying that

[11] In the estimation of the production function pooled over the pre-and post-reform periods, a trade liberalization dummy is included additively and multiplicatively.

simultaneity bias were present in the OLS and fixed-effects estimates. Our subsequent analysis is therefore based on the GMM-IV estimates.

Before trade liberalization, private capital has the largest elasticity, followed by the infrastructure quality index, raw materials, and then labor. The positive coefficients on the aggregate indexes of infrastructure stock and quality suggest that an increase in the quantity and quality of infrastructure generates significant output. For the post-reform, and contrary to the previous results, the index of infrastructure stock has the largest elasticity, followed by raw materials, and then labor an private capital. The elasticity of aggregate index of infrastructure quality turned out negative. The post-reform positive coefficient of the index of infrastructure stock also indicates that the stock of public infrastructure was associated with industrial output improvement.

The pooled sample results indicate that raw materials have the largest elasticity, followed by labor, and private capital. However, the elasticities of output associated with the synthetic indexes of stock and quality of infrastructure are negative, indicating that the quantity and quality of public infrastructure were associated with industrial output deficit during the entire period of 1986 to 2003. The returns to scale are less than one in all cases suggesting decreasing returns to scale.

Table 3. Pre-and post-reform production elasticities in Cameroon's industry

Input	Elasticity								
	Pre-reform			Post-reform			Pooled pre-and post-reform		
	OLS	Industry-effects	GMM-IV	OLS	Industry-effects	GMM-IV	OLS	Industry-effects	GMM-IV
Capital	0.363	0.361	0.297	0.125	0.012	0.105	-0.064	0.18	0.144
Labour	0.055	0.045	0.031	0.219	0.028	0.206	0.117	0.117	0.109
Raw materials	1.169	1.977	0.25	1.168	0.75	0.276	1.089	1.09	0.246
infrastructure stock index	0.74	1.286	0.096	0.308	0.493	0.49	-0.639	-0.513	-0.373
infrastructure quality index	0.905	0.939	0.293	-0.446	0.097	-0.077	-0.911	0.141	-0.388
Returns to scale (RTS)	3.233	4.608	0.967	1.375	1.38	0.999	-0.408	1.016	-0.262

6.2. Total factor productivity and growth accounting

Using our GMM-IV estimates of the production functions in Table 3, TFP was computed for each industry and sub-period using equation 5. Table 4 shows the differences in TFP average annual growth rates across trade regimes and industries. The results in column (1) show that the pre-reform subperiod was an unsuccessful one for the Cameroonian industry i.e. TFP grew at a rate of 4.1 percent per annum compared to 5.1 percent per year after trade reform. Coming to subsectors, TFP dropped in 4 of 29 industries with the highest decline of 1.8 percent per year occurring in real-estate and business services industry. TFP grew in the remaining industries, with the dramatic increase of 19.2 percent per annum occurring in paper-printing industry.

The post-reform period (column 2) can be considered as a successful one for the entire Cameroonian industry since TFP grew more faster at a rate of 5.4 percent per year. There were however differences across industries. Trade liberalization positively affected productivity gains in 17 industries, with building materials, rubber-plastic, and metal-machinery-equipment industries registering the highest growth in TFP of nearly 18.4, 20.3, and 20.6 percent per annum, respectively. The remaining industries under investigation experienced deteriorations in their productivity growth performance following trade liberalization. The sharpest decline of nearly 6.2 percent per year occurred in services to collectivities industry.

The impact of trade reform was clearer when the pre-and post-reform samples were pooled. Indeed, the results in columns (3) and (4) Table 4 indicate that in the entire industry, TFP declined by 5.5 percent per annum in the pre-reform period and grew at a rate of 1.2 percent per year in the post-refrom period. For the subsectors, and before trade reform, TFP dropped in 22 of 29 industries with rubber-plastic industry experiencing the worst decline of 44.2 percent per year. TFP grew in the remaining 7 industries, with the dramatic increase of nearly 36.3 percent per year occurring in services to collectivities industry. The post-reform results reveal that trade liberalization positively affected productivity in 23 of 29 industries, with fishing and real-estate and business services industries experiencing the dramatic growth in productivity of respectively 35 and 42.3 percent per annum.

Finally, it is important to distinguish the impact of trade reform on the tradeable and non-tradeable industries. Within the tradeable goods sector and before trade reform, the results in column (1) Table 4 indicate that TFP grew on average at a rate of 4.6 percent per annum whereas productivity increased at a rate of 2.8 percent per year in the non-tradeable industries. After trade reform, the results in column (2) Table 4 indicate that the tradeable industries were positively hit while non-tradeable industries were negatively affected by the openning of the trade regime. In fact, TFP annual average growth rate increased from 4.6 percent before trade reform to 6.5 percent after trade reform in the tradeable sector, and slightly declined from 2.8 percent during protection to 2.7 percent per year during trade regime openness in the non-tradeable activities. When both pre-and post-reform samples were pooled, the effects of trade reform became clearer. TFP dropped on average at a rate of 7 percent per annum before trade reform and grew at a rate of 3.1 percent after trade reform in the tradeable activities. TFP contracted by 1.3 percent per annum in the non-tradeable sector before trade reform and deteriorated further (-3.1 percent per annum on average) after trade reform.

Table 4. Pre-and post-liberalization productivity annual growth rates across Cameroon industries (%)

Industry	Pre-reform	Post-reform	Improvement (+)/drop (-)	Pooled pre-and post-raform samples		
	(1)	(2)	(3)	Pre-reform (4)	Post-reform (5)	Improvement (+)/drop (-) (6)
Agricultural crop production	-0.547	5.56	+	-2.968	3.994	+
Agricultural production for industry and exports	-0.446	4.323	+	-9.642	2.692	+
Breeding and hunting	2.848	3.811	+	-15.143	3.069	+
Fishing	12.618	12.995	+	-2.99	35.005	+
Forestry and logging	2.118	-1.116	-	-5.54	-3.212	+
Mining and quarrying	-1.018	-0.184	-	-12.917	-2.475	+
Production of flour and vegetable	1.548	4.46	+	-20.494	3.442	+
Processing of agriculture products	1.783	3.945	+	-5.463	3.931	+
Other food	15.983	2.893	-	8.431	2.931	-
Beverage and tobacco	0.504	4.477	+	-9.221	4.185	+
Textile and weaving	3.707	2.189	-	0.063	1.484	+
Shoes and leather	0.922	11.003	+	-18.352	-0.258	+
Wood and furniture	2.624	4.869	+	-2.742	5.896	+
Paper and printing	19.152	6.938	-	17.612	-31.85	-
Chemical products	2.561	2.744	+	-3.138	-0.218	+
Rubber and plastic	2.042	20.271	+	-44.19	5.538	+
Building materials	3.959	18.443	+	-12.63	17.258	+
Basic metal	2.528	2.346	-	-10.079	3.898	+
Metal, machinery and equipment	0.696	20.579	+	23.744	7.671	-
Transport equipment	13.093	0.826	-	1.873	1.376	-
Miscellaneous	13.361	7.952	-	-1.969	14.259	+
Total tradeable industries	**4.605**	**6.458**	**+**	**-7.049**	**3.078**	**+**
Electricity, gas and water	3.011	7.366	+	2.506	-49.954	-
Construction	2.538	2.837	+	-2.703	2.488	+
Whole sale and retail trade	2.972	1.643	-	-1.332	1.246	+
Restaurants and hotels	11.613	2.541	-	-12.636	2.296	+
Transport, storage and communication	0.286	2.193	+	-6.954	2.592	+
Financial institution	3.225	1.891	-	-3.476	0.795	+
Real-estate and business services	-1.819	9.979	+	-14.421	42.259	+
Services to collectivities	0.862	-6.202	-	36.296	-4.82	-
Total non-tradeable industries	**2.771**	**2.685**	**-**	**-1.3**	**-3.632**	**-**
Total industry	**4.096**	**5.404**	**+**	**-5.497**	**1.182**	**+**

Source: Author's calculations.

Note: Productivity growth rates are calculated by a regression of TFP indices on a constant trend.

We now turn to output growth accounting using still the input coefficients from the GMM-IV methodology. In the upper part of Table 5 the average annual percentage growth rates of output, private inputs, index of infrastructure stocks, infrastructure quality index, and TFP are reported. The lower section of Table 5 gives the contribution to industrial output growth of private inputs, aggregate indexes of infrastructure quantity and quality, and TFP. Also, Table 5 reports the growth performance of each subperiod as well as of the pooled sample.

The results reveal several striking features between subperiods. Industrial output grew at an annual average rate of 3.1 percent over the pre-reform period. The post-reform average annual growth rate of output was higher i.e. 5.4 percent. Looking at the growth rates of inputs, we see that the private capital declined annually at the rate of 0.4 percent before trade reform and grew at a rate of 1.4 percent per year during the post-reform era. The trend for the labor input was similar, but with different magnitudes i.e. in the pre-reform period labor dropped at a drastic rate of 20.8 percent per year and grew at a rate of 5.1 percent per annum after trade reform. The rate of growth in the raw materials input increased from an average of 3.4 percent per annum in the pre-reform period, to 6.3 percent per annum in the post-refrom period.

Coming to infrastrcuture, and during the pre-reform period, the annual average increase in the synthetic index of infrastructure stock was 9.7 percent, whereas the synthetic index of infrastructure quality grew at a rate of 10.4 percent per annum. On the other hand, and during the post-reform period, the synthetic index of infrastructure stock grew at a rate of 7.8 percent per year while the synthetic index of infrastructure quality grew at a more lower rate of 1.5 percent per year. Finally, the rate of growth in the TFP improved from an average of 4.1 percent per annum in the import-substitution period to 5.4 percent per annum in the liberalization period. Over the entire period from 1986 to 2003, output grew on average at a rate of 4.2 percent per year. For the inputs, private capital and raw materials increased on average at the rates of 0.5 and 4.8 percent per annum, respectively while labor declined by 8.8 percent per year on average. Finally, the pooled sample registered a negative annual average rate of productivity growth of 2.2 percent over the 1986 to 2003 period.

The assessment of the contribution to output growth of various inputs and TFP shows that, the industrial output growth during the pre-reform period relied principally on private capital, raw materials, TFP, labor, and index of infrastructure stock, while the aggregate index of infrastructure quality did not contribute at all. The post-reform industrial output, and in terms of importance, relied mainly on raw materials, followed by index of infrastructure stock, and then private capital. The contribution of labor, TFP, and infrastructure quality index to industrial output growth was negative. Finally, when both pre-and post-reform samples were pooled, the results in the lower part and last column of Table 5 show that the main contributor to industrial output growth was raw materials, followed by private capital, labor, and then index of infrastructure quality. The synthetic index of infrastructure stock and TFP did not contribute at all.

Table 5. Pre-and post-reform output growth accounting in Cameroon industry

Variable	Period		
	Pre-reform (1986-94)	Post-reform (1995-03)	Pooled pre-and post-reform (1986-03)
Aveage annual growth rate (%):			
Output	3.05	5.363	4.198
Capital	-0.363	1.359	0.495
Labor	-20.814	5.128	-8.76
Materials	3.366	6.347	4.846
Infrastructure stock index	9.685	7.848	8.763
Infrastructure quality index	10.438	1.475	5.862
TFP	4.1	5.4	-2.2
Contribution to output growth (%):			
Capital	504.728	130.64	424.137
Labor	91.31	-15.069	310.57
Materials	147.783	322.942	434.096
Infrastructure stock index	15.291	278.994	-271.609
Infrastructure quality index	-72.309	-5.41	68.674
TFP	110.674	-166.583	-750.173

Source: Author's calculations.

6.3. Role of infrastructure in productivity growth

We now proceed with the estimation of equation (6). We used only the GMM-IV system estimator with lagged levels and differences of all the explanatory variables as instruments. Table 6 depicts the results for the two different subperiods, 1986-94 and 1995-03, respectively using the industry productivity retrieved from the estimations done separately for each subperiod. Concerning the base results in columns (1) and (4), the estimated coefficient on aggregate index of infrastructure stock is positive and significant before trade reform and negative and insignificant after trade reform. The base results also indicate that the coefficient associated with the synthetic index of infrastructure quality is negative and significant before trade reform and positive and significant after trade reform.

The results in columns (2) and (5) indicate that when we controlled for trade variables or for the degree of industries integration into foreign tarde, the pre-reform preceding findings are robust to such inclusion. Also, the coefficient on effective rate of assistance is unexpectedly positive and significant at the 1 percent level. For the post-reform results in column (5), we see that the inclusion of trade variables significantly affects the magnitude and sign of the stock and quality of infrastructure variables. Indeed, the coefficients on infrastructure stock index and infrastructure quality index are positive and significant at the 10 and 5 percent levels, respectively. However, the coefficients associated with all the trade variables are insignificant.

It is important to note that statistically significant differences are not necessarily quantitatively important in explaining industry productivity growth. To assess how important are the previous results, Table 6 columns (3) and (6) report the results of estimation of productivity growth equation with the independent variables in standardized form i.e. based on the standard deviation of each variable across the full sample. In this form, the estimated coefficients describe the impact on industry productivity growth resulting from a one standard deviation change in each explanatory variable. For instance, during the pre-reform period, a one standard deviation increase in the stock of infrastructure increases industry productivity growth by 33.1 percentage points per year. Also, and during the post-reform era, a one standard deviation increase in the stock of infrastructure increases industry productivity growth by 37.6 percentage points per year, while a one standard deviation increase in the quality of infrastructure increases industry productivity by 10 percentage points per annum.

Table 6. Impact of infrastructure on industry productivity growth (Subperiods results): Panel regression using GMM-IV system estimator. Dependent variable: $\Delta \ln TFP_{it}$

Variable	Pre-reform (1986-94)			Post-reform (1995-03)		
	(1)	(2)	(3)[a]	(4)	(5)	(6)[a]
Constant	-1.023	-0.823**	0.042*	-3.4698	-5.3647	-0.0358
	(2.55)	(1.83)	(2.63)	(1.15)	(1.19)	(1.4)
$\ln G_s$	0.309*	0.331*	0.331*	-0.1264	0.2565***	0.3762**
	(2.61)	(2.35)	(2.35)	(1.18)	(1.62)	(2.1)
$\ln G_q$	-0.116**	-0.183**	-0.183**	0.5105**	0.2502**	0.0998*
	(1.93)	(2.27)	(2.27)	(2.16)	(1.83)	(2.83)
lnXS		-0.016	-0.016		0.0544	-0.0538
		(1.57)	(1.57)		(0.47)	(0.47)
lnlnMPR		0.254	0.254		0.0282	0.0432**
		(0.89)	(0.89)		(1.16)	(2.3)
lnERA		0.126*	0.126*		-0.4544	-0.4185
		(3.3)	(3.3)		(1.09)	(0.81)
Sargan test	8.48	12.12	23.32	18.1	26.86	24.25
(p-value)	(0.456)	(0.345)	(0.988)	(0.596)	(0.186)	(0.156)
2nd order	-0.75	-0.87	-0.87	1.19	1.17	1.17
correlation	(0.456)	(0.385)	(0.385)	(0.233)	(0.242)	(0.242)
(p-value)						
R^2	0.311	0.265	0.173	0.265	0.38	0.106
# obserations	261	261	261	261	261	261

Source: Author's calculations.

Notes: [a] Independent variables in standardized form. Coefficients indicate effect of a one standard deviation change on the dependent varaible. The results are corrected for possible heteroscedasticity. T-statistics are within parentheses. Significance at the 10, 5 and 1 percent levels is denoted by ***, ***, and *

Table 7 reports the regression results of equation (6) using the industry-level productivity indices retrieved from estimation of the production function that employs the pooled pre-and post-reform samples. Column (1) presents the restricted results. The coefficients on the indexes of stock and quality of infrastructure are respectively postive and negative and significant at the 1 and 5 percent levels. The coefficients on the trade variables are insignificant. The primary interest in the restricted specification lies in the post-reform specific intercept term. The results in column (1) indicate that post-reform productivity grows more faster by 2.5 percentage points per year than the pre-reform one.

The results of the unrestricted specification are reported in column (2) Table 7. These results reveal that the post-reform slope terms differ along two dimensions among the five explanatory variables in the initial productivty growth regression i.e. aggregate indexes of stock and quality of infrastrucrure. Indeed, the slope coefficient for index of infrastructure stock differs between post-reform observations and the rest of the sample (pre-reform). For instance, while the synthetic index of the quantity of infrastructure increases industry productivty growth in the pre-reform sample by 7.9 percent annually, the increase for post-reform period is 43.3 percent annually.[12]

In quantitative terms, the results in column (3) Table 7 indicate that a one standard deviation increase in the index of the stock of infrastructure increases industry productivity growth by 3.9 and 12.4 percentage points, respectively during the pre-and post-reform periods. The results in column (3) Table 7 further suggest that the post-reform industry productivity growth was very responsive to changes in infrastructure quality index. A one standard deviation increase in the quality of infrastructure index increases industry productivity growth by 8.7 percentage points after trade reform, but has essentially no effect before trade libealization.

Table 7. Impact of infrastructure on industry productivity growth (Pooled results, 1986-94 and 1995-03): Panel regression using GMM-IV system estimator. Dependent variable: $\Delta \ln TFP_{it}$

Variable	(1)	(2)	(3)[a]
Constant	-1.0654	0.0748	0.0627
	(1.46)	(1.1)	(1.31)
$\ln G_s$	0.3685*	0.0792*	0.0392**
	(2.5)	(3.1)	(2.3)
$\ln G_q$	-0.4677**	-0.7545***	-0.1475**
	(1.85)	(1.7)	(1.75)
$\ln XS_{t-1}$	0.034	0.0249	0.0117
	(1.55)	(1.47)	(1.17)
$\ln\ln MPR_{t-1}$	0.2369	0.0531	0.2824
	(1.18)	(1.41)	(0.22)
$\ln ERA_{t-1}$	-0.2747	-0.5073	0.1908
	(0.85)	(1.29)	(1.00)
Dummy	0.0252**	-0.9349	-0.2664
	(1.86)	(1.21)	(1.07)
Dummy*$\ln G_s$		0.3533*	0.1236**
		(2.5)	(3.01)
Dummy*$\ln G_q$		0.0403***	0.0873*
		(1.63)	(2.02)
Dummy*$\ln XS_{t-1}$		0.0093	0.0185
		(1.12)	(1.05)
Dummy*$\ln\ln MPR_{t-1}$		-0.1545	-0.0753
		(1.16)	(1.05)
Dummy*$\ln ERA_{t-1}$		0.0245	0.0245
		(1.49)	(0.11)
Sargan test	5.32	5.572	6.57
(p-value)	(0.334)	(0.123)	(0.989)
2nd order correlation	-0.99	-1.04	-1.01
(p-value)	(0.321)	(0.3)	(0.315)
R^2	0.512	0.1516	0.388
# obserations	522	522	522

Source: Author's calculations.

Notes: [a] Independent variables in standardized form. Coefficients indicate effect of a one standard deviation change on the dependent varaible. The results are corrected for possible heteroscedasticity. T-statistics are within parentheses. Significance at the 10, 5 and 1 percent levels is denoted by ***, ***, and *

[12] In column (2) Table 7, the net slope term for post-reform sample is the sum of the slope for pre-reform sample and the slope of post-reform sample interaction term.

7. Conclusion and Policy Implications

The main objective of this paper was to investigate whether the quantity and quality of infrastructure affect differently the Cameroonian industrial performance before and after trade liberalization. Our evaluation was first based on the estimation of a flexible (translog) production function augmented to cinclude the synthetic indexes of infrastructure stock and infrastructure quality; the study used industry-level panel for a sample of 29 industries and aggregate national infastructure data over the pre-reform period (1986-94) and the period following immediately trade reform i.e. 1995-03; the production function was estimated separately for the pre-reform and post-reform periods as well as for the pooled sample of pre- and post-reform periods; industry productivity indexes were then derived. Second, to measure the contribution of infrastructure and private inputs to industrial output growth, the growth accounting framework was used.

Finally, the effects of the aggregate indexes of infrastructure stock and infrastructure quality on industry productivity growth rates were assessed. The productivity growth equation was first estimated on each subperiod separately (using the industry prductivity measures retrieved from the estimation of the production function on each subperiod separately), and then on the pooled sample of pre-and post-reform periods using the industry productivity indices retrieved from the estimation of the production function on pooled sample. In the estimation of different production functions and productivity growth equations, we employed the GMM-IV system estimator to control for the potential endogeneity of infrastructure as well as that of other regressors.

Our results can be summarized in four points. First, the synthetic measure of infrastructure stock and output were positively associated in the pre-and post-reform periods, repectively. Over the entire period from 1986 to 2003 i.e. pooled pre-and post-reform samples, the coefficients on the indexes of infrastructure stock and infrastructure quality were negative, pointing to a negative contribution of infrastructure stock and quality to industrial output. Second, the output growth accounting findings suggest that the accumulation in infrastructure stocks was relevant in explaining both pre-and post-reform industrial output growth, with a stronger role in the latter subperiod, whereas only infrastructure quality contributed to post-reform output growth. Third, the aggreagte index of infrastructure stock boosted the pre-and post-reform productivity growth, but the post-reform effect tended to be stronger. A one standard deviation increase in aggregate index of infrastructure stock resulted in a pre-and post-reform productivity increase of 3.9 and 12.4 percentage points, respectively. Finally, the synthetic index of infrastructure quality had a significant positive effect only on post-reform industry productivity growth rates. A one standard deviation increase in the infrastructure quality index increased post-reform productivity growth by 8.9 percentage points and had essentially no effect before trade reform.

Our analysis lead to two concrete policy implications. First, ifrastructure development should be a key ingredient for fostering industry productivity growth in Cameroon. The, accumulation of infrastructure combined with better quality should rank at the top of the trade liberalization accompanying measures agenda.

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Appendix

Table A. Summary statistics of variables before and after trade liberalization

Variable	Mean			Standard Deviation			Minimum			Maximum		
	Pre-reform sample	Post-reform sample	Pooled pre-and post-reform samples	Pre-reform sample	Post-reform sample	Pooled pre-and post-reform samples	Pre-reform sample	Post-reform sample	Pooled pre-and post-reform samples	Pre-reform sample	Post-reform sample	Pooled pre-and post-reform samples
Output	101.523	232.856	167.18	90.226	217.717	178.991	2.516	10.7	2.516	466.34	1251.61	1251.61
Capital	7.681	16.346	12.013	7.387	47.44	34.193	0.07	0.002	0.002	50.932	595.725	595.725
Labor	36434	168676	102.555	175102	411.583	322830	11	790	11	1643340	2546300	2546300
Materials	74.769	133.61	104.189	68.174	121.011	102.442	2.741	5.68	2.741	376.9	615.23	615.23
Aggregate index of infrastructure stock	3.612	4.55	4.081	0.262	0.243	0.533	3.312	4.134	3.312	3.998	4.846	4.856
Aggregate index of infrastructure quality	0.502	1.598	1.05	0.32	0.045	0.594	0.185	1.532	0.185	1.338	1.668	1.668
Export share (XS)	0.38	0.187	0.27	0.77	0.268	0.552	0.0002	0.000	0.000	0.426	1.124	1.124
Import penetration rate (MPR)	0.29	0.208	0.243	0.397	0.289	0.342	-2.621	0.000	-2.621	1.26	1.344	1.344
Effective rate of assistance (ERA)	0.111	0.125	0.082	0.057	0.022	0.043	0.024	0.04	0.024	0.398	0.185	0.398

Table B. Im-Pesaran-Shin test of unit root hypothesis of Cameroon's industry production function

Model tested	lny	lnk	lnm	lnl	lnGs	lnGq
			Pre-reform sample			
Zero lag	-1.921	-2.164	-1.751	-2.372	-1.977	-1.651
Intercept	(0.893)	(0.868)	(0.982)	(0.149)	(0.83)	(0.995)
Trend						
			Post-reform sample			
Zero lag	-2.196	-2.164	-2.595	-2.213	-0.724	-4.173
Intercept	(0.44)	(0.504)	(0.015)	(0.406)	(0.989)	(0.000)
Trend						
			Pooled pre-and post-reform samples			
Zero lag	-2.055	-1.889	-2.173	-2.292	-1.351	-2.912
Intercept	(0.78)	(0.868)	(0.48)	(0.183)	(0.775)	(0.000)
Trend						

Notes: Figures within parentheses are the p-values. lny is the logarithmic of real output; lnk is the logarithmic of capital; lnm is the logarithmic of materials; lnl is the logarithmic of labor; lnGs is the aggregate index of infrastructure stocks; and lnGq is the aggregate index of the quality of infrastructure.

Table C. Pre, post and pooled samples GMM-IV panel data estimates of Cameroon's industry production function

Variable	OLS			Industry-effects			GMM-IV		
	Coefficient	Std. error	t-value	Coefficient	Std. error	t-value	Coefficient	Std. error	t-value
1) Pre-reform sample:									
Constant	3.098	2.08	1.49	/	/	/	18.919	22.015	0.86
lnK	0.404	0.693	0.58	0.394	0.694	0.57	-0.05	0.575	0.09
lnL	-0.077	0.354	0.22	-0.038	0.351	0.11	-0.024	0.225	0.11
lnM	1.377	0.675	2.04	1.34	0.673	1.99	0.211	0.053	3.98
lnGs	-0.398	0.224	1.78	1.885	2.112	0.89	-0.406	0.498	0.82
lnGq	0.437	0.391	1.12	-1.506	1.934	0.78	0.728	0.901	0.81
$(lnK)^2$	0.221	0.046	4.8	0.225	0.046	4.93	0.194	0.068	2.84
$(lnL)^2$	0.056	0.012	4.57	0.056	0.012	4.53	0.039	0.011	3.64
$(lnM)^2$	0.175	0.073	2.39	0.189	0.071	2.65	0.155	0.071	2.2
$(lnGs)^2$	0.799	0.293	2.73	-0.818	1.247	0.66	0.635	0.752	0.84
$(lnGq)^2$	0.926	0.819	1.13	-0.861	0.595	1.45	0.124	0.144	0.86
lnK*lnL	0.004	0.025	0.14	0.007	0.025	0.29	0.011	0.026	0.41
lnK*lnM	-0.226	0.045	5.02	-0.234	0.044	5.3	-0.21	0.054	3.87
lnK*lnGs	0.143	0.172	0.83	0.141	0.172	0.82	0.223	0.123	1.82
lnK*lnGq	0.081	0.103	0.79	-0.069	0.102	0.67	-0.054	0.057	0.95
lnL*lnM	-0.031	0.023	1.34	-0.035	0.022	1.57	-0.037	0.021	1.81
lnL*lnGs	-0.07	0.097	0.72	-0.078	0.097	0.81	-0.045	0.066	0.68
lnL*lnGq	0.05	0.068	0.73	0.055	0.068	0.8	0.062	0.031	2.02
lnM*lnGs	-0.244	0.172	1.42	-0.23	0.172	1.34	-0.374	0.125	2.99
lnM*lnGq	-0.006	0.125	0.05	-0.025	0.124	0.2	-0.017	0.071	0.25
lnGs*lnGq	-0.602	0.815	0.74	4.695	3.895	1.21	-0.244	0.966	0.25
Sargan test							22.456		
(p-value)							(0.306)		
2nd order							-1.32		
correlation							(0.186)		
Im-Peseran-Shin	-2.553			-2.344			-2.497		
test on residuals	(0.025)			(0.118)			(0.009)		
# of industries	29			29			58		
# observations	261			261			522		
R^2	0.895			0.749			0.281		

Note: The figures within parentheses of the Im-Peseran-Shim tests are the p-values.

Table C cont…

Variable	OLS			Industry-effects			GMM-IV		
	Coefficient	Std. error	t-value	Coefficient	Std. error	t-value	Coefficient	Std. error	t-value
2) Post-reform sample:									
Constant	-0.278	0.459	0.61	/	/	/	-17.106	6.087	2.81
lnK	-0.143	0.076	1.88	-0.036	0.148	0.24	-0.003	0.001	3.00
lnL	-0.167	0.057	2.93	-0.187	0.131	1.43	-0.118	0.303	0.39
lnM	0.373	0.141	2.65	0.371	0.28	1.32	0.449	0.151	2.97
lnGs	0.705	0.363	1.94	0.159	0.057	2.79	0.212	0.081	2.62
lnGq	0.016	0.035	0.46	-0.866	0.266	3.26	0.147	0.037	3.97
$(\ln K)^2$	0.051	0.016	3.21	0.005	0.004	1.19	0.038	0.014	2.67
$(\ln L)^2$	0.047	0.013	3.57	0.023	0.013	1.86	0.042	0.045	0.94
$(\ln M)^2$	0.093	0.079	1.18	0.18	0.027	6.68	0.129	0.116	1.12
$(\ln Gs)^2$	-0.461	0.387	1.19	1.069	0.728	1.47	0.392	0.498	0.79
$(\ln Gq)^2$	-0.086	0.022	3.91	0.734	0.314	2.34	0.212	0.081	2.62
lnK*lnL	-0.034	0.015	2.32	-0.01	0.004	2.24	-0.025	0.019	1.35
lnK*lnM	-0.031	0.038	0.82	-0.006	0.013	0.49	-0.032	0.037	0.87
lnK*lnGs	-0.078	0.128	0.61	-0.019	0.024	0.78	-0.024	0.04	0.6
lnK*lnGq	0.646	0.696	0.93	0.159	0.133	1.2	0.351	0.216	1.62
lnL*lnM	-0.045	0.023	1.97	-0.027	0.009	2.9	-0.056	0.04	1.39
lnL*lnGs	-0.101	0.104	0.98	-0.041	0.021	1.97	-0.074	0.053	1.39
lnL*lnGq	0.354	0.542	0.65	0.176	0.108	1.64	0.299	0.203	1.46
lnM*lnGs	0.173	0.244	0.71	0.03	0.048	0.62	0.07	0.123	0.57
lnM*lnGq	-0.88	0.336	2.62	-0.35	0.258	1.36	-0.668	0.445	1.5
lnGs*lnGq	0.065	0.078	0.83	-0.722	0.294	2.46	-0.821	0.125	6.57
Sargan test							13.08		
(p-value)							(0.179)		
2nd order							-0.896		
correlation							(0.226)		
Im-Peseran-Shin	-2.896			-3.04			-2.786		
test on residuals	(0.011)			(0.001)			(0.001)		
# of industries	29			29			58		
# observations	261			261			522		
R^2	0.178			0.445			0.506		

Note: The figures within parentheses of the Im-Peseran-Shim tests are the p-values.

Table C cont… and end

Variable	OLS			Industry-effects			GMM-IV		
	Coefficient	Std. error	t-value	Coefficient	Std. error	t-value	Coefficient	Std. error	t-value
1) Pooled sample:									
Constant	-0.276	0.627	0.44	/	/	/	0.459	0.276	1.66
lnK	-0.143	0.731	0.2	-0.151	0.073	2.07	0.021	0.003	7.00
lnL	-0.167	0.547	0.3	-0.186	0.055	3.38	-0.065	0.031	2.1
lnM	1.373	1.358	1.01	0.386	0.256	1.51	0.398	0.1148	3.49
lnGs	0.705	0.841	0.84	0.981	0.342	2.87	0.751	0.309	2.43
lnGq	0.491	0.116	4.23	-0.154	0.103	1.5	0.811	0.927	0.87
$(lnK)^2$	0.051	0.015	3.34	0.051	0.015	3.34	0.039	0.014	2.76
$(lnL)^2$	0.047	0.013	3.72	0.047	0.013	3.72	0.035	0.045	0.77
$(lnM)^2$	0.093	0.076	1.22	0.093	0.076	1.23	0.132	0.116	1.14
$(lnGs)^2$	-0.461	0.719	0.64	0.256	0.239	1.07	-0.228	0.132	1.73
$(lnGq)^2$	-0.083	0.118	0.7	0.353	0.468	0.75	-0.587	0.436	1.35
lnK*lnL	-0.034	0.014	2.42	-0.034	0.014	2.41	-0.024	0.018	1.27
lnK*lnM	-0.031	0.036	0.85	-0.031	0.036	0.86	-0.034	0.037	0.93
lnK*lnGs	-0.078	0.123	0.63	-0.079	0.123	0.65	-0.024	0.039	0.62
lnK*lnGq	0.646	0.669	0.97	0.656	0.668	0.98	0.332	0.207	1.6
lnL*lnM	-0.045	0.022	2.05	-0.045	0.022	2.05	-0.057	0.04	1.42
lnL*lnGs	-0.101	0.099	1.02	-0.103	0.099	1.03	-0.073	0.053	1.38
lnL*lnGq	0.355	0.521	0.68	0.371	0.52	0.71	0.309	0.202	1.52
lnM*lnGs	0.173	0.235	0.73	0.174	0.235	0.74	0.067	0.123	0.54
lnM*lnGq	-0.879	1.283	0.68	-0.89	0.282	3.16	-0.628	0.438	1.43
lnGs*lnGq	1.064	1.245	0.85	-0.043	0.041	1.05	-0.158	0.512	0.31
Dum	0.257	0.986	0.26	0.098	0.104	0.94	0.737	0.112	6.58
Dum*lnK	0.547	1.029	0.53	0.556	0.289	1.92	-0.055	0.655	0.08
Dum*lnL	0.089	0.661	0.14	0.109	0.659	0.16	0.036	0.039	0.92
Dum*lnM	0.004	0.053	0.08	-0.008	0.029	0.28	0.602	0.717	0.84
Dum*lnGs	-0.103	0.433	0.24	-0.378	0.793	0.48	-0.056	0.092	0.61
Dum*lnGq	-0.576	0.116	4.97	0.592	0.642	0.92	0.525	0.199	2.64
Dum*(lnK)2	0.085	0.025	3.37	0.025	0.037	0.68	0.077	0.035	2.22
Dum*(lnL)2	0.005	0.009	0.53	0.005	0.009	0.56	0.002	0.023	0.08
Dum*(lnM)2	0.041	0.054	0.76	0.041	0.054	0.76	0.012	0.07	0.17
Dum*(lnGs)2	0.231	0.023	10.05	0.272	0.096	2.83	0.749	0.537	1.39
Dum*(lnGq)2	0.505	0.143	3.53	-0.214	0.151	1.42	0.666	0.491	1.36
Dum*lnK*lnL	0.038	0.03	1.26	0.038	0.03	1.25	0.034	0.032	1.06
Dum*lnK*lnM	-0.195	0.059	3.29	-0.195	0.059	3.29	-0.176	0.066	2.67
Dum*lnK*lnGs	0.22	0.217	1.01	0.222	0.217	1.02	0.244	0.129	1.9
Dum*lnK*lnGq	-0.727	0.677	1.07	-0.737	0.677	1.09	-0.387	0.215	1.8
Dum*lnL*lnM	0.015	0.033	0.44	0.015	0.033	0.45	0.02	0.045	0.44
Dum*lnL*lnGs	0.031	0.142	0.22	0.033	0.142	0.23	0.03	0.08	0.35
Dum*lnL*lnGs	-0.305	0.526	0.58	-0.322	0.525	0.61	-0.246	0.205	1.2
Dum*lnL*lnGq	-0.417	0.296	1.41	-0.418	0.296	1.41	-0.439	0.176	2.5
Dum*lnM*lnGs	0.873	0.29	3.01	0.884	0.288	3.07	0.612	0.444	1.38
Dum*lnM*lnGq	-0.666	0.165	4.04	0.442	0.343	1.29	-0.633	0.421	1.5
Dum*lnGs*lnGq	-0.276	0.163	1.69	0.153	0.081	1.89	-0.459	0.176	2.61
Sargan test							13.04		
(p-value)							(0.758)		
2nd order							-0.62		
correlation							(0.533)		
Im-Peseran-Shin	-3.921					-3.07	-2.89		
test on residuals	(0.002)					(0.001)	(0.03)		
# of industries	58					58	58		
# observations	522					522	522		
R^2	0.468					0.289	0.178		

Note: The figures within parentheses of the Im-Peseran-Shim tests are the p-values.

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