A Note on the Data for Ghanaian Manufacturing Firms: 1991-1997

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Abstract

In this note the construction of a data set that enables the rate of productivity growth and investment over a seven year period to be measured for Ghana is described. Ghana has by far the longest experience of trade liberalisation in Africa so the outcomes of such macro policies for growth at the micro level is an important policy issue. The note reports the construction of a data set for the human and physical capital stocks of the firms and provides measures of real value-added using both output and input price deflators. Some basic regressions are reported using the data and the note concludes with a discussion as to how this data set can be used to analyse issues of firm performance, differences in firm-level efficiency and processes of technological diffusion.

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Introduction

The purpose of this note is to explain the construction of a data set that enables the growth rate of manufacturing productivity and the extent of investment, over a seven year period, to be analysed for an African country: Ghana. The note is in four parts. We begin by giving details of the sample size and the number of firms which exited and the numbers which entered the sample as new firms, defined to be aged 1 or less when first interviewed. In Part II the overall structure of the data set is described and the methods used to derive measures of human and physical capital and price deflators for output and value-added are documented. In Part III we present some basic regressions to show the major features of the data. In Part IV we outline how the data can be used to analyse the factors that limit the extent of investment in Ghana and investigate issues of firm performance and processes of technological diffusion.

Part I: The Surveys

The data is drawn from surveys of Ghana's manufacturing sector which have been conducted over the period 1992 to 1998. Annual data is available for the period 1991 to 1997. The data for 1991 to 1993 were collected in an annual survey which was part of the RPED (Regional Program on Enterprise Development) organised by the World Bank. The data for 1994 and 1995 were collected in a single survey conducted in 1996. Similarly the data for 1996 and 1997 were collected in a survey carried out in 1998. All the surveys involved the collection of both firm level information and detailed information on a sample of workers in the firm. Both firm and worker information was collected in face-to-face interviews.

The initial sample was drawn from the 1987 Census of Manufacturing Activities, Ghana (1987a). The sample was stratified by size, sector and location. Four size categories were used to structure the sample: micro, which were defined as firms employing less than five; small firms, employing between 5 and 29 persons; medium firms, employing from 30 to less than 100 persons and large firms, employing more than 100. In the sampling from the Industrial Census large enterprises were over sampled. The two other criteria used in stratifying the sample were the sector and location of the firms. It was initially decided to focus on four sectors, food, textiles and garments, wood and metal which together comprised some 70 per cent of employment. Investigation of the data from the census indicated that a finer classification would be useful. Two sectors, textiles and wood, have relatively large firms while furniture and garments are dominated by very small firms. The localities chosen were Greater Accra, Kumasi, Takoradi and Cape Coast. Where firms had gone out of business they were replaced by firms of the same size category, sector and location. In the subsequent surveys firms which had exited were replaced in a similar manner.

There is conflicting evidence as to the number of manufacturing enterprises in the economy. Steel and Webster (1991, p.6) use the Population Census, Ghana (1987b), and Industrial Statistics to estimate that in 1984 there were more than 500,000 persons employed in enterprises with less than 30 employees. The 1987 Industrial Census identified about 50,000 employees of such enterprises in less than 8,000 establishments. Further, the 1987 Industrial Census showed far more workers in the sector employing more than 30 workers than the figures from the Industrial Statistics, about twice as many.

The differences between the estimates based in the Population Census and the Industrial Survey is probably due to the fact that the former include household based enterprises while the latter excludes them. If that is the case then the sampling frame chosen for this survey captures the population of firms while are located outside of the household. The initial sampling from the Census showed that a substantial number of firms had exited. As there was no more up-to-date information on the population it is not possible to use population weights.

At the same time as the firms were surveyed a sample of workers and apprentices was chosen from each firm designed to cover the full range of personnel employed by the firms. The objective was to have up to 10 workers and 10 apprentices from each firm where firm size allowed. As a result of this survey design it is possible to estimate both individual level equations and firm level ones.

Table 1 Sample sizes

	Continuous	Dormant	Exit	Lost	Uncooperative	Total
Number of Firms	191 (a)	4	34	5	19	253
Number of Firms with						
7 rounds of data	106	0	0	0	0	106
6 rounds of data	16	0	0	0	0	16
5 rounds of data	8	0	13	1	0	22
4 rounds of data	29	0	3	0	3	35
3 rounds of data	4	3	5	1	1	14
2 rounds of data	27	1	6	1	9	44
1 round of data	1	0	7	2	6	16

(a) 23 of these firms were aged 1 year or less when they were first interviewed.

Over the seven years covered by the survey Table 1 gives information on the sample sizes that are available. During the course of the surveys a total of 278 firms have been interviewed. Of these 278 firms a sub-set of 253 have provided data on the components of value-added and sufficient information that the capital stock and employment of the firm could be calculated. We classify these 253 firms as of five types: continuous, dormant, exits, lost and uncooperative. Continuous are those that have supplied information for each year they have been in the sample. Firms which are classified as dormant are those which, when they were dropped from the sample, had ceased undertaking any new activity; they remained in existence sometimes selling goods from stock. 34 firms exited during the course of the survey, 5 were lost and 19 proved uncooperative after some point. The firms which were uncooperative are not exits from producing but they are exits from the sample. Table 1 also provides information on how long is the available panel element from the surveys. For the longest possible period, ie seven years, there are 106 firms. Similarly there are an additional 16 firms for which there are 6 continuous years of data.

Of the 191 firms which were continuously in the sample 23 were aged one year or less at some point when they were interviewed. These firms we term “entrys” in the sense that they are new firms. In part IV below we will consider the pattern of both exits and entry. In analysis of underlying changes in productivity it has been found that exit is concentrated in low productivity firms. It is clearly of interest to ask if this is the case for Ghana over this period.

Part II: The Structure of the Data Set

The three major additions to the primary data, documented in this note, are the derivation of physical stocks from investment flows, the imputation of firm-level human capital stocks based on worker information and the construction of firm specific price indices for outputs and material inputs.

The Capital Stock

In the primary data information was collected on the value of the capital stock of plant and machinery. Two valuations were sought, the first the replacement value and the second the sale value. Information was also sought on the sale value of land and buildings. The SAS program for creating capital stock series, based on the investment data, for both plant and equipment and for land and buildings, is given as appendix A. There are three possible measures of the capital stock for plant and machinery which can now be used: its replacement value, its sale value and the derived series. For land and building there is its sale value and the derived series.

Table 2a The Capital Stock

Variable		N	Mean	Std Deviation	Minimum	Maximum
FIRM	Firm Identification	1338	126	75	1	286
WAVE	Wave identification	1338	4	2	1	7
Physical Capital (Plant and Equipment)						
CAP	Replacement Value of Capital Stock of Plant and Equipment (Millions of nominal cedis)	1187	2320	14600	0.020	257000
CAPN	Imputed Replacement Value of Capital Stock of Plant and Equipment (Millions of nominal cedis)	1338	1810	11400	0.006	257000
CAPNCP	Imputed Replacement Value of Capital Stock of Plant and Equipment (Millions of constant 1991 price cedis)	1338	4600	2450	0.006	52100
INVCP	Investment in plant and equipment (Millions of constant 1991 price cedis)	1263	22.364	1450.000	0	3320.000
INV	Nominal Investment in plant and equipment (Millions of nominal cedis)	1263	76.101	505.000	0	7920.000
INVCPR	invcp/capncp	1263	0.07	0.17	0.00	1.34
INVNR	inv/capn	1263	0.06	0.16	0.00	1.34
Land and Buildings						
KLB	Sale Value of Land and Buildings (Millions of nominal cedis)	815	952.000	4190.000	0	65000.000
KLBN	Imputed Sale Value of Land and Buildings (Millions of nominal cedis)	1021	754.000	3830.000	0	65000.000
KLBNCP	Imputed Sale Value of Land and buildings (Millions of constant 1991 price cedis)	966	234.000	950.000	1.453	11600.000
INVLBCP	Investment in land and buildings (Millions of constant 1991 price cedis)	988	3.684	28.548	0	584.000
INVLB	Investment in land and buildings (Millions of nominal cedis)	988	12.781	121.000	0	3240.000
INVLBCPR	invlbcp/klbncp	868	0.05	0.36	0	8.33
INVLBR	invlb/klb	713	0.05	0.40	0	9.38

Table 2b Investment Rates (a)

Variable	N	Mean	Std Deviation	Minimum	Maximum
			1991		
INVCPR	178	0.06	0.19	0.00	1.34
INVNR	178	0.06	0.19	0.00	1.34
INVLBCPR	0	.	.	.	.
INVLBR	0	.	.	.	.
			1992		
INVCPR	170	0.08	0.18	0.00	1.23
INVNR	170	0.08	0.17	0.00	1.20
INVLBCPR	130	0.04	0.23	0.00	2.11
INVLBR	82	0.06	0.19	0.00	1.00
			1993		
INVCPR	168	0.08	0.18	0.00	1.20
INVNR	168	0.07	0.17	0.00	1.15
INVLBCPR	93	0.01	0.06	0.00	0.61
INVLBR	61	0.00	0.02	0.00	0.17
			1994		
INVCPR	181	0.08	0.19	0.00	0.97
INVNR	181	0.07	0.18	0.00	0.97
INVLBCPR	145	0.04	0.20	0.00	1.53
INVLBR	108	0.02	0.10	0.00	0.90
			1995		
INVCPR	183	0.08	0.19	0.00	1.13
INVNR	183	0.08	0.18	0.00	1.11
INVLBCPR	152	0.04	0.38	0.00	4.61
INVLBR	118	0.03	0.14	0.00	1.33
			1996		
INVCPR	192	0.03	0.09	0.00	0.63
INVNR	192	0.03	0.09	0.00	0.62
INVLBCPR	177	0.03	0.15	0.00	1.28
INVLBR	174	0.05	0.23	0.00	2.40
			1997		
INVCPR	191	0.06	0.12	0.00	0.80
INVNR	191	0.06	0.11	0.00	0.67
INVLBCPR	171	0.09	0.66	0.00	8.33
INVLBR	170	0.11	0.75	0.00	9.38
			All Years		
INVCPR	1263	0.07	0.17	0.00	1.34
INVNR	1263	0.06	0.16	0.00	1.34
INVLBCPR	868	0.05	0.36	0.00	8.33
INVLBR	713	0.05	0.40	0.00	9.38

(a) INVCPR is the investment to capital ratio in constant prices, INVNR is the investment to capital ratio in nominal prices, where investment and capital refer to plant and equipment.

INVLBCPR is the investment to capital ratio in constant prices, INVLBR is the investment to capital ratio in nominal prices, where investment and capital refer to land and buildings.

The SAS program to impute the value of the capital stock begins by setting out the price deflators that are used both to deflate the nominal investment series and, where necessary, to revalue the capital stock. As a result of detailed investigation of the data set some changes were made to the primary data which are made in the first part of the SAS program reported in Appendix A.

In the derivation of the capital stocks it is assumed that the most recent data is the most reliable so the procedure is to work backwards from the most recent figures and impute a nominal value of the capital stock over the whole period for which we have information for the firm. We then work forward beginning with the nominal capital stock in wave 1 and calculating a constant price capital stock series based on a constant price investment series. The deflator for investment used a weighted average of the urban CPI and the nominal exchange rate, with weights of 0.25 and 0.75 respectively. The result is new data for constant price investment (invcp), capital stock at nominal prices (capn) , capital stock at constant prices (capncp) and the investment to capital ratio (invcpr) which is defined as invcp/capncp. The data is restricted to values of invcpr of less than 1.5 and if capncp is less than zero the observation is deleted. The results given in Table 2a also show the replacement value of the capital stock (cap) from the primary data.

It will be noted in Table 2a that there are more observations for the capital stock series than for the investment data. This is due to the fact that the SAS program uses the reported capital stock series if there is no information on flows. Table 2b shows the investment rates over the seven years of the data. It will be noted that these are low throughout the period and there is no evidence of any rise in the investment rate over the period of the surveys.

The Human Capital Stock

To obtain a measure of the human capital stock available to the firm it was necessary to merge the worker with firm level information. At the worker level data was collected on earnings, education, age and tenure (length in current job). The human capital stock comprises the following elements: the age of the workforce, their education in years and the tenure of the workers. In aggregating from the worker to the firm level it is necessary to use weights to ensure that we can move from individual data to firm based averages. To do this we weighted the human capital variables by the proportion of workers in a given occupational class within the firm. Eight common occupational groups across the rounds of the survey were identified which are shown in Table 3. There are 8692 worker observations over the seven rounds of the survey. The means shown in Table 3 are the proportion of workers in each occupation.

Table 3 Worker level data on occupations

Occupation	Definition of occupation	N	Mean	Std.Dev
MGMT	Dummy if worker Management	8692	0.04	0.21
ADMINP	Dummy if worker Administrator/Profession	8692	0.07	0.25
SALES	Dummy if worker Sales staff	8692	0.09	0.29
SUPER	Dummy if worker a Supervisor	8692	0.08	0.27
TECH	Dummy if worker a Technician	8692	0.07	0.25
PROS	Dummy if a Production or Support worker	8692	0.31	0.46
MASTER	Dummy if worker a Master	8692	0.08	0.27
APPREN	Dummy if worker an Apprentice	8692	0.26	0.44

The most important occupational groups in the sample are production and support workers (which are one category) and the apprentices. These occupational categories for the worker level data are matched with the occupational categories given in the firm level data. Table 4 show the equivalent firm level categories of occupations.

At the firm level we have 1328 observations. The sales occupation in Table 3 is equivalent to commercial workers in Table 4, the technical occupational classification in Table 3 is the same as the maintenance category of workers in Table 4. The means in Table 4 are the average number of workers of each occupation in the firms in the sample. The average size of firm, measured by employment across the seven rounds of the data, is 68 employees and the standard deviation is 147, so the range of enterprises covered by the survey is very large. Firms range in size from the self-employed worker to 1,741 employees.

With the matching by occupations we can create human capital variables which are weighted averages of the firms' workers characteristics and a weighted average of the earnings of workers in the firm. Table 5 shows the result of this exercise.

Table 4 Firm-level data on workers by occupation

Variable	Definition	N	Mean	Std Dev	Minimum	Maximum
MAN	Management	1328	2.2	4.6	0	52
ADMIN	Administration	1328	2.8	8.5	0	149
COMM	Commercial	1328	3.7	11.6	0	185
SUPERV	Supervisor	1328	3.1	11.1	0	205
MAINT	Maintenance	1328	3.7	16.6	0	215
PRODW	Production	1328	45.0	113.8	0	1392
MAST	Masters	1328	2.1	7.9	0	146
APPR	Apprentices	1328	5.3	9.2	0	70
TOTW	All workers	1328	68	147	0	1741

Table 5 The Human Capital Stock of the Firm and Real Earnings

	Definition	N	Mean	Std Deviation	Minimum	Maximum
Human Capital Variables						
EDUWGT	Weighted education	1310	10.1	2.4	0	17
YRSWGT	Weighted imputed years of education	1310	10.9	3.0	0	21
PEXWGT	Weighted potential experience	1310	13.4	7.5	0	54
AGEWGT	Weighted age of workers	1310	30.3	7.7	15	62
TENWGT	Weighted tenure of workers	1310	5.2	4.1	0	30
Earnings						
ERNWGT	Weighted real hourly earnings before tax (in 1991 cedis)	1310	112.4	99.8	0	1285
ERNBTWGT	Weighted real monthly earnings before tax (in 1991 cedis)	1310	20917.0	14611.7	0	100178

Two measures of education have been constructed from the data. The first (EDUWGT) is based on answers to the question of the level and form the worker completed. The second (YRSWGT) is imputed from the date given of when the worker left school, it being assumed that they started education at the age of six. The first is the definition used in the regressions reported in the next section. With this definition the weighted years of education of the workforce is 10 with a standard deviation of 2.4. Most firms in Ghana have a workforce which has completed middle school. The number of secondary school completers is small as is the number of those with tertiary education. The next three dimensions of human capital which have been measured are intended to capture experience. The first is potential experience (PEXWGT) which is (age - years of school -6), the second is age (AGEWGT) and the third is tenure (TENWGT) which is defined as the length of time working in their current firm. In the regressions in the next Part of this note, which are intended solely to be illustrative of possible uses of the data, two components of human capital are used, education (EDUWGT) and tenure (TENWGT). Finally in Table 5 two weighted firm level averages of earnings are given, the first (ERNWGT) is weighted real hourly earnings, the second (ERNBTWGT), is weighted real monthly earings. Both are measured before tax at 1991 prices.

Price Indices for Output and Raw Material Inputs

There are two sources for the firm-specific price indices that have been constructed. For Waves 4 and 5 of the data, which collected information for the years 1994 to 1997, information was sought on the prices of output and material inputs of the most important goods that the firms produce. We were given access to World Bank data collected as part of a supplementary survey of the RPED project for prices covering the period 1991 to 1994 from some of the same firms as were covered in the main survey. We begin by describing how the data for the years 1994-1997 were first used to calculate the price indices for outputs and material inputs.

The information on the goods and their prices were extracted from the primary data and inputed into Excel. In Excel a spread sheet was created which was changed (by hand) so that the names and rankings of the goods was made comparable across the years. This Excel file was then manipulated (the details are given in Appendix B) to provide as comprehensive a data series as possible across the four years of data. It will be noted from the detailed documentation that where information on the products of the firm was available, but no prices, we have used price information for similar goods across firms to create a price index for the firm with missing price information.

In the case of the supplementary RPED data available from the World Bank we have not attempted to match products across the waves. An initial attempt to do this gave no useful information linking the years 1993 and 1994. So rather than link products we created overlapping firm prices where possible and then created a linked index. Appendix B contains details of the programs used to carry out this. These programs are available on request.

Where data was missing for all the years we have used sectoral averages so that a complete set of firm deflators is available for all 278 firms which have been covered over the course of the surveys. The sectoral averages were created from the firms for which we did have observations. In Table 6 we show the price index for outputs, in Table 7 that for material inputs and in Table 8 we present some macro price indices to check that the results shown for the firms are, at least broadly, consistent with the macro data.

Table 6 shows a nearly six fold rise in output prices over the seven years. Over this period the urban CPI index (Table 8) rose 5.5 times. These figures imply that, at the end of the seven year period, prices in the manufacturing sector had risen by 7 per cent more than urban prices generally. This discrepancy does not seem large given the very high rates of inflation which characterised the economy over this period. The rise in the price of material inputs shown in Table 7 is slightly lower. Broadly the figures suggest input prices rose, over the whole period, in line with output prices. As Table 8 shows the fall in the exchange rate and the rise in the CPI were also broadly in line over this period. A rather crudely measured real exchange rate calculation shown in Table 8 suggests a substantial real devaluation over the period 1991 to 1994 and then a nearly equally large real appreciation over the period from 1994 to 1997. The price

Table 6 Price Index for Outputs

Variable	N	Mean	Std Dev	Minimum	Maximum
FIRM	278	140.41	81.73	1.00	287.00
SECTOR	278	4.69	2.19	1.00	8.00
INDEX91	278	100.00	0.00	100.00	100.00
INDEX92	278	121.33	11.32	100.00	155.37
INDEX93	278	154.73	19.70	105.51	247.63
INDEX94	278	210.81	39.76	123.04	394.15
INDEX95	278	301.75	58.16	138.48	576.39
INDEX96	278	477.09	138.17	193.97	1057.12
INDEX97	278	594.69	172.67	229.91	1709.00

Table 7 Price Index for Inputs

Variable	N	Mean	Std Dev	Minimum	Maximum
FIRM	278	140.41	81.73	1.00	287.00
SECTOR	278	4.68	2.11	1.00	7.00
CINDEX91	278	100.00	0.00	100.00	100.00
CINDEX92	278	126.60	19.69	100.00	168.25
CINDEX93	278	164.05	25.27	115.79	271.16
CINDEX94	278	232.55	38.31	135.42	483.19
CINDEX95	278	333.06	52.50	148.51	613.04
CINDEX96	278	475.62	107.60	210.13	853.74
CINDEX97	278	588.09	140.59	256.58	1040.82

Table 8 Consumer Price Indices, Nominal and Real Exchange Rates

	CPI		Nominal Exchange Rate		Unit value US export prices	Real Exchange Rate (RER)	
	1977=100	1991=100	cedis/US$	1991=100		(a)	1991=100
1990	14331		326.3		113.9		
1991	17063	100.0	367.8	100.0	114.9	0.24	100.0
1992	18658	109.3	437.1	118.8	115.0	0.22	91.7
1993	23479	137.6	649.1	176.5	115.4	0.18	75.0
1994	29547	173.2	956.7	260.1	117.9	0.15	62.5
1995	47824	280.3	1200.4	326.4	123.8	0.19	79.2
1996	73545	431.0	1637.2	445.1	124.5	0.21	87.5
1997	94601	554.4	2050.2	557.4	122.6	0.22	91.7

(a) RER = CPI(based on 1991)*100/(exchange rate in cedis/US$ * Unit Value US export prices)

indices derived from the survey data seem broadly consistent with the macro data we can check them against. Clearly we wish to know how the price deflators affect our view of changes in underlying productivity over the period. Some preliminary results looking at this question, and the success of the physical and human capital stock variables in explaining value-added, are presented in the next part of this note.

Part II I: Production and Earnings Functions

In this Part we report the results of using the deflators and the measures of human and physical capital in a production function over the seven years for which we have data. The analysis is intended to be descriptive and to see the pattern that emerges of the level of technical progress over time in Ghana's manufacturing sector. We then estimate a firm based earnings function as a check on the role of the human capital variables that have been used in the production function. The time dummies in the earnings function also provide a comparison between changes in real earnings and underlying productivity change in the sector.

In Tables 9a and 9b we present a standard Cobb-Douglas production function incorporating labour, human and physical capital where the physical capital stock includes both plant and machinery and land and building. In Tables 10a and 10b we report similar regression in which the capital stock in land and buildings is excluded. The human capital variable used in the regressions is the firm level weighted average of education and tenure

Table 9a Production Function
Dependent Variable: Ln (Real Output)

R-square	0.98
Adj R-sq	0.98
N	796

Variable		Estimate	Standard Error	t statistic	prob > |T|
INTERCEPT		2.31	0.24	9.56	0.00
LRMATA	Ln (Material Inputs)	0.69	0.01	56.29	0.00
LRMISC	Ln (Miscellaneous Inputs)	0.13	0.01	10.14	0.00
LEMP	Ln (Employment)	0.04	0.05	0.87	0.39
LCAPNCP	Ln (Plant and Equipment)	0.04	0.01	3.57	0.00
LHCTWGT	Ln (Human Capital)	0.10	0.04	2.30	0.02
LKLBNCP	Ln (Land and Buildings)	0.01	0.01	1.02	0.31
Time Dummies					
WAVE3		_0.07	0.04	_1.69	0.09
WAVE4		_0.01	0.04	_0.21	0.83
WAVE5		_0.03	0.04	_0.66	0.51
WAVE6		_0.12	0.04	_2.90	0.00
WAVE7		_0.17	0.04	_3.94	0.00
Location dummies					
ACCRA		0.03	0.05	0.68	0.50
KUMASI		0.01	0.05	0.25	0.80
CAPE COAST		_0.05	0.08	_0.67	0.51
Sector Dummies					
FOOD		0.33	0.14	2.34	0.02
BAKERY		0.25	0.15	1.72	0.09
TEXTILE		0.23	0.16	1.50	0.13
GARMENT		0.11	0.15	0.76	0.45
WOOD		0.35	0.15	2.29	0.02
FURNITURE		0.18	0.14	1.24	0.22
METAL		0.18	0.14	1.30	0.20
MACHINES		0.18	0.15	1.16	0.25
ANYFOR	Any foreign ownership	_0.07	0.04	_1.87	0.06
STATGH	State and Ghana ownership	0.01	0.06	0.13	0.90
FMAGE	Firm age	0.00	0.00	2.05	0.04
UNION	Labour force unionised	0.07	0.05	1.57	0.12
EXPORTS	Dummy if firm exports	0.05	0.04	1.39	0.16

White test χ^2 [df]	298.62 [314]	p = 0.72
Test for Constant returns to scale	F [1,768]	P= 0.75

Table 9b Production Function
Dependent Variable: Ln (Real Value-added)

R-square	0.83
Adj R-sq	0.82
N	807

<table>
<tr><th>Variable</th><th></th><th>Estimate</th><th>Standard Error</th><th>t statistic</th><th>prob > |T|</th></tr>
<tr><td>INTERCEP</td><td></td><td>7.82</td><td>0.62</td><td>12.53</td><td>0.00</td></tr>
<tr><td>LEMP</td><td>Ln (Employment)</td><td>0.29</td><td>0.13</td><td>2.19</td><td>0.03</td></tr>
<tr><td>LCAPNCP</td><td>Ln (Plant and Equipment)</td><td>0.14</td><td>0.03</td><td>4.59</td><td>0.00</td></tr>
<tr><td>LHCTWGT</td><td>Ln (Human Capital)</td><td>0.52</td><td>0.13</td><td>3.92</td><td>0.00</td></tr>
<tr><td>LKLBNCP</td><td>Ln (Land and Buildings)</td><td>0.10</td><td>0.03</td><td>3.42</td><td>0.00</td></tr>
<tr><td>Time Dummies</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>WAVE3</td><td></td><td>0.00</td><td>0.13</td><td>_0.04</td><td>0.97</td></tr>
<tr><td>WAVE4</td><td></td><td>0.29</td><td>0.12</td><td>2.34</td><td>0.02</td></tr>
<tr><td>WAVE5</td><td></td><td>0.18</td><td>0.13</td><td>1.41</td><td>0.16</td></tr>
<tr><td>WAVE6</td><td></td><td>_0.10</td><td>0.13</td><td>_0.81</td><td>0.42</td></tr>
<tr><td>WAVE7</td><td></td><td>_0.23</td><td>0.13</td><td>_1.80</td><td>0.07</td></tr>
<tr><td>Location Dummies</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>ACCRA</td><td></td><td>0.07</td><td>0.15</td><td>0.48</td><td>0.63</td></tr>
<tr><td>KUMASI</td><td></td><td>0.09</td><td>0.15</td><td>0.62</td><td>0.53</td></tr>
<tr><td>CAPE COAST</td><td></td><td>_0.33</td><td>0.24</td><td>_1.39</td><td>0.16</td></tr>
<tr><td>Sector Dummies</td><td></td><td></td><td></td><td></td><td></td></tr>
<tr><td>FOOD</td><td></td><td>0.65</td><td>0.42</td><td>1.54</td><td>0.12</td></tr>
<tr><td>BAKERY</td><td></td><td>0.70</td><td>0.44</td><td>1.61</td><td>0.11</td></tr>
<tr><td>TEXTILE</td><td></td><td>0.23</td><td>0.47</td><td>0.49</td><td>0.62</td></tr>
<tr><td>GARMENT</td><td></td><td>_0.77</td><td>0.43</td><td>_1.77</td><td>0.08</td></tr>
<tr><td>WOOD</td><td></td><td>_0.36</td><td>0.45</td><td>_0.81</td><td>0.42</td></tr>
<tr><td>FURNITURE</td><td></td><td>_0.23</td><td>0.43</td><td>_0.55</td><td>0.58</td></tr>
<tr><td>METAL</td><td></td><td>0.23</td><td>0.42</td><td>0.55</td><td>0.58</td></tr>
<tr><td>MACHINES</td><td></td><td>0.25</td><td>0.46</td><td>0.55</td><td>0.59</td></tr>
<tr><td>ANYFOR</td><td>Any foreign ownership</td><td>_0.07</td><td>0.11</td><td>_0.64</td><td>0.52</td></tr>
<tr><td>STATGH</td><td>State and Ghana ownership</td><td>_0.25</td><td>0.19</td><td>_1.35</td><td>0.18</td></tr>
<tr><td>FMAGE</td><td>Firm age</td><td>0.00</td><td>0.00</td><td>0.64</td><td>0.53</td></tr>
<tr><td>UNION</td><td>Labour force unionised</td><td>0.49</td><td>0.13</td><td>3.71</td><td>0.00</td></tr>
<tr><td>EXPORTS</td><td>Dummy if firm exports</td><td>0.23</td><td>0.12</td><td>2.03</td><td>0.04</td></tr>
<tr><td>White test χ^2 [df]</td><td></td><td>321.81 [261]</td><td></td><td>p = 0.006</td><td></td></tr>
<tr><td>Test for Constant returns to scale</td><td></td><td>F [1,781]</td><td></td><td>P= 0.20</td><td></td></tr>
</table>

Table 10a Production Function
Dependent Variable: Ln (Real Output)

		OLS Estimates		Fixed effects Estimates	
		R-square	0.9716		
		Adj R-sq	0.9709		
		N	1056	1056	
Variable		Parameter	t statistic	Parameter	t statistic
INTERCEPT		2.66	10.95		
LRMATA	Ln (Material Inputs)	0.65	58.09	0.59	44.51
LRMISC	Ln (Miscellaneous Inputs)	0.15	13.62	0.13	10.61
LEMP	Ln (Employment)	0.08	1.88	0.01	0.19
LCAPNCP	Ln (Real Capital Stock)	0.05	6.18	0.02	0.34
LHCTWGT	Ln (Human Capital Stock)	0.06	1.53	0.13	2.66
Wave dummies					
WAVE2		0.06	1.27	0.07	1.85
WAVE3		_0.05	_1.03	0.03	0.73
WAVE4		0.03	0.72	0.10	2.68
WAVE5		0.01	0.24	0.09	2.21
WAVE6		_0.11	_2.44	_0.01	_0.37
WAVE7		_0.15	_3.33	_0.05	_1.32
Location dummies					
ACCRA		0.03	0.60		
KUMASI		0.02	0.35		
CAPE COAST		_0.07	_0.89		
Sector dummies					
FOODS		0.25	1.59		
BAKERY		0.26	1.59		
TEXTILE		0.14	0.83		
GARMENT		0.15	0.92		
WOOD		0.24	1.42		
FURNITURE		0.11	0.67		
METAL		0.15	0.94		
MACHINES		0.22	1.29		
ANYFOR	Any foreign ownership	_0.05	_1.36		
STATGH	State and Ghana ownership	_0.01	_0.16		
FMAGE	Firm age	0.002	1.87		
UNION	Labour force unionised	0.09	2.12		
EXPORTS	Dummy if firm exports	0.05	1.26		
White χ^2 [df]		267 [309]			
F Test of Constant Returns to Scale		F [1,1027]=0.13 p=0.71		F [1,827]=3.15 p=0.08	

Table 10b Production Function
Dependent Variable: Ln (Real Value-added)
where the price index for output is used to deflate nominal output and the cost index is used to deflate material input costs

		OLS Estimates		Fixed effects Estimates	
		R-Square	0.81		
		Adj R-sq	0.81		
		N 1078		N 1056	
Variable		Parameter	t statistic	Parameter	t statistic
INTERCEP		8.29	14.48	0.02	
LEMP	Ln (Employment)	0.35	3.04	0.02	0.12
LCAPNCP	Ln (Real Capital Stock)	0.24	10.88	_0.21	_1.36
LHCTWGT	Ln (Human Capital Stock)	0.41	3.70	0.56	4.22
WAVE2		0.07	0.63	0.10	1.07
WAVE3		0.05	0.42	0.16	1.59
WAVE4		0.38	3.40	0.46	4.76
WAVE5		0.28	2.46	0.37	3.76
WAVE6		_0.06	_0.54	0.07	0.67
WAVE7		_0.16	_1.34	0.02	0.15
ACCRA		0.05	0.39		
KUMASI		0.05	0.41		
CAPE COAST		_0.48	_2.22		
FOOD2		0.56	1.30		
BAKERY		0.74	1.68		
TEXTILE		0.12	0.25		
GARMENT		_0.51	_1.16		
WOOD		_0.35	_0.77		
FURN		_0.21	_0.49		
METAL		0.24	0.57		
MACHINES		0.20	0.44		
ANYFOR	Any foreign ownership	_0.01	_0.09		
STATGH	State and Ghana ownership	_0.22	_1.31		
FMAGE	Firm age	0.01	1.85		
UNION	Labour force unionised	0.56	4.74		
EXPORTS	Dummy=1 if firm exports	0.20	1.87		
White χ^2 [df]		274 [257]			
F Test of Constant Returns to Scale		F [1,1052]=0.07 p=0.79		F [1,852]=14.3 p=0.0002	

Table 11 Earnings Function for Firm Based Data
Dependent Variable: Ln (Weighted Real Hourly Earnings)

R-square	0.55
Adj R-sq	0.54
N	1197

Variable		Estimate	Standard error	t statistic	prob > |T|
INTERCEPT		2.15	0.26	8.35	0.00
EDUWGT	Weighted education	0.07	0.01	8.37	0.00
AGEWGT	Weighted age	0.06	0.00	13.72	0.00
TENWGT	Weighted tenure	0.02	0.01	2.92	0.00
Time Dummies					
WAVE2		0.03	0.07	0.40	0.69
WAVE3		0.08	0.07	1.11	0.27
WAVE4		_0.01	0.07	_0.20	0.84
WAVE5		_0.25	0.07	_3.57	0.00
WAVE6		_0.14	0.07	_1.90	0.06
WAVE7		_0.19	0.07	_2.60	0.01
Location dummies					
ACCRA		0.32	0.08	3.83	0.00
KUMASI		0.13	0.08	1.56	0.12
CAPE COAST		_0.17	0.13	_1.34	0.18
Sector Dummies					
FOOD		_0.32	0.20	_1.60	0.11
BAKERY		_0.04	0.08	_0.43	0.67
TEXTILE		_0.34	0.23	_1.48	0.14
GARMENT		_0.85	0.21	_4.13	0.00
WOOD		_0.41	0.21	_1.93	0.05
FURNITURE		_0.57	0.20	_2.83	0.00
METAL		_0.44	0.20	_2.21	0.03
MACHINES		_0.42	0.22	_1.91	0.06
ANYFOR	Any foreign ownership	0.07	0.06	1.20	0.23
STATGH	State and Ghana ownership	0.03	0.10	0.34	0.74
FMAGE	Firm age	0.00	0.00	_0.36	0.72
UNION	Labour force unionised	0.22	0.06	3.57	0.00
White χ^2 [df]		271 [239]			

multiplied by the number of employees in the firm. We control for sector, ownership, firm age, unionisation and export status. In Tables 9a and 10a we present the production function using the log of real output as the dependent variable; in Tables 9b and 10b we present the value-added function where we deflate nominal value-added by the firm specific output price index from Table 6 and the inputs by the cost inputs from Table 7. In Tables 10a and 10b we also report results for fixed effects. The importance of distinguishing between gross output and value-added production functions has been pointed out by Basu and Fernald (1995). “Value-added is thus an economic index number without physical interpretation. As an index number, value-added is not atheoretic: it construction implicitly assumes competition and constant returns to scale", (p. 167) In moving between the two specifications we are therefore interested to see if constant returns to scale are accepted.

For the gross output production functions reported in Tables 9a and 10a constant returns to scale is accepted at the 5 per cent significance level for both the OLS and fixed effects estimates. The consequence of allowing for fixed effects is to more than half the point estimates on both capital and labour which is what would be expected if unobservables are correlated with these variables. The coefficient on human capital doubles. In the fixed effects estimate (Table 10a) there is evidence from the time dummies that productivity is higher in waves 4 and 5 of the survey. It needs to be noted that it is over this period that the real exchange rate altered from declining to rising. The significant positive coefficient on the time dummies for this period may indicate measurement errors in the deflators. Certainly over the whole period of the surveys there is no evidence, from either the OLS or the fixed effect estimate, for any rise in productivity. None of the location or sectoral dummies are individually significant. There is some evidence that firms do become more efficient as they age and that exporting firms are more efficient, although nether of these effects is significant. The most significant effect comes from unionisation which increases gross output by nearly 10 per cent.

For the value-added production function reported in Tables 9a and 10a constant returns to scale is accepted for the OLS estimate but is rejected in the fixed effects estimate in Table 10a; indeed the point estimate on the capital stock in the fixed effect estimate is negative. We note for the OLS estimate that the coefficients on labour and capital are highly significant, sum almost exactly to unity, and are remarkably similar to those found in the macro literature, Mankiw, Romer and Weil (1992). A common pattern across both the gross output and value-added production functions is that the coefficient on human capital increases both in size and significance as a result of moving to fixed effects. The pattern of the coefficients on the time dummies for value-added is similar to that already observed for gross output. Unionisation is again highly significant. We use the fixed estimates in the next section to assess the determinants of underlying efficiency in the firms.

In Table 11 we investigate whether the firm level data can produce an earnings function similar to that observed on the basis of individual data, Teal (2000). This is of interest as a check on the calculation of the values of the human capital stocks across the firms. It also enables us to see how changes in real wages over the seven year period compare with the changes in labour productivity implicit in the production functions shown in Tables 9 and 10.

The three human capital variables used in the firm level earnings function, education, age and tenure are all significant and indicate rates of return of 7 per cent for education, 6 per cent for experience measured by age and 2 per cent for tenure. These are in line with individual based earning function and are obviously subject to the same reservations as are advanced for imputing rates of return from such functions.

The most important finding from Table 11 is that there is clear evidence for long run falls in real earnings. The time dummies in Table 11 suggest that this fall occurred in the period from 1991 to 1994 and after that there was a slight rise. Even if this was the case the level of real wages at the end of the period was 18 per cent below the level at the beginning. There are, however, reasons to believe that the real fall in wages continued over the whole period. The size of firms in the sample has been rising as larger firms have been added as the survey has progressed. As larger firms pay more this will be inducing an upward bias to the estimates. Full controls for this are necessary before the extent of the fall in real wages can be assessed, see Teal (2000) for a discussion of these issues.

In summary this review of the data suggests that investment rates have been low, there has been no growth in underlying firm productivity and real wages have been falling.

Part IV Using the Data to Measure Firm Performance

The data set described above provides the means to assess the extent of productivity growth in the Ghanaian manufacturing sector over a seven year period. This is much longer than that possible for any other sub-Saharan African (SSA) country. The key fact to emerge from this preliminary review of the data is that the low investment rates of the early 1990s, which were noted in Bigsten et al (1999), have continued in Ghana. There is no evidence from this preliminary analysis of any increase in investment rates.

Skills-based explanations of under-performance

SSA is generally seen as lacking the skill base that is a precondition for the rapid growth of manufactured exports that has characterized the East Asian economies. It has been argued that this is likely to be a determinant of the relative absence of technology diffusion (Biggs and Srviastava 1996; Biggs, et al., 1995). Skills have many dimensions. One is the stock of human capital available to the firm, another is the skill with which inputs can be turned into outputs. In standard measures of technical efficiency, based on the residual from a production function, these two elements are combined. Our measures of human capital, combined with the existence of panel data, enable the two to be separated.

In Table 12 we report how the underlying efficiency of firms vary by firm size. Size is defined as the average number of employees over the survey. The efficiency measure is obtained from the coefficients on the fixed effects estimate of the gross output production function reported in Table 10a. In this production function there are 218 firms and the efficiency measure in Table 12 is the exponent of the coefficients of the firm fixed effects. The efficiency index is obtained from this efficiency measure by creating a variable where the most efficient firm has a value of unity. The average level of efficiency across all the firms in the sample is 19 per cent. The level of efficiency differs substantially across firms of differing size. In round numbers the underlying efficiency of firms with an average of 500 employees is more than twice that of small and micro firms.

The determinants of firm efficiency are analysed in Table 13. The dependent variable is the log of the firm efficiency measure from Table 12. The first equation includes a measure of firm size (mlemp) which is the mean of the log of the number of employees across the rounds of the survey. This is highly significant as indeed would be expected from Table 12. A 10 per cent rise in firm size increases efficiency by nearly 2 per cent. The second equation in Table 13 drops the firm size measure to see if ownership is important. It is clear that some foreign ownership does not increase efficiency relative to state and Ghanaian ownership, the two coefficients are virtually identical. The least efficient sectors are garments and furniture, which are also the sectors where the smallest firms are located. As a comparison between the two equations in Table 13 shows dropping the control for size increases the relatively poor performance of these two sectors. The key to increased efficiency lies in size; a result which pushes back, rather than answers, the question as to what determines efficiency.

Table 12 The Efficiency of Firms by Firm Size

	Efficiency Measure	Efficiency Index	Firm size (Number of Employees)
Very Large Firms [N=22] > 200 employees	180	0.33	500
Large Firms [N=19] > 100 and < 200 employees	134	0.24	142
Medium firms [N=53] > 30 and < 100 employees	110	0.20	52
Small Firms [N=93] > 6 and < 30 employees	85	0.16	15
Micro firms [N=31] < 6 employees	80	0.15	4
All firms [N=218]	104	0.19	82

Table 13 The Determinants of Firm efficiency
Dependent Variable: Ln(Firm Efficiency Measure)

		Parameter	t statistic	Parameter	t statistic
INTERCEPT		_2.00	_11.12	_1.35	_7.34
Location dummies					
ACCRA		_0.02	_0.21	_0.06	_0.55
KUM		_0.02	_0.21	_0.13	_1.21
CAPE		_0.18	_1.19	_0.28	_1.63
Sector Dummies					
FOODS		_0.17	_1.19	_0.21	_1.30
BAKERY		_0.13	_0.83	_0.39	_2.26
TEXTILE		_0.32	_1.80	_0.27	_1.33
GARMENT		_0.45	_3.14	_0.63	_3.87
WOOD		_0.37	_2.09	_0.36	_1.77
FURNITURE		_0.50	_3.54	_0.58	_3.64
METAL		_0.30	_2.17	_0.42	_2.64
MACHINES		_0.20	_1.11		
ANYFOR	Any foreign ownership	0.04	0.62	_0.33	_1.66
STATGH	State and Ghana ownership	0.00	0.01	0.21	3.04
MEXPORTS	Export Dummy	0.14	1.46	0.21	1.73
MLEMP	Log of Employment	0.17	8.01	0.28	2.71
N		218		218	
Adjusted R^2			0.47		0.31

Firm Dynamics and Firm Efficiency

In the introduction we set out the number of the firms that exited and entered the sample. We now wish to consider if exits are concentrated among the least efficient firms. Table 14 reports the proportions exiting and entering by their average size over the period for which they were observed. It is clear that exits are concentrated among the smaller firms. In fact none of the large, or very large firms, exited during this period. Entry too is concentrated among smaller firms. However it will be noted that there was entry among the very large firms, it is not at all clear firms need to start small.

In order to establish if less efficient firms are more likely to exit we ran a logit on the decision to exit. We model this for firms in the sample and define an exit as a firm which exited at some point during the period of the surveys.[1] We report this logit in Table 15 Model 1. We control for location, sector, ownership, firm age and size. There is no evidence that less efficient firms are more likely to exit. Indeed the parameter on the efficiency variable is positive although not significant at the 5 per cent level. Size dominates the formal result showing that smaller firms are much more likely to exit. As we have already shown that smaller firms are much less efficient it is clearly important to ask if, when the size variable is dropped, the efficiency measure becomes significant. This we do in Model 2. The coefficient on the efficiency term changes sign but is far from significant. It appears that in this sample, over this period, less efficient firms were not more likely to exit. This result should not surprise. The sample begins in 1991 which is the period after the major trade liberalisation measures had been introduced. It is known that many firms exited in the period prior to the survey. Over this period, while there was a substantial real devaluation followed by an almost equal appreciation, there was little change in trade policy.

[1]We also ran a logit for the decision to exit over the whole period of the sample and the results were similar.

Table 14 The Probability of Exiting and Entering

	Proportion Exiting	Proportion Entering	Firm size (Number of Employees)
Very Large Firms [N=22] > 200 employees	0	0.05	500
Large Firms [N=17] > 100 and < 200 employees	0	0	142
Medium firms [N=51] > 30 and < 100 employees	0.16	0.04	52
Small Firms [N=85] > 6 and < 30 employees	0.09	0.16	15
Micro firms [N=30] < 6 employees	0.30	0.13	4
All firms [N=205]	0.12	0.10	82

Table 15 A Logit on the Decision to Exit

		Model 1 Parameter	Standard Error	Model 2 Parameter	Standard Error
INTERCEPT		_0.79	1.66	_1.36	1.50
EFFIND	Efficiency Index	8.34	4.93	_1.28	4.08
Location Dummy					
ACCRA		_0.85	0.99	_0.63	0.92
KUM		_0.51	0.95	_0.06	0.92
CAPE		0.14	1.47	0.29	1.46
Sector Dummies					
FOOD2		_0.45	1.26	_1.00	1.14
BAKERY		0.74	1.26	0.99	1.12
TEXTILE		0.64	1.53	_0.35	1.38
GARMENT		0.86	1.25	0.29	1.07
WOOD		_0.48	1.56	_1.81	1.39
FURN		0.76	1.21	_0.17	1.04
METAL		0.05	1.18	_0.44	1.03
ANYFOR		2.26	0.79	1.67	0.73
STATGH		3.48	1.04	2.36	0.89
FMAGE		_0.01	0.02	_0.03	0.02
MLEMP		_1.02	0.32		
N			198		198

Investment and new technology

The lack of new technology in Africa is clearly related to the low investment rates and the lack of export orientation. So in addressing the reasons for the relative lack of technological diffusion it is necessary to address the question as to why investment rates are so low and why exports remain concentrated in the wood working sector.

There are two dimensions to these questions. The first is investment in the traded sector. Why is investment not profitable in the export sector? Is it that the sector faces high interest costs? What has been the effect of the large changes in the real exchange rate that occurred over the 1990s? Is it that the uncertainty associated with entering the export market are such as to render it too risky even though profit rates are high? Is it that firms are too small to be able to enter the export market successfully? The second dimension is investment in the non-traded sector. Here the ability of domestic firms to respond to demand will be crucial. Is it that they have not responded, or has the growth of demand been limited? How important have been financial constraints for the firms? What kind of firms have been able to invest and grow? How is the finding that investment rates are low to be linked to the view that under-use of capacity is substantial. The skills explanation for under-performance may link directly to the low investment rates. Is the lack of skills a reason for low investment? If so, which kind of skills is it that the firms lack? Does the skill constraint within the firms operate primarily through limiting the investment opportunities the firm can exploit?

Some possible answers to these questions are given in Söderbom and Teal (2000). They show that if by skills is meant the observable human capital of the firm in terms of more educated and more experienced labour these do not increase investment. However the unobservable component which we measure as the underlying efficiency of firms, has a major impact on the propensity to invest. Possibly not surprisingly firms which operate at a higher level of efficiency are able to absorb more technology in the form of new investment.

Trade and technology diffusion

Exporting is likely to be associated with technological diffusion if it is associated with new products or new markets. Even if it is not exporting may greatly expand the market available to the firms. In so far as firms are limited to internal sources of finance and these, in turn, are limited by their markets, exporting may provide a mechanism by which additional sources of investment funds become available. Such funds may then be invested either in new technology within the sector, in new sectors, or in an extension of existing operations. Exporting may thus provide access to a higher growth path for the firm. Whether firms have done this, and how it can be done, can be investigated from the data.

If exports facilitate technological diffusion, the failure of SSA firms to develop technologically sophisticated exports for new markets, and the lack of demand for skilled labor, are reinforcing factors limiting the growth of the manufacturing sector within African economies. The skill intensity of African exports can be determined by using the data for human capital from part 1 above.

Sub-contracting and technology diffusion

Sub-contracting will have very different implications for technology diffusion depending on whether the firm is using an old or new technology. Old or new here refers to the experience of the firm rather than to the age of the technology. Sub-contracting in many firms in Ghana takes the form of employing casual labour to deal with spikes in demand. Such sub-contracting is a device for enabling firms to respond to demand rather than a source of learning.

Foreign direct investment

There is some evidence that foreign ownership increases total factor productivity although the preliminary assessment of the evidence in Part III indicates that any direct effect from ownership onto underlying productivity is small. However it is clearly possible that there are indirect effects that need to be investigated and that there may be important links from ownership to the quality of the management.

References

S. Basu and J.G. Fernald (1995) “Are apparent productive spillovers a figment of specification error?”, *Journal of Monetary Economics* (36), pp.165-188.

T. Biggs, M. Shah and P. Srivastava (1995) Technological Capabilities and Learning in African Enterprises, World Bank Technical paper No. 288, African Technical Department.

T. Biggs and P. Srivastava (1996) *Structural Aspects of Manufacturing in sub-Saharan Africa: Findings from a seven country enterprise survey*, World Bank Discussion paper No.346.

A. Bigsten, P. Collier, S. Dercon, B. Gauthier, J.W. Gunning, A. Isaksson, A. Oduo, R. Oostendorp, C.Pattilo, M.Soderbom, M.Sylvain, F. Teal and A. Zeufack (1999) ‘Investment in Africa’s manufacturing sector: a four country panel data analysis’, *Oxford Bulletin of Economics and Statistics*, Vol. 61, No. 4, Nov. 1999, pp.489-512.

Ghana (1987a) *Central Bureau of Statistics, Industrial Census 1987*, Statistical Service, Accra.

Ghana (1987b) *1984 Population Census of Ghana*, Statistical Service, Accra.

S. Lall, G. Navaretti, A. Teitel and G. Wignaraja (1994) *Technology and Enterprise Development: Ghana under Structural Adjustment*, Macmillan.

N. G. Mankiw, D. Romer and D. Weil (1992) ‘A contribution to the empirics of economic growth’, *Quarterly Journal of Economics*, Vol. CVII, pp. 407-437.

M. Söderbom and F. Teal (2000) “Skills, Investment and Exports from Manufacturing Firms in Africa”, CSAE Working Paper, WPS/2000.8.

W.F. Steel L.M. and Webster (1991) *Small Enterprises under Adjustment in Ghana*, World Bank Technical paper Number 138, Industry and Finance Series.

F. Teal. (2000) “Private sector wages and poverty in Ghana: 1988_1998", CSAE Working Paper, WPS/2000.6.

Appendix A The Capital Stock of Plant and Machinery
A SAS program to calculate capital stocks

```
libname cd 'e:\sasprogs\sasrped5may99\ghrped1_5\createdata';
libname j4 'e:\sasprogs\sasrped5may99\ghrped1_5\wave4' ;
libname j5 'e:\sasprogs\sasrped5may99\ghrped1_5\wave5';

proc sort data=cd.scale17;by firm wave;
proc sort data=cd.sizew5;by firm;
proc sort data=cd.invlb;by firm wave;

data temp0;merge cd.scale17 cd.invlb;by firm wave;
if invqu=. then invqu=inv;
/*Check on data
proc sort;by wave; proc means; var invqu invplant invbuild invland;by wave;
run;
*/

/*Corrections based on reviweing questionnaris
Firm 19 did undertake a substantial investment
in wave 2 that was not refected inthe capital
 stock figures beyond wave 2 in the data*/

if firm=19 then do;
if wave=3 then cap=cap+(2950400*166.8/116.4);
if wave=4 then cap=cap+(2950400*238.4/116.4);
if wave=5 then cap=cap+(2950400*314.9/116.4);
if wave=6 then cap=cap+(2950400*441.6/116.4);
if wave=7 then cap=cap+(2950400*557.7/116.4);
end;

if firm=42 and wave=2 then cap=422000000;

if firm=68 and wave=2 then invqu=0;
if firm=73 and wave=1 then invqu=0;
if firm=91 and wave=4 then invqu=0;
if firm=106 and wave=4 then invqu=0;
if firm=106 and wave=5 then invqu=0;
if firm=113 and wave=1 then invqu=0;
if firm=131 and wave=4 then cap=500000000*238.4/166.8;
if firm=131 and wave=5 then cap=500000000*314.9/166.8;
if firm=140 and wave=4 then invqu=0;
if firm=140 and wave=5 then invqu=0;
if firm=147 and wave=3 then invqu=0;
if firm=155 and wave=4 then invqu=950000;
if firm=155 and wave=5 then invqu=500000;
if firm=159 and wave=4 then invqu=0;
if firm=159 and wave=5 then invqu=0;
if firm=180 and wave=3 then invqu=0;
if firm=185 and wave=4 then invqu=0;
if firm=185 and wave=5 then invqu=0;

invcap=invqu/cap;

proc sort;by firm ;


data labp17;merge temp0 cd.sizew5;by firm;
options linesize=80;
```

```
title ' Merged waves 1_4 Production Data (labp15)';
if klbsal=. then klbsal=klbrep;

data cap1;set labp17;
if wave=1;
klb1=klbsal;
cap1=cap;
invqu1=invqu;
invlb1=invland+invbuild;
keep firm wave cap1 invqu1 klbl invlb;
proc sort;by firm;
data cap2;set labp17;
if wave=2;
cap2=cap;
klb2=klbsal;
invqu2=invqu;
invlb2=invland+invbuild;
keep firm wave cap2 invqu2 klb2 invlb2;
proc sort;by firm;
data cap3;set labp17;
if wave=3;
cap3=cap;
klb3=klbsal;
invqu3=invqu;
invlb3=invland+invbuild;
keep firm wave cap3 invqu3 klb3 invlb3;
proc sort;by firm;
data cap4;set labp17;
if wave=4;
cap4=cap;
klb4=klbsal;
invqu4=invqu;
invlb4=invland+invbuild;
keep firm wave cap4 invqu4 klb4 invlb4;
proc sort;by firm;
data cap5;set labp17;
if wave=5;
cap5=cap;
klb5=klbsal;
invqu5=invqu;
invlb5=invland+invbuild;
keep firm wave cap5 invqu5 klb5 invlb5;
proc sort;by firm;
data cap6;set labp17;
if wave=6;
cap6=cap;
klb6=klbsal;
invqu6=inv;
invlb6=invland+invbuild;
keep firm wave cap6 invqu6 klb6 invlb6;
proc sort;by firm;
proc means; run;

data cap7;set labp17;
if wave=7;
cap7=cap;
klb7=klbsal;
invqu7=inv;
invlb7=invland+invbuild;
```

```
keep firm wave cap7 invqu7 klb7 invlb7;
proc sort;by firm;

data cap;merge cap1 cap2 cap3 cap4 cap5 cap6 cap7;by firm;

/*The deflator used for the capital stock is a weighted average of
the urban cpi (0.25) and the US$ excahnge rate 0.75

           cpi     er        delator  US export UVs   Exports Volume
1990         83.99    88.7              99.1
1991         100      100        100       100          201.7
1992         109.3    118.8       116.4     100.1         207.1
1993         137.6    176.5       166.8     100.4         241.5
1994         173.2    260.1       238.4     102.6         241.8
1995         280.3    326.4       314.9     107.7         259.5
1996         431.1    445.1       441.6
1997         554.5    558.8       557.7

 */


capn7=cap7;
capn6=cap6;
capn5=(capn6_invqu5)*314.9/441.6;
if capn5=. then capn5=cap5;
capn4=(capn5_invqu4)*238.4/314.9;
if capn4=. then capn4=cap4;
capn3=(capn4_invqu3)*166.8/238.4;
if capn3=. then capn3=cap3;
capn2=(capn3_invqu2)*116.4/166.8;
if capn2=. then capn2=cap2;
capn1=(capn2_invqu1)*100/116.4;
if capn1=. then capn1=cap1;

klbn7=klb7;
klbn6=klb6;
klbn5=(klbn6_invlb5)*280.3/431.1;
if klbn5 le 0 then klbn5=klb5;
klbn4=(klbn5_invlb4)*173.2/280.3;
if klbn4 le 0 then klbn4=klb4;
klbn3=(klbn4_invlb3)*137.6/173.2;
if klbn3 le 0 then klbn3=klb3;
klbn2=(klbn3_invlb2)*109.3/137.6;
if klbn2 le 0 then klbn2=klb2;
klbn1=(klbn2_invlb1)*100/118.8;
if klbn1=. then klbn1=klb1;

capn1cp=capn1;
capn2cp=capn1+(invqu1/1.164)_0.02*capn1;
if capn2cp=. then capn2cp=capn2/1.164;
if capn2=. then capn2=capn2cp*1.164;
capn3cp=capn2cp+(invqu2/1.668)_0.02*capn2cp;
if capn3cp=. then capn3cp=capn3/1.668;
if capn3=. then capn3=capn3cp*1.668;
capn4cp=capn3cp+(invqu3/2.384)_0.02*capn3cp;
if capn4cp=. then capn4cp=capn4/2.384;
if capn4=. then capn4=capn4cp*2.384;
capn5cp=capn4cp+(invqu4/3.149)_0.02*capn4cp;
if capn5cp=. then capn5cp=capn5/3.149;
```

```
if capn5=. then capn5=capn5cp*3.149;
capn6cp=capn5cp+(invqu5/4.416)_0.02*capn5cp;
if capn6cp=. then capn6cp=capn6/4.416;
if capn6=. then capn6=capn6cp*4.416;
capn7cp=capn6cp+(invqu6/5.577)_0.02*capn6cp;
if capn7=. then capn7=capn7cp*5.577;

klbn1cp=klbn1;
klbn2cp=klbn1+(invlb1/1.093);
if klbn2cp=. then klbn2cp=klbn2/1.093;
if klbn2=. then klbn2=klbn2cp*1.093;
klbn3cp=klbn2cp+(invlb2/1.376);
if klbn3cp=. then klbn3cp=klbn3/1.376;
if klbn3=. then klbn3=klbn3cp*1.376;
klbn4cp=klbn3cp+(invlb3/1.732);
if klbn4cp=. then klbn4cp=klbn4/1.732;
if klbn4=. then klbn4=klbn4cp*1.732;
klbn5cp=klbn4cp+(invlb4/2.803);
if klbn5cp=. then klbn5cp=klbn5/2.803;
if klbn5=. then klbn5=klbn5cp*2.803;
klbn6cp=klbn5cp+(invlb5/4.311);
if klbn6cp=. then klbn6cp=klbn6/4.311;
if klbn6=. then klbn6=klbn6cp*4.311;
klbn7cp=klbn6cp+(invlb6/5.545);
if klbn7=. then klbn7=klbn7cp*5.545;

invcp1=invqu1;
invcp2=invqu2/1.164;
invcp3=invqu3/1.668;
invcp4=invqu4/2.384;
invcp5=invqu5/3.149;
invcp6=invqu6/4.416;
invcp7=invqu7/5.577;

invlbcp1=invlb1;
invlbcp2=invlb2/1.093;
invlbcp3=invlb3/1.376;
invlbcp4=invlb4/1.732;
invlbcp5=invlb5/2.803;
invlbcp6=invlb6/4.311;
invlbcp7=invlb7/5.545;

data capn1; set cap;
wave=1;
cap=cap1;
capn=capn1;
capncp=capn1cp;
invcp=invcp1;
inv=invqu1;
invlb=invlb1;
invlbcp=invlbcp1;
klbncp=klbn1cp;
klb=klb1;
klbn=klbn1;
keep firm wave cap capn capncp invcp inv invlb klb invlbcp klbncp klbn;

data capn2; set cap;
wave=2;
cap=cap2;
```

```
capn=capn2;
capncp=capn2cp;
invcp=invcp2;
inv=invqu2;
invlb=invlb2;
invlbcp=invlbcp2;
klbncp=klbn2cp;
klb=klb2;
klbn=klbn2;
keep firm wave cap capn  capncp invcp inv invlb klb invlbcp klbncp klbn;
proc means; run;
data capn3; set cap;
wave=3;
cap=cap3;
capn=capn3;
capncp=capn3cp;
invcp=invcp3;
inv=invqu3;
invlb=invlb3;
invlbcp=invlbcp3;
klbncp=klbn3cp;
klb=klb3;
klbn=klbn3;
keep firm wave cap capn  capncp invcp inv invlb klb invlbcp klbncp klbn;
data capn4;  set cap;
wave=4;
cap=cap4;
capn=capn4;
capncp=capn4cp;
invcp=invcp4;
inv=invqu4;
invlb=invlb4;
invlbcp=invlbcp4;
klbncp=klbn4cp;
klb=klb4;
klbn=klbn4;
keep firm wave cap capn  capncp invcp inv invlb klb invlbcp klbncp klbn;
data capn5;   set cap;
wave=5;
cap=cap5;
capn=capn5;
capncp=capn5cp;
invcp=invcp5;
inv=invqu5;
invlb=invlb5;
invlbcp=invlbcp5;
klbncp=klbn5cp;
klb=klb5;
klbn=klbn5;
keep firm wave cap capn  capncp invcp klb inv invlb invlbcp klbncp klbn;
data capn6;   set cap;
wave=6;
cap=cap6;
capn=capn6;
capncp=capn6cp;
invcp=invcp6;
inv=invqu6;
invlb=invlb6;
invlbcp=invlbcp6;
```

```
klbncp=klbn6cp;
klb=klb6;
klbn=klbn6;
keep firm wave cap capn  capncp invcp klb inv invlb invlbcp klbncp klbn;
data capn7;   set cap;
wave=7;
cap=cap7;
capn=capn7;
capncp=capn7cp;
invcp=invcp7;
inv=invqu7;
invlb=invlb7;
invlbcp=invlbcp7;
klbncp=klbn7cp;
klb=klb7;
klbn=klbn7;
keep firm wave cap capn  capncp invcp inv invlb klb invlbcp klbncp klbn;

data cd.capn17;set capn1 capn2 capn3 capn4 capn5 capn6 capn7;

invcpr=invcp/capncp;
invnr=inv/capn;

invlbcpr=invlbcp/klbncp;
invlbr=invlb/klb;

if capncp le 0 then delete;
if klbncp  le 0 then klbncp=.;
if invcpr gt 1.5 then delete;

/*These are dummies for firms carrying out any investment*/
if invcp=0 then pinvd=0;if invcp gt 0 then pinvd=1;
if invlbcp=0 then lbinvd=0; if invlbcp gt 0 then lbinvd=1;

/*pinvrci is the plant investment rate conditional on any investment
lbinrci is the land and building investment rate condiitonal on any investment*/

if pinvd=1 then pinvrci=invcpr;
if lbinvd=1 then lbinrci=invlbcpr;

proc means;var firm wave cap capn capncp
 invcp inv invlb invcpr  klbncp invnr invlbcpr invlbr invlbcp pinvd lbinvd pinvrci lbinrci;
run;
proc means; var firm wave cap capn capncp invcp inv invcpr invnr
klb klbn klbncp invlbcp invlb invlbcpr invlbr;
run;
```

Appendix B
Creating a new data file with the firm level variables (for price indices): Documentation

The SAS programmes which converted the data into a form which was imported into Excel was list9697.sas (for 1996, 1997) and list9495.sas (for 1994, 1995). list9697.sas creates a 'list' for the years 1996 and 1997. List9495.sas creates a list for 1994 and 1995 and also merges this list with that for 1996/97 to create FULLLIST.sd2 which is what is imported into excel to be changed.

Workbooks: fullist.xls; fullist1.xls; fullist2.xls; compiled.xls; compile2.xls. [These workbooks and list9697.sas and list 9495.sas can be found in 'Ghana Firm prices\data programs\price index 94-97\steps' on the data file available with this note].

Workbook: fullist.xls

Contains data from the 'original' files. The only changes done are to

- the names of the goods and
- the rankings of the goods

to synchronise them across the waves as far as possible. The number of goods for each wave has increased from the original tables in the questionnaire, so as to permit a different number for goods that don't match. No changes made to the values (price, quantity, etc).

The variables from the original files have been renamed:

Variable name	Explanation
SECTOR	Identified sector for each firm
CODE	Indicates the year (first 2 digits) and the good number (last digit). For example, 941 means 'good 1 in 1994'; 978 means 'good 8 in 1997'; 960 means 'good 10 in 1996'. Thus, a good with a code 942 would be the same good as that with a code 952, 962 and 972 (if they exist). This is a created variable.
GOOD	The name of the good (changed where appropriate). Comes from variables *s3q11a*a (* = 1-5); s3q11b*a (* = 1-5); f3q8ba1-8; f3q8aa1-8.*
UNIT	Unit of quantities sold (changed where appropriate) Comes from variables *s311a*b2 (* = 1-5); s311b*b2 (* = 1-5); f3q8bb1-8; f3q8ab1-8.*
QUAN	Quantity of goods sold Comes from variables *s311a*b1 (* = 1-5); s311b*b1 (* = 1-5); f3q8bd1-8; f3q8ad1-8.*
PRICE	Price per unit good sold. Comes from variables *s3q11a*c (* = 1-5); s3q11b*c (* = 1-5); f3q8bc1-8; f3q8ac1-8.*
COST	Cost of producing each unit of good. Comes from variables *s3q11a*e (* = 1-5); s3q11b*e (* = 1-5); f3q8bf1-8; f3q8af1-8.*
TCOST	Total cost (per period) of producing the quantity of goods sold. Comes from variables *s3q11a*f (* = 1-5); s3q11b*f (* = 1-5); f3q8bg1-8; f3q8ag1-8.*
REVENUE	Total revenue (per period) from sale of goods. Comes from variables *s3q11a*d (* = 1-5); s3q11b*d (* = 1-5); f3q8be1-8; f3q8ae1-8.*
Comment (OK)	Means that recoding and ranking have been done as best as possible.

File: fullist1.xls

This is the same file as fullist.xls, except with the addition of:

a variable: PRICEM (imputed price): This indicates the imputed price for goods with missing observation, based on the average of similar products in the same year. This has been done for as many goods as possible; it was not possible for all goods with missing observations since some of these goods were not sold by other firms (or, at least, no data from other firms existed). The observations of the other firms used in imputing these missing prices are listed in the accompanying ….
Sheet1: FIRM1 .. and so on give the ID of firms from which the average was calculated. The firm in question itself (the one with the missing value) is also included in this list, although, obviously, it was not used in the calculation.

Workbook: fullist2.xls

This file contains many worksheets, one of which is fulllist - taken from fullist1.xls. From main sheets, the data was 'separated' into different worksheets, each containing data for a specific year and good number. The aim of this is to recreate the data set into a form to be used in SAS, with only one observation per firm, with all information about the separate goods going across horizontally.

In order to separate out the data into such sheets, macros were written, so that they could be run again easily, should any changes be made to the original data file.

Blanks in fullist were converted to 'NA' entries. This is to avoid confusion, as the VLOOKUP function (see under compiled.xls) substitutes a blank with a '0' entry.

The separate worksheets were coded according to the data contained, for example, Sheet954 contains data for all good no. 4 in the year 1995 (i.e., all goods with Code 954), and so on.

The naming of these sheets are included in the macro, hence, if the macros need to be re-run again, all existing sheets must be deleted first, as the macro will not create a sheet with a name that is used on another existing sheet.

The variable names in these sheets are now modified, so that they are different for each good in each year. Thus, in Sheet954, all variables (price, unit, etc) have a suffix "954".

The variables CODE, SECTOR, PRICEM, COMMENT have been deleted, and REVENUE is shortened to REV.

There are 8 sheets for 1994, 8 for 1995, 10 for 1996, 10 for 1997.

Sheet 1 of fullist1.xls is maintained in here.

Workbook: compiled.xls

This workbook compiles the data of the separate worksheets in fullist2.xls, into 4 worksheets - one for each year. Thus:

. Sheet1994 contains data for 1994 (from sheet941 to sheet948) in fullist2.xls;
. Sheet1995 contains data for 1994 (from sheet951 to sheet958) in fullist2.xls;
. Sheet1996 contains data for 1994 (from sheet961 to sheet960) in fullist2.xls;
. Sheet1997 contains data for 1994 (from sheet971 to sheet970) in fullist2.xls;

Each sheet contains all firms within the 'corrected' data set, i.e., all firms with an entry somewhere in fullist.xls.

The way the data is compiled, is via the VLOOKUP function. Thus, changes in any sheet in fullist2.xls will automatically be 'recorded' in compiled.xls. This also means that, in order to view compiled.xls, fullist2.xls must also be opened.

Workbook: compile2.xls

This is a copy of compiled.xls, except that the 'paste special - values' command is used. These sheets therefore give absolute values, instead of Excel formulas. This is the step which, if any changes are done in the original files, the 'paste special' command must be carried out (manually) to update compile2.xls. This would be the final files to be transfered back into a SAS readable format.

The different worksheets in COMPILE2.XLS is (I think!!) copied into separate *.POR files (P1994.POR, P1995.OIR, P1996.POR, P1997.POR) which are then used in the price conversions.

The variables and their corresponding sources from the original files (except for the imputed files) are as follows:

ariable name	orresponding source	ariable name	orresponding source
OOD94* OOD95* OOD96* OOD97*	q11a*a (* = 1-5) q11b*a (* = 1-5) q8ba1-8 q8aa1-8	NIT94* NIT95* NIT96* NIT97*	11a*b2 (* = 1-5) 11b*b2 (* = 1-5) q8bb1-8 q8ab1-8
ICE94* ICE95* ICE96* ICE97*	q11a*c (* = 1-5) q11b*c (* = 1-5) q8bc1-8 q8ac1-8	UAN94* UAN95* UAN96* UAN97*	11a*b1 (* = 1-5) 11b*b1 (* = 1-5) q8bd1-8 q8ad1-8
OST94* OST95* OST96* OST97*	q11a*e (* = 1-5) q11b*e (* = 1-5) q8bf1-8 q8af1-8	COST94* COST95* COST96* COST97*	q11a*f (* = 1-5) q11b*f (* = 1-5) q8bg1-8 q8ag1-8
EV94* EV95* EV96* EV97*	q11a*d (* = 1-5) q11b*d (* = 1-5) q8be1-8 q8ae1-8	RM	m ID

A SAS program, price9197.sas is then run. The first part of this program takes the SPSS portable files documented above and creates a sas data file of the price index for 1994 to 1997. In the second part of this program we input the supplementary RPED data to create a price index for 1991 to 1994. The final part of the program then merges the data across all seven waves to create a firm-specific price index for 1991 to 1997. [The SAS program is in 'd:\Ghana Firm prices\data programs\price index 94-97']

As we wished this index to be comprehensive we have imputed missing values to firms on two bases. If there was sectoral information but a firm-specific price was missing we used the sectoral average.

The price index for costs uses the same underlying data as for output prices. The SAS program is cost9197 and it has a similar structure to that already described for price9197.tu [The SAS program is in 'd:\Ghana Firm prices\data programs\price index 94-97']