Constraints on Manufacturing Growth in Kenya[1]

by

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1. Introduction

Kenya experienced relatively high growth rates up until the first oil crisis in 1973. During the sixties and early 1970s there was an investment boom in Kenya. Between 1964 and 1971 gross fixed capital formation grew by 17.2% per year in constant prices, while the growth rate was only 0.1% per year between 1971 and 1993. From 1994, however, there has been some recovery. There was a rapid build-up of manufacturing capital in the 1960s, much in relatively recent machinery and equipment. Eventually excess capacity was built up, and since several of the industries were meant to serve the wider East African market they suffered when the community collapsed. Given the excess capacity there was less need for new investment. The investment boom of the 1960s was largely built on MNCs, but given that the wider East African market was no longer available from the Kenyan base and given that Kenya was not perceived as a location from which MNCs could penetrate the world market, MNC investment slowed down dramatically in the mid-1970s. The global recession in the early 1980s plus the coup attempt in 1982 further reduced incentives to invest. Several MNCs actually withdrew or sold off their investments in Kenya in the late 1980s. During the coup attempt there was looting of Asian property, which further increased their sense of insecurity. Structural adjustment efforts from the early 1980s have gradually changed the economic environment, but so far the response of the manufacturing sector has been rather poor.

Manufacturing growth depends on investment and productivity change. This paper will use micro data to investigate their determinants and interaction. It is worth asking whether the reforms and inducements introduced are sufficient to make Kenya competitive outside of agro-processing, horticulture and tourism. Has an environment that is sufficiently efficient and attractive to investors been put in place? Kenya does need both higher levels of manufacturing investment and productivity improvements to achieve high growth in the sector.

This paper presents some results on these issues from a comprehensive report on the Kenyan RPED study (Bigsten, Kimuyu, 1998). Section 2 briefly describes the data. Section 3 presents an analysis of the determinants of investment in Kenyan manufacturing, while Section 4 reports results on the determinants of productivity and efficiency. The conclusions from the analysis are summarised in Section 5.

2. The Data[3]

The RPED survey of Kenyan manufacturing firms was undertaken at three points in time. The first round of interviews was done in February-March 1993, the second in May-June 1994 and the third in August-September 1995. Much of the data gathered refers to the most recent financial year of the firms, which means that such data refers to the period 1992-1994. When firms were asked about their current situation, their replies refer to the actual time of the interview. The towns covered were the four major towns of Nairobi, Mombasa, Nakuru, and Eldoret. Our survey did not cover the whole of manufacturing, but concentrated on four sub-sectors: food processing, textiles and garments, wood working, and metal working. However, since these four sub-sectors comprise about 73% of formal manufacturing employment, we still provide a reasonably comprehensive picture of the manufacturing sector in Kenya. In terms of employment the food sector is the largest of the four. It provides 32%

[3] This section is based on Aguilar and Bigsten (1998),

of the employment in our four subsectors, compared to 26% for textiles and garments, 25% for metal, and 17% for wood. If we, instead, look at employment by firm size, we see that 20% is in the category 1-5 employees, 17% in 6-20, 7% in 21-75, 19% in 76-500, while as much as 36% is in the 500+ category.

All the four sectors chosen for analysis emerged early in the country's industrialisation process. In 1961 they produced 68.4% of manufacturing value added in Kenya, and the share was still high in 1990, when it was 65.6%. In terms of productivity (value added/employment) the food sector lies considerably above the manufacturing average, while the other three lie well below. Particularly the wood working sector is characterised by a lower productivity, although the gap vis-a-vis the rest has decreased over the last three decades. In 1990 the labour productivity index in food processing was 127 (manufacturing average = 100), while it was 86 in fabricated metal, 57 in textiles and garments, and 45 in the woodworking sector. The gap among the first three sectors was rather stable over the period 1961-1990, while the index of woodworking moved up from 18 in 1961 to 45 in 1990.

The primary sample consisted of a total of 200 firms in manufacturing, 50 each in food processing (ISIC 31), textiles and garments (32), woodworking (33), and metalworking (38). The sample included both the formal and the informal sectors with 75% of the interviews in formal firms and 25% in informal ones. The formal firms were chosen from the Central Bureau of Statistics' master file of registered firms. This is in principle continuously updated, but it did have numerous problems such as the inclusion of firms, which either had never started or which were defunct. Still, it was the best source available. We defined five size-strata for each of the four industrial sectors included in the study. These strata include firms from 1 to 5 employees, from 6 to 20, from 21 to 75, from 76 to 500, and 501 or more employees. Thus, a total of 20 strata were defined for the formal sector. Firms were randomly chosen within each stratum according to their distribution among the four cities covered by the study. The selection process slightly over-represented employment in the larger formal firms. Apart from the stratification by size, the selection was itself random across the four cities included in the study. Out of our primary sample of 150 formal firms 12 firms declined to be interviewed. A few other firms were not found, had closed or switched into other activity. These firms that could not be interviewed were replaced by firms with the same characteristics from our reserve list.

To construct a sample frame for the informal sector we undertook a primary listing of firms engaged in the four sectors in the four cities. The listing for Nakuru and Eldoret was close to complete, while for Nairobi and Mombasa we only covered some sections of the towns. On the basis of this listing, we estimated the distribution of firms across the four subsectors, and found this to be 30% textile, 28 % metalworking, 30 % woodworking and 12 % food processing. If we had tried to represent the employment in the informal sector as well as formal employment, we would have had to choose most of our sample from this sector. However, since the degree of variation in the informal sector is much smaller than in the formal one we decided to include a relatively small number of informal firms. The primary sample of 50 firms was then chosen in the given proportions. With regard to the informal sample we assumed that the best predictor of its distribution among the cities was the population. We therefore selected 65 % of the informal firms in Nairobi, 27% in Mombasa, 8% in Nakuru and 5% in Eldoret. In the case of the informal sector, no stratification according to size was necessary. Thus, this subsample includes only four strata; one for each industrial branch.

We also added the firms from the pilot survey to the first round sample to beef up the sample. A total of 276 firms were interviewed at least once. We interviewed 224 firms in 1994, 216 firms in 1994, and 218 firms in 1995. The sample had a significant rate of attrition, although smaller than expected. Of the 224 firms interviewed in 1993, 29 firms were lost in the second wave and a further 26 were lost in the 1995 wave.

Since we have a stratified sample, particularly between formal and informal firms, we have constructed weights that make it possible to make representative employment oriented as well as firm oriented inferences. The employment weights, which also may be taken as proxies for output weights, are weights, which give each employee in a firm the same probability of being included in the sample. The firm weights are weights giving each firm the same probability to be sampled. We have weights for the whole sample as well as for the formal and informal categories separately. These weights are useful for industry-wide inferences as well as for inferences about the informal and formal sectors respectively.

3. Investment Behaviour[4]

3.1. Introduction

It has long been argued that investments in less developed economies are constrained by financial markets being segmented, resulting in inefficient financial intermediation and misallocation of resources (McKinnon, 1973). This has been supported by the empirical results reported by King and Levine (1993) and Easterly and Levine (1995),, which indicate that African growth has been hampered by poorly developed financial markets. In the case of Kenya, consecutive financial crises in the late 1980s triggered significant reforms of the financial system in 1989, aimed at enhancing prudential controls and ensuring a more efficient, market-oriented, allocation of credit. Although some important steps, such as the liberalisation of interest rates, were taken in the early 1990s, the poor investment record of the economy largely persisted. This section aims to shed light on whether factors of external finance have influenced the investment behaviour of Kenyan manufacturing firms. We confine the analysis to investment in equipment, since investments in land and buildings are rare and different in nature compared to investments in equipment.

One remarkable feature of the data is the predominance of zero investments, even among relatively large firms. We explicitly take this into account in Section 3.2, where we outline the theoretical framework for investment behaviour. This is based on recent theoretical contributions explaining how firms from time to time may find it optimal to refrain from investing if there are non-convexities in the adjustment cost function. We derive an investment equation under the assumption of perfect financial markets, and then discuss how financial imperfections would affect the model. In Section 3.3 we present descriptive statistics concerning firms' investments in general, and the role of external finance in particular. We discuss the empirical formulation of the theoretical investment equation, and present the regression results, in Section 3.4. We provide conclusions from the investment analysis in Section 3.5.

3.2. Theoretical Background

In this section we summarise the theoretical investment model, a neo-classical model under perfect financial markets, which is used to analyse the mechanics discussed in the

[4] This section is based on Söderbom (1998).

introduction. Following standard theory, the model is based on the theory of adjustment costs. Consider a price taking firm with a constant returns production function

$$Y(s) = A(s)F\{K(s), L(s)\},$$

where Y represents output, K denotes capital, L is employment, A represents total factor productivity, and s is time. In the absence of taxes, the firm's profit at time s is given by

$$\Pi(s) = p(s)A(s)F\{K(s), L(s)\} - w(s)L(s) - G\{I(s), p^I(s)\},$$

where p is the output price, w is the wage, I is investment, and G is an amalgam of the purchase price of capital, p^I, and adjustment costs. At any point in time the firm's objective is to maximise the sum of expected discounted profits,

$$\max_{L_s, I_s} E_t \int_t^{\infty} e^{-r} \Pi(s) ds, \tag{3.1}$$

subject to the capital evolution constraint

$$\dot{K}(s) = I(s) - \delta K(s), \tag{3.2}$$

where r is the discount rate (assumed to be constant), t is the current time period, and δ is the geometric depreciation rate of capital. We assume a fairly flexible form for the adjustment cost function, allowing for non-convexities:

$$G(I(t), p^I(t)) = B_1 \frac{b_1}{1+b_1} \left(\frac{I(t)}{S} \right)^{\frac{1+b_1}{b_1}} \left[p^I(t) \right]^{\{1_{\{I(t)>0\}} b_2 + 1_{\{I(t)<0\}} b_3\}} \Delta t + 1_{\{I(t) \neq 0\}} \cdot S \cdot Z \Delta t \tag{3.3}$$

where B_1 and b_1 are strictly positive parameters, $1_{\{A\}}$ is an indicator function equal to one if the event A is true and zero otherwise, b_2 and b_3 are parameters allowing for a price wedge between the purchase price and the selling price of capital goods, Δt is a (short) interval of time, S represents the size of the firm (which is treated as constant, for simplicity), and Z is a 'flow' fixed adjustment cost. The presence of fixed costs generates infrequent investments, since the firm benefits from concentrating its investment activities to a few short periods rather than incurring the fixed costs in every period. This incentive to make very rapid and concentrated capital adjustments is balanced by the first part of (3.3), which, due to convexity, implies that large investments would be extremely costly.

The firm will invest if and only if there exists at least one investment level for which

$$I_t \cdot E_t \int_t^{\infty} \exp\{-(r+\delta)\} \Pi'_K(s) ds - G(I_t, p_t^I) > 0 \tag{3.4}$$

holds. Given that it is optimal to invest, the optimal level will satisfy the first-order condition

(3.5) $$B_1\left(\frac{I(t)}{S}\right)^{(1/b_1)}\left[p^I(t)\right]^{b_2} = E_t\int_t^{\infty}\exp\{-(r+\delta)\}\Pi'_K(s)ds$$

for $I(t)>0$.[5] In this analysis we focus on (3.5), determining the optimal level. We assume a Cobb-Douglas production function and utilise first order conditions for labour demand, and that expected future variables appearing in (3.5) can be written as $E_t X(t+s) = X(t)e^{E_t(g_{Xt})s}$, where $E_t(g_{Xt})$ is the expected growth rate of $X=\{p, A, w\}$. Equation (3.5) can then be written in log linear form as

(3.6) $$\ln I(t) = \alpha_0 - \alpha_1 \ln p^I(t) + \alpha_2 \ln p(t) + \alpha_3 \ln A(t) - \alpha_4 \ln w(t) + \alpha_5 E_t g_t^p + \alpha_6 E_t g_t^A - \alpha_7 E_t g_t^w - \alpha_8 r_t,$$

where $\alpha_0 - \alpha_8$ are (positive) composites of the structural parameters.[6]

One potentially strong assumption under which (3.6) has been derived is that economically viable investment projects can always be funded, and that the cost of funds is independent of the source of financing. This makes investments independent of liquidity. However, whenever there exist financial market imperfections, caused by, say, informational asymmetries between the firm's managers and potential lenders, the use of internal funds will be less costly than external financing, and changes in the debt-equity relation may therefore affect investments. Since the firm's cash flow is a natural proxy for changes in internal funds, one common strategy to test the null of no financial imperfections is to examine whether investment responds to cash-flow movements, conditional on the fundamental variables appearing on the right-hand side of (3.6). Hence, if this is the case, policy measures mitigating the imperfections will be effective in increasing investments.

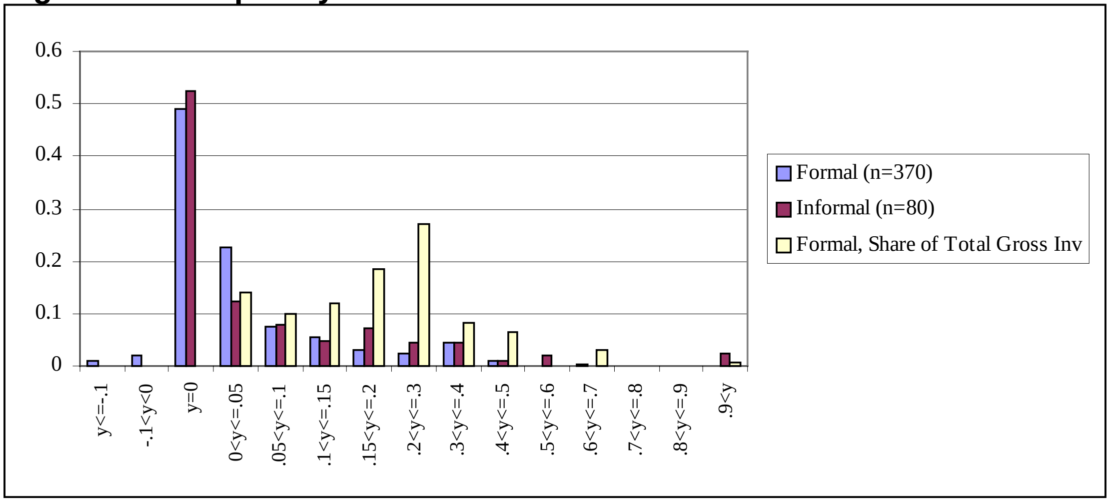
3.3 Descriptive Analysis of Investments and Financial Issues

We begin the empirical analysis by examining descriptive statistics on firms' investments, with a particular focus on financing. We have discarded the smallest firms in the data-set, because the economic theory above is unlikely to provide a good approximation for the decision rules of too small firms. We have also deleted observations which, due to missing data, cannot be used in the regression analysis below. This has left a sample of 450 observations on 216 firms.

We start by exploring the distribution of investment rates (i.e. the investment to capital ratio). Empirical studies of investments typically report this distribution to be highly skewed to the right. As can be seen in Figure 3.1, there is a large frequency of zero investments, and it is extremely unusual for these firms to sell off equipment, as indicated by the low frequency of negative investment rates. Moreover, not only do half of the firms refrain from investing during a year, but the vast majority of the firms make no or modest investments (approximately 75 percent of the firms have investment rates less than 0.1). Finally, note that a large share of total investment expenditure is accounted for by a very small fraction of the firms, as indicated by the "share of aggregate" bar.

[5] Optimum is guaranteed by the strict convexity of the adjustment cost function for all non-zero investments.
[6] Note that the log of the expectation is approximated by the expectation of the log. See Denny and Nickell (1992).

Figure 3.1. Frequency Distribution of Net Investment Rates and Share of Total



Note: *y* represents the net investment to capital ratio. Sampling weights were used.

Next, we turn to aspects of investment funding. First, we examine the sources of investment financing, reported in Table 3.1. We find that company retained earnings is the primary source of finance. For informal firms and formal firms with less than 75 employees, the reliance of internal funds is 86 and 82 percent, respectively. The corresponding number for large formal firms is 66 percent. By international standards, these averages are atypically high, which is to be expected in an economy with a shallow financial market. There is some evidence that large firms use internal funds to a less degree than do informal and small formal (L<=75) firms. The null that the averages for these three categories are equal can be rejected at the ten percent level, but not at the five percent level. To shed some light on whether firms are rationed or not, we examine the data on application for formal loans. We find that, during one year, most firms do not apply for loans at all. Only 18 percent of all formal firms apply, and 27 percent of the informal firms. Proceeding by examining the main reason for not applying, we find that a large share (70 percent) of the non-applying formal firms state that loans are not needed. We take the responses (4)-(7) to indicate that the firm is close to, or at, its desired financial structure, which is the case for 87 percent of the non-applying formal firms. These results cast doubts on the idea that poor access is a binding problem.

Table 3.1 Funding and Loan Applications

	Informal Firms	Formal Firms		
		L<=75	L>75	All
Funding of Investments				
Internally generated funds	0.860	0.824	0.664	0.754
Bank loan	0.058	0.088	0.148	0.114
Other	0.082	0.088	0.188	0.132
Number of observations	34	94	77	171
Number of missing values	(7)	(9)	(4)	(13)
Loan Applications				
Share of Firms Applying for Loan in One Year	0.268	0.153	0.251	0.182
Number of observations	76	237	125	362
Number of missing values	(4)	(7)	(1)	(8)
Main Reason for Not Applying				
1. Process too difficult	0.149	0.026	0.000	0.019
2. Excessive collateral	0.253	0.019	0.020	0.019
3. Expected disapproval of application	0.120	0.016	0.000	0.012
4. Loan not necessary	0.149	0.709	0.668	0.698
5. Excessive interest rate	0.072	0.083	0.085	0.083
6. Reluctance to incur debt	0.123	0.030	0.105	0.050
7. Already heavily indebted	0.069	0.040	0.026	0.036
8. Other	0.065	0.077	0.096	0.082
Number of observations	54	192	87	279
Number of missing values*	(2)	(4)	(5)	(9)

Note: Sampling weights were used.
* Referring to the subset of the sample not applying for a loan.

3.4 Empirical Formulation and Econometric Results

The remainder of this section will be devoted to econometric analysis of investment behaviour, based on the theoretical discussion in Section 3.2. In order to obtain an empirical specification based on the theoretical investment equation (3.6) and the discussion of financial market imperfections, we need to address some points of model specification. These can be summarised as follows.

i) It is apparent from (3.6) that expectations are instrumental in determining investments. Since our panel is short and unbalanced, any dynamic formulation is bound to reduce the already small sample considerably. We therefore concentrate on the case where expectations are assumed to be static, i.e. where we have postulated that the firm expects the current state to last forever. We proceed in the second part of the econometric analysis by utilising explicit data on expectations, which however only are available for a subsample.

ii) It is essential for estimation to obtain an accurate proxy for the productivity variable A. Assuming that this variable is fixed over time, which is not unreasonable in view of the short time span covered here, we estimate a production function regressing the log of output on employment and capital (both logged) and a set of firm dummies. We then use the fixed effects as measures of productivity.

iii) In view of the measurement problems of the capital stock we use the profit to output ratio, (C/Y), as a liquidity measure rather than the more commonly used profit to capital ratio. The former a traditional key statistic of the profitability of the firm.

iv) As is common in many firm level data sets we do not have information on firms' output prices, discount rates, or capital goods prices. We assume that these are constant within certain sub-samples, defined by size, sector, and whether the firm is formal or informal, and employ a corresponding set of control variables in the estimation.[7] Unobserved heterogeneity is, to some extent, controlled for by the fixed effects obtained from the production function, as discussed above.

v) It follows from the theoretical discussion in Section 3.2 that the firm from time to time will find it optimal to refrain from investment activity altogether. We have seen in Section 7.3 that investment inactivity is common in the present sample, and in order to avoid selection bias we employ econometric techniques that allow the level of investment to be correlated with the decision to invest. The general formulation of the selection model we employ can be written

(3.7a) $\Pr(I > 0) = \Pr(X_1\theta + u_1 > 0)$ (indicating the decision to invest)

(3.7b) $\ln I = X_2\beta + u_2$, iff I>0 (indicating the investment expenditure).

Here, θ and β are parameter vectors, X_1 and X_2 are explanatory variables, and u_1 and u_2 are error terms, allowed to follow some bivariate distribution. If this distribution is assumed to be normal, the famous Heckman (1976, 1979) model results. Although the model is identified by these distributional assumptions even if $X_1 = X_2$, in practice it is necessary to impose exclusion restrictions, so that X_1 contains some variable(s) not appearing in X_2.[8] In our case, this means that we need to find variables that affect the decision to invest (equation 3.4), but not the investment expenditure (3.5). This will be fulfilled by any variable(s) affecting the total adjustment cost, *G*, and not the marginal cost $G_I'(\cdot)|_{I>0}$. The apparent candidate, the fixed cost *Z* (see equations 3.4 and 3.5), is not observed, so we need to find proxies for it. We expect search and managerial decision costs to constitute a considerable share of the fixed costs, and we therefore focus on factors linked to infrastructure, network participation, and organisational structure of the firms as potential proxies. After some elaboration, we have chosen to use dummy variables for location (infrastructure), ethnicity of the manager (Asian managers are known to be more inclined to participate in network activities), ownership structure, and legal status of the firm (organisational characteristics).

vi) Potential endogeneity problems arise for productivity (*A*), wages (*w*), and the profit rate (*C*/*Y*), if these are treated as exogenous variables. However, we believe that these problems are minor, and, in any case, smaller than those associated with using instrumental variable techniques. Therefore we treat these variables as exogenous.[9]

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[7] Panel data procedures (e.g. within or first differences) would yield considerable efficiency losses given the short (and unbalanced) panel and given the fact that only half of the observations on investments are positive. Also, measurement error bias would be enhanced. The panel nature of the data is recognized by correcting the standard errors for the lack of independence between observations that may arise because many firms are observed several times.

[8] See Leung and Yu (1996).

[9] Although it is reasonable to anticipate new equipment to be more productive than old capital, investments will still not affect A since differences in productivity characteristics will be reflected in differences in the value of the capital goods. Therefore, the investment will be subsumed in the capital stock value that enters the production function, from which the individual A:s are computed. Wages and profits may be endogenous to investments because of increased profitability potential of the firm. However, such effects are in all likelihood small, mainly because a considerable change in annual investment yields only a small change in overall capacity, but also because it will take some time before the new capital goods become fully operative.

Econometric Results

a) Static Expectations

If firms hold static expectations they expect the current state to last forever, implying that the growth terms in (3.6) become irrelevant for the investment equation (since they are zero for all firms). In view of this, and the other issues discussed under (i)-(vii) above, we rewrite equation (3.6) as

$$(3.8) \qquad \ln I_{it} = \alpha_0 + \alpha_1 \ln A_i - \alpha_2 \ln w_{it} + \alpha_3 (C/Y)_{it} + controls + \varepsilon_{it},$$

which is the equation we will estimate in this section. Besides the variables of interest and the strata intercepts, we have found that three interaction terms were necessary to include to control for slope differences between strata with regard to the role of productivity.[10,11] In Table 3.2 we show parameter estimates of the static investment equation (3.8).[12] We use four different econometric techniques: OLS and median regression, which neglect selectivity, and limited information maximum likelihood (known as Heckman's two-step method) and full information maximum likelihood, which allow for selectivity. We will comment on the results of these in turn.

The first column shows OLS estimates on the sub-sample of positive investments.[13] The productivity proxy seems to work well in all cases except for small and micro firms in the food sector, for which the coefficient is insignificantly different from zero. For small and micro firms in the wood, textile and metal sectors, the estimated productivity coefficient is equal to 0.37, and significant at the ten percent level. For medium sized firms in the wood, textile and metal sectors the parameter estimate is 0.94, and for large firms in any of these sectors the estimate is 1.04. Both estimates are significant at the one percent level. For medium and large firms in the food sector, finally, the estimated coefficients are equal to 0.57, and 0.67, respectively, and both estimates are significant at the one percent level. These estimates are interpretable as the elasticity of investment with respect to productivity, which, hence, in some cases is rather pronounced.

Proceeding with the wage coefficient, we see that it does not have the anticipated sign, and it is far from significant. The estimated coefficient of the profit rate, however, is equal to 0.87, and significant at the five percent level. This estimate is the semi-elasticity of investment with respect to the profit rate, $(\partial I/\partial \pi)(1/I)$, and its magnitude means that a one percentage point

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[10] Since we primarily are interested in the structural role of explanatory variables, we do not use sampling weights in the regressions. Instead, we estimate a "general" model, allowing different intercepts and slope coefficients of the variables of interest, for four size groups , the four sectors, and for formal and informal firms. We then attempt to reduce the model by constraining insignificant strata differences to zero. The reduction of the general model is shown in the longer version of the paper (Söderbom, 1998).

[11] Sample means for investing firms are as follows: ln(investment)=12.69, ln(A)=13.69, ln(wage)=0.85, Profit rate=0.24, Food=0.20, Wood=0.29, Textile=0.21, Formal=0.82, Small=0.24, Medium=0.29, Large=0.36, Food*ln(A)=2.87, Medium*ln(A)=4.04, Large*ln(A)=5.43, Expected Sales Change=18.76. N=225 for all variables except Expected Sales Change for which N=67.

[12] Omitted dummy variables are micro (L<=5) and metal.

[13] We wish to highlight two model diagnostics. First, we note that the R2 is quite high for a cross-section sample. We believe that this may partly be due to the collinearity reflected in the high condition number of the moment matrix (see above), but mostly because investment levels are strongly correlated with firm size; regressing log of investment on the size dummies only produces an R2 of 0.63 alone. Second, the acceptance of the Ramsey (1969) RESET test (F-test (2)) implies that no unknown variables have been omitted from the regression specification. This is encouraging, not least because selection bias effectively is the same as omitted variable bias, and any important selection effect would therefore have led to the rejection of the null in this test.

increase in the profit rate will be associated with a 0.87 percent higher investment level. This implies a rather low correlation between liquidity and investments: a firm having a fairly high profit rate of 0.20 is expected to invest only 8.7 percent more than a firm with a modest profit rate of 0.10, everything else equal.

The dependent variable has fairly fat tails, suggesting that the OLS results may be sensitive to outliers. Because median regressions are less sensitive to outliers than OLS, we report such results in the second column of Table 3.2.[14] Compared to the OLS results, we see that the estimated productivity coefficient for small and micro firms in the wood, textile and metal sectors is slightly higher (0.47), and significant at the five percent level, whereas the coefficients of the productivity interactions are very similar. The estimate of the wage coefficient is practically zero. The profit coefficient is similar to the OLS estimate, and its standard error is somewhat larger, indicating significance at the ten percent level.

Neither of the estimators considered so far control for selectivity effects, and may therefore be inconsistent. The third column of Table 3.2 shows the results of the selection model using Heckman's two-stage approach (limited information maximum likelihood; LIML). For brevity, we do not report the parameter estimates of the Probit, but we do note that the null of normality of the Probit residuals cannot be rejected, as indicated by χ^2-test (3.2). The estimates of the structural equation are very similar to those obtained by OLS. Most importantly, the coefficient on the selectivity term is insignificant, suggesting that selection bias is not a problem for the OLS estimates. Further analysis indicates that $\hat{\lambda}$ is not acutely correlated with the other regressors, which would have invalidated the selectivity test. In the final column of Table 3.2, we present full information maximum likelihood (FIML) estimates of the selection model. We do this primarily because there is some evidence in the literature that FIML is less unstable than LIML when collinearity is high (Nelson, 1984). As can be seen, however, the FIML estimates are close to the OLS estimates, and the selectivity term is again insignificant.

Based on the LIML and the FIML results, we conclude that the OLS and the median regression estimates do not suffer from selectivity bias. We finally turn to the question of whether the assumption of static expectations has implications for the results. Since the data on expected percentage change in sales were only obtained in the last survey round, and since there are a number of missing values, the sample size is small and the precision of the estimates is likely to be low. OLS results of the expectations augmented investment equation are reported in Table 3.3. Because we would like to see how the estimate of the profit coefficient is affected by the presence of the expectation variable, we also report results of the static equation based on the smaller sub-sample. Interaction terms were not significant, and were therefore not included in the regressions. Control variables were included, but for brevity we do not report the associated parameter estimates.

[14] The standard errors have been bootstrapped.

Table 3.2 Estimation Results of Static Investment Equation Dependent Variable Ln[*I*(*t*)]

Variable	1. Ordinary Least Squares	2. Median Regression	3. Heckman Two-Step Model	4. Maximum Likelihood
Structural Variables				
Productivity	0.372*	0.470**	0.384**	0.387**
	(0.195)	(0.227)	(0.156)	(0.157)
Wage	0.039	0.008	0.024	0.022
	(0.113)	(0.168)	(0.115)	(0.116)
Profit Rate	0.867**	0.832*	0.911**	0.918**
	(0.369)	(0.472)	(0.363)	(0.366)
Control Variables				
Food	6.087**	6.487**	6.455#	6.516#
	(2.511)	(2.635)	(2.065)	(2.106)
Wood	0.059	0.165	0.041	0.038
	(0.267)	(0.334)	(0.240)	(0.242)
Textile	0.131	0.245	0.109	0.105
	(0.278)	(0.325)	(0.256)	(0.258)
Formal	0.156	0.161	0.055	0.041
	(0.444)	(0.503)	(0.357)	(0.370)
Small ($5<L<=20$)	0.557	0.529	0.632*	0.645*
	(0.391)	(0.440)	(0.352)	(0.362)
Medium ($20<L<=75$)	-5.699*	-6.916**	-5.570**	-5.543**
	(3.313)	(3.294)	(2.808)	(2.823)
Large ($L>75$)	-6.236*	-5.298	-6.477**	-6.562**
	(3.309)	(3.949)	(3.014)	(3.054)
Intercept	4.858**	3.518	4.440**	4.367**
	(2.242)	(2.551)	(1.842)	(1.901)
Interaction Terms				
Food*Productivity	-0.368**	-0.380**	-0.397#	-0.402#
	(0.170)	(0.173)	(0.145)	(0.148)
Medium*Productivity	0.570**	0.588**	0.568#	0.567#
	(0.248)	(0.284)	(0.211)	(0.211)
Large*Productivity	0.670#	0.638**	0.699#	0.707#
	(0.239)	(0.250)	(0.215)	(0.220)
Selectivity Term				
λ			0.342	0.396
			(0.406)	(0.533)
R^2	0.763		Adj. R^2=0.748	
Pseudo R^2		0.561		
Log Likelihood				-644.6
F-test (1)	$F(13, 131)=55.3$ Prob >F=0.00		$F(14, 210)=48.4$ Prob >F=0.00	
F-test (2)	$F(3, 208)=0.44$ Prob >F=0.73			
χ^2-test (1)				$\chi^2(39)=80.2$ Prob $>\chi^2=0.00$
χ^2-test (2)			$\chi^2(2)=2.52$ Prob $>\chi^2=0.28$	
χ^2-test (3)			$\chi^2(2)=0.38$ Prob $>\chi^2=0.83$	
[N, T, NT]	[132, 3, 225]	[132, 3, 225]	[132, 3, 225]	[216, 3, 450]

Note: Standard errors in parenthesis. *, **, and # indicate significance at 10%, 5%, and 1% level of confidence, respectively. OLS standard errors are cluster-corrected, where each firm is treated as a cluster, and robust to heteroscedasticity. Number of employees are denoted by *L*.
F-test (1) is the test of H_0: all coefficients = 0;
F-test (2) is the Ramsey (1969) test for omitted variables (H_0: no omitted variables);
χ^2-test (1) is the log likelihood ratio test of H_0: all coefficients = 0;
χ^2-test (2) is the Tauchen (1985) conditional moments test of the null that Probit residuals are normal;
χ^2-test (3) is the Pagan-Vella (1989) test of the null that the 2-step model residuals are bivariate normal.

Comparing columns 1 and 2 in Table 3.3, we see that the inclusion of the expectation variable has only very minor effects on the parameter estimates. The point estimate of the profit coefficient in the static equation is 1.20, hence higher than for the full sample, but the difference is not significant. In the expectations augmented equation the profit coefficient estimate is equal to 1.27, which is not significantly different than the estimate of the static equation. The coefficients of the productivity and the wage variables are virtually unchanged. Thus, there are no signs, from this small experiment, that assuming static expectations leads to biased estimates.

Table 3.3 OLS Estimates of Expectations Augmented Investment Equation

Dependent Variable Ln[*I*(*t*)]

Variable	Static Equation	Dynamic Equation
Productivity	0.666#	0.685#
	(0.198)	(0.203)
Wage(*t*)	-0.117	-0.102
	(0.215)	(0.214)
Profit Rate(*t*)	1.200**	1.269**
	(0.570)	(0.562)
E(t)[ΔSales(*t*+1)]		0.008
		(0.008)
Adjusted R^2	0.791	0.797
F-test (1)	F(10, 56)=34.0 Prob >F=0.00	F(11, 55)=31.2 Prob >F=0.00
F-test (2)	F(3, 53)=0.45 Prob >F=0.72	F(3, 52)=0.36 Prob >F=0.78
[N, T, NT]	[67, 1, 67]	[67, 1, 67]

Note: Control variables for size, sector, and for whether the firms is formal or informal, were included in the regression. Standard errors in parenthesis. Significance at 10%, 5%, and 1% level of confidence is indicated by *, **, and #, respectively. Standard errors are robust to heteroscedasticity.

F-test (1) is the test of H_0: all coefficients = 0;

F-test (2) is the Ramsey (1969) test for omitted variables (H_0: no omitted variables).

3.5. Conclusions about Investment Determination

This section has analysed the investment behaviour of Kenyan manufacturing firms. We show that investments have been low during the survey period, and that firms to a small extent rely on external finance when they invest. The fact that most firms do not want loans suggests that it is other factors than restricted access to credit that explain this modest degree, for instance the cost of external capital, or the increased bankruptcy risk that follows with formal borrowing. We have estimated a neo-classical investment equation augmented with a cash-flow term. We have found a statistically significant role for cash-flow, although its point estimate implied that investments are not overly sensitive to changes in liquidity: OLS results indicate that a one percentage increase in the profit to output rate is associated with 0.87 percent higher investments. We have found a considerably more important role for productivity, with the estimated elasticity being as high as unity for a subset of firms. Since the productivity variable is composition of factors, other than capital and labour, that affect the output value, this means that firms, which manage to exploit profitable opportunities, undertake more investments.

The policy implication of these findings is that increased credit access will have a limited effect on investments, unless this is accompanied with a general improvement of the profitability opportunities of the firms. A stagnating manufacturing sector will not start to grow unless there exist profitable projects. Profitable projects as such cannot, indeed should not, be accomplished or identified by policy makers. What is needed is a policy that enables the firms to exploit profitable opportunities.

4. Productivity and Technical Efficiency[15]

4.1. Introduction

In the previous section we showed that productivity is a major determinant of investment and thus manufacturing growth. In this section we therefore go on to investigate what the determinants of productivity (and efficiency) are, and how the determinants vary across sectors and among different categories of firms. We will attempt to unveil some of the underlying factors behind the variation in performance. This will give us further clues as to what the growth constraints in Kenyan manufacturing are.

Since our analysis is confined to Kenyan firms alone, we cannot say anything conclusive about the impact of general factors such as corruption, infrastructure, institutional inefficiency and low demand simply because these are more likely to affect the overall *level* of performance, and not its variation among firms. Our focus is therefore on firm-specific variables, including location, age, growth, human capital, export behaviour, credit access and ownership. The analysis is divided into three parts: The variation in partial factor productivities for different firm sizes (Section 4.2), the estimation of technical efficiency using fixed effects and stochastic frontier production function models (Section 4.3) and the estimation of determinants for productivity using average production functions (Section 4.4). Section 4.5 concludes the section.

4.2. Partial Factor Productivities

Partial factor productivities and capital-labour ratios for the sample firms are presented in table 2 below. They describe the contribution of a single input to output, which, in turn, may identify potential gains to be made from reallocating inputs to activities, or firm types, in which they are more productive. Such ratios can also reveal differences in factor intensities, which *could* be evidence of imperfections in factor markets, such as price discrimination. However, these measures say nothing conclusive about total factor productivity, nor do they inform us about a firm's technical efficiency.

Two measures of labour productivity are reported: the first is the simple output to the number of workers ratio (*Y/L*) and the second is the ratio of output to total wage cost (*Y/wL*). Both these measures display an inverted ∪-shaped relationship with firm size, peaking in the 76-500- and 21-75-worker intervals respectively. The increase in *Y/L* is more accentuated than the one in *Y/wL*, which most likely is an effect of the higher wages paid by larger firms. Also capital productivity (*Y/K*) and the capital-labour ratio reveal inverted ∪-shaped correlations. Informal firms employ much less capital per employee than do formal firms, and as a consequence capital productivity is higher, and labour productivity lower, for this category. Disaggregating the data into sub-sectors does not substantively alter these observations.

[15] This Section is based on Lundvall, Ochoro, and Hjalmarsson (1998)

Table 4.1 Median relative factor productivities by size categories for the pooled sample.

Firm category	*Y/L*	*Y/wL*	*Y/K*	*K/L*
Informal	**72**	**5.05**	**4.30**	**15**
Formal, 1 – 5 workers	**106**	**5.45**	**0.46**	**171**
Formal, 6 – 20 workers	**195**	**7.78**	**1.38**	**181**
Formal, 21 – 75 workers	**287**	**9.60**	**1.50**	**190**
Formal, 76 – 500 workers	**405**	**9.31**	**1.42**	**333**
Formal, 500 + workers	**187**	**8.63**	**0.82**	**260**

NOTE: All values are expressed in thousands of Kenyan Shillings except *L*.

These findings are broadly consistent with other studies of developing countries, perhaps with the additional observation that the relationships in the Kenyan data are somewhat more stable.

4.3. Technical Efficiency

Technical efficiency is sometimes confused with productivity, which is wrong, although the two terms are closely related. Productivity is basically the ratio of output to input, whereas technical efficiency refers to the ratio of actual output to the maximum output feasible given inputs. The set of maximum output levels corresponding to all positive input combinations forms the production frontier, the outer edge of the production possibility set, which in our case is defined by a frontier production function. It follows that any pair-wise comparison of efficiencies among firms strictly depends on the shape of the estimated frontier. For example, there is nothing contradictory with a firm being both more productive and less efficient than another firm, which can happen if the firms differ in size and the technology exhibits non-constant returns to scale.

Hence, the scale property of the frontier production function is of great importance, especially if one wishes to make any statement about the size-efficiency relationship. As the estimates for returns to scale vary across different methodologies, it can sometimes be meaningful to impose the restriction of constant returns, a possibility considered below. Another important issue is on what level of aggregation firms are expected to share the same frontier production function. The approach taken in this section is to assume a single frontier for all sub-sectors, which carries the advantage of making inter-sectoral comparisons possible. Whether these differences really refer to technical efficiency can be questioned, however. In any case, they can certainly be interpreted as differences in productivity, which is the view taken below.

We use two models: a fixed-effects (FE) model and a random effects (RE) model, in order to check the invariance of our results to the particular method selected. Both models provide estimates of the production model,

(4.1) $$y_{it} = \alpha + \mathbf{x}_{it}\beta + v_{it} - u_i ,$$

where y_{it} is output; α is an intercept term; $\mathbf{x}_{it}$ is a vector of inputs; β is a vector of coefficients; v_{it} is a disturbance term assumed iid $N(0, \sigma^2_v)$; and $u_i \geq 0$ is a technical *in*efficiency term assumed fixed in the FE- and random in the RE-model. The indices i=1,…, N and t=1,…, T refer to the firms and periods for which the observations were made, respectively. Motivated by the noisiness of the data and the short time span of the panel, we restrict technical efficiency to be time invariant.

In the FE-model, we retrieve the u_i's by first expressing (4.1) as deviations from individual means,

$$(4.2) \qquad (y_{it} - \bar{y}_i) = (\mathbf{x}_{it} - \bar{\mathbf{x}}_i)\beta + (v_{it} - \bar{v}_i),$$

where the upper bar denotes individual means over time, and perform least squares on the resulting expression. The transformation removes the time invariant terms α and u_i. Secondly, we recover these parameters using,

$$(4.3) \qquad \hat{\alpha} - \hat{u}_i = \hat{\alpha}_i = \bar{y}_i - \bar{\mathbf{x}}_i \hat{\beta},$$

which is true because we assume the errors to average out to zero over time. In essence, this is the least squares dummy variable estimator. For a fully efficient firm, u_i=0, and therefore, $\hat{\alpha}_i = \hat{\alpha}$. Hence, we may finally compute the FE-estimates of the u_i's for the remaining firms using,

$$(4.4) \qquad \hat{u}_i = \max(\hat{\alpha}_i) - \hat{\alpha}_i.$$

This estimator is consistent in *T*, provided that also $\hat{\beta}$ is consistent, which holds as *N* goes to infinity (Greene 1993). Throughout these estimations, we will use the natural logarithms of output and inputs. The appropriate measure of technical efficiency (*TE*) of firm *i*, in accordance with the original Farrell (1957) concept, is therefore,

$$(4.5) \qquad TE_i = \exp(-\hat{u}_i),$$

which is 1.00 for fully efficient firms and in the (0, 1)-interval for firms with some degree of technical inefficiency of production.

In the RE-model, we treat the u_i's in equation (1) as random, and we assume they are independent from the v_{it}'s and iid $|N(0,\sigma^2_u)|$. Firm-specific technical efficiencies are predicted by deriving expressions for the conditional expectation of the right-hand side in equation (4.5) conditional upon the observed value of (v_{it} - u_i) in the manner set forth by Battese and Coelli (1993).

The issue of whether u_i should be treated as fixed or random is by no means trivial. Both approaches have strengths and weaknesses. The FE-model permits the firm-specific effects to be correlated with the explanatory variables: the parameter estimates are still unbiased and consistent. Moreover, the errors need not be normal and if heteroscedasticity is present, the estimates remain consistent albeit inefficient. On the other hand the approach is sensitive to statistical noise. The RE-model explicitly accommodates the noise component, but produces biased and inconsistent estimates if the errors are not independent from inputs. Furthermore, the predicted efficiencies of the RE-model have been shown to be very sensitive to heteroscedasticity in any of the two error terms (Caudill and Ford 1993).

Another additional difficulty concerns the potential endogeneity of inputs. Because no valid instruments are available, however, the production functions are estimated directly, despite the fact that they may be subject to some unknown degree of simultaneity bias.

The production functions are restricted to the Cobb-Douglas form, motivated by its small number of parameters and the poor performance of the more flexible translog specification regarding compliance with the regularity conditions. We use of capital, number of workers and time as inputs. Intermediate inputs are not included because of the poor quality of that variable. Alternative specifications do not change the main conclusions drawn.

Two FE-models were estimated, one without restrictions and one with constant returns to scale imposed. Mean technical efficiencies are reported in Table 4.2 below.

Table 4.2 Mean predicted technical efficiencies by firm categories for three different models. The number of observations in each cell for the fixed-effect models (Obs(FE)) and the random effects model (Obs (RE)) are reported for each cell. The models are FE – unrestricted Fixed Effects model, FE-CRS – Fixed Effects with CRS imposed, RE – Random Effects model.

Firm category:	Obs (FE)	FE	FE-CRS	Obs (RE)	RE
Informal	**56**	**0.04**	**0.20**	**70**	**0.41**
Formal	**155**	**0.34**	**0.43**	**196**	**0.45**
Formal, 1-5 workers	**19**	**0.09**	**0.24**	**22**	**0.35**
Formal, 6-20 workers	**35**	**0.20**	**0.39**	**44**	**0.45**
Formal, 21-75 workers	**59**	**0.34**	**0.45**	**73**	**0.47**
Formal, 75-149 workers	**23**	**0.50**	**0.52**	**29**	**0.49**
Formal, 150+ workers	**19**	**0.68**	**0.51**	**28**	**0.42**
Food, formal	**41**	**0.49**	**0.60**	**56**	**0.54**
Wood, formal	**39**	**0.23**	**0.31**	**44**	**0.38**
Textiles, formal	**34**	**0.21**	**0.32**	**49**	**0.40**
Metals, formal	**41**	**0.41**	**0.47**	**47**	**0.47**
All	**211**	**0.26**	**0.37**	**266**	**0.44**

NOTE: For the FE-models TE is calculated by replacing max($\hat{\alpha}_i$) with the 90th percentile, in the process defining the upper decentile (in terms of $\hat{\alpha}_i$) of firms as technically efficient. This is motivated by a desire to make the frontier 'less deterministic'. All conclusions remain qualitatively intact irrespective of whether the 80th, 95th or 99th percentile is employed, the only change is the overall *level* of TE.

The cell means across firm categories reveal several interesting relationships. All models predict strongly positive size-efficiency relationships up to and including the 75-149-worker segment. For the largest size category, efficiency declines in the FE-CRS and RE-models, proposing a similar inverted ∪–shaped relationship as discovered in the previous section. This pattern does not occur in the FE-model, which we regard as a less likely result, probably driven by the unrealistically low estimated returns to scale.

Informal firms are less efficient than formal ones in all models, although the magnitude of this difference varies considerably across models. The higher the estimated returns to scale, the less is this difference.

Food is the most productive sector, followed by metals. Productivity in food is 40-120% higher, and in metals 20-85% higher, than in wood and textiles, depending on model. These relationships also hold when size categories are compared for individual sectors.

4.4. Determinants of Productivity

We try here to unveil some of the underlying causes for the differences in technical efficiency identified above. Average production functions are used for this purpose. Our analysis therefore focuses on productivity, not technical efficiency, although the arguments presented below relate to both concepts. We prefer this approach to an analysis of the determinants for technical efficiency because it is simpler, does not rely upon the assumption that efficiency is independent of inputs, and that parameter coefficients of all variables are directly interpretable in a straightforward manner. Also, if the background variables of interest for the performance of manufacturers are available a priori, as is the case here, ordinary least squares regression will 'do just fine', as Knox Lovell (1993, p.7) puts it.

For natural reasons, the discussion below focuses on firm-specific factors rather than factors that are common to all firms. Of course, factors such as corruption, regulations, taxes, infrastructure, overall education levels and cultural attitudes by the workforce, aggregate demand, political instability and institutional efficiency all affect performance of firms to some extent. But the point is that they affect all firms more or less equally, and they do not predict the variation between firms in any foreseeable way. The firm-specific factors we consider are: location, age, growth, investment rate, capacity utilisation, skilled labour ratio, race of owners, whether or not the firm exports, degree of foreign ownership, and access to credit.

Naturally, the direction of causality of these determinants is not always obvious. In fact, for some it may go both ways. For example, are firms more productive because they export, have access to credit and have foreign owners, or is it the other way around, so that they possess all these characteristics because they are productive? Or, are both statements true? Clearly, one can certainly argue for either case. The estimated relationships should therefore be regarded as associations rather than causal links.

The results are presented in table 4.3 below. Both pooled and sector models are considered, and weights are used in the estimations to correct for heteroscedasticity. Constant returns to scale cannot be rejected in any model except in textiles according to the Wald tests reported at the bottom end of the table, which is consistent with our previous analysis. The time variable is insignificantly different from zero in all models, which means that no technical change is picked up in the regressions, except textiles.

The sector dummy variables in the pooled model confirm our earlier findings that food, followed by metal, is the most productive sector. The coefficients suggest that food is approximately 70% more productive than wood and textiles, and 40% more productive than metals, which is roughly consistent with our earlier inter-sectoral comparisons.

The Nairobi and Mombasa dummy variables are mainly positive (except in textiles) suggesting that location in the capital or in the main trading port may influence productivity positively.

The firm age variable is insignificant everywhere except textiles. Hence, we find no support for learning-by-doing effects in Kenyan manufacturing, nor do we find support for the hypothesised positive age-productivity relationship in the firm growth literature. Nevertheless, we cannot rule out the possibility that such effects exist, but are completely offset by an depreciating influence of rising firm age on equipment.

Table 4.3 Parameter estimates of productivity regressions. Standard errors are given with two non-zero digits in parentheses immediately under the coefficients. Parameter coefficients are rounded to the same number of digits to the right of the decimal point as the standard error. Pooled and sector models reported. Dependent variable is ln(Output).

	Pooled Coefficient (standard error)	Food Coefficient (standard error)	Wood Coefficient (standard error)	Textiles Coefficient (standard error)	Metal Coefficient (standard error)
Intercept	**9.118***	**8.772***	**9.557***	**13.138***	**9.077***
	(0.461)	**(1.110)**	**(0.872)**	**(1.039)**	**(1.025)**
ln(*Capital*)	**0.249***	**0.246***	**0.196***	**0.191***	**0.255***
	(0.030)	**(0.083)**	**(0.060)**	**(0.068)**	**(0.064)**
ln(*Workers*)	**0.733***	**0.749***	**0.824***	**0.422***	**0.788***
	(0.051)	**(0.134)**	**(0.104)**	**(0.114)**	**(0.103)**
Year	**-0.010**	**0.030**	**0.017**	**-0.228***	**0.128**
	(0.046)	**(0.122)**	**(0.089)**	**(0.088)**	**(0.092)**
WOOD♠	**-0.677***				
	(0.120)				
TEXTILES♠	**-0.784***				
	(0.127)				
METAL♠	**-0.435***				
	(0.118)				
NAIROBI♠	**0.494***	**0.135**	**0.630***	**-0.480#**	**0.215**
	(0.108)	**(0.247)**	**(0.184)**	**(0.263)**	**(0.306)**
MOMBASA♠	**0.459***	**0.513**	**0.261**	**-1.320***	**0.448**
	(0.142)	**(0.357)**	**(0.309)**	**(0.300)**	**(0.354)**
ln(*Age*)	**-0.039**	**-0.003**	**-0.196**	**-0.372***	**-0.265**
	(0.065)	**(0.165)**	**(0.130)**	**(0.122)**	**(0.183)**
Growth♠	**-0.216***	**0.085**	**-0.230**	**-0.185**	**-0.281**
	(0.100)	**(0.262)**	**(0.214)**	**(0.197)**	**(0.188)**
Contract♠	**-0.234***	**-0.500***	**-0.099**	**-0.138**	**-0.444***
	(0.087)	**(0.250)**	**(0.163)**	**(0.158)**	**(0.206)**
Investment rate	**0.444**	**0.144**	**0.183**	**0.250**	**1.111#**
	(0.312)	**(0.632)**	**(0.553)**	**(0.772)**	**(0.671)**
Capacity utilisation	**0.363***	**0.135**	**0.323**	**0.857***	**0.339**
	(0.165)	**(0.421)**	**(0.339)**	**(0.289)**	**(0.334)**
Skill worker ratio	**0.254**	**1.223***	**-0.032**	**0.111**	**-0.203**
	(0.162)	**(0.522)**	**(0.280)**	**(0.270)**	**(0.421)**
African owner♠	**-0.219***	**-0.209**	**-0.329**	**-2.334***	**-0.262**
	(0.109)	**(0.246)**	**(0.217)**	**(0.351)**	**(0.265)**
Export♠	**0.228***	**0.330**	**0.521***	**0.135**	**-0.156**
	(0.103)	**(0.248)**	**(0.223)**	**(0.202)**	**(0.209)**
Foreign ownersh (%)	**-0.001**	**0.001**	**-0.004#**	**0.008#**	**0.004**
	(0.001)	**(0.004)**	**(0.002)**	**(0.004)**	**(0.003)**
Overdraft facility♠	**0.503***	**0.902***	**0.218**	**-0.044**	**0.677***
	(0.110)	**(0.293)**	**(0.187)**	**(0.219)**	**(0.286)**
Observations	**602**	**114**	**152**	**127**	**142**
R-square	**0.861**	**0.855**	**0.854**	**0.904**	**0.893**
White test[a]	**0.333**	**0.746**	**0.549**	**0.737**	**0.499**
CRS test[b]	**0.630**	**0.952**	**0.820**	**0.000**	**0.596**

NOTE: The *- (#-) symbol signify significance at the 5% (10%) confidence level.
a) White test of heteroscedasticity. The null is homoscedasticity. Probability value reported.
b) Wald test of the linear hypothesis: ln(L)+ln(K)=1.00. Probability value reported.
♠ Dummy variable

The firm growth variable was divided into two separate variables to allow for distinct growth-productivity relationships for expanding and contracting firms. Because of the poor quality of this variable in terms of magnitude, but not in sign, we entered firm growth in the regressions as dummy variables. Specifically, we defined the variable *Growth* to take the value of one for firms with a positive growth rate of three percent or more, and zero otherwise, and the variable *Contract* to take the value of one for firms with a negative growth rate exceeding three percent, and zero otherwise. Interestingly, *Growth* is negative and significant in the pooled model, which contradicts our expectations, but not so in the sector models. On the other hand, *Contract* is significantly negative both in the pooled, food and metal models, indicating that contracting firms are considerably less productive.

The investment ratio is positive and insignificant at the 5%-level in all models. If anything, this is weak evidence for a positive association between productivity and the investment rate. Again, causality can clearly go both ways: Probably, as argued in the section 3, is even the reversed direction more likely for this particular variable. In any case, the results in table 4.3 do not contradict the previous findings, although the size and significance of the parameter estimates should be interpreted with great care.

The capacity utilisation rate (which belongs to the (0,1]-interval) enters with the predicted positive sign, and is significant in the pooled and textiles models.

Human capital, captured in the *skill worker ratio*-variable, defined as the ratio of skilled labour to the total labour force, does not influence productivity significantly in any sector except food, where the effect is positive and rather strong.

Enterprises with African owners appear less productive in all models. The effect is significant in the pooled and textiles models. Also, the *Overdraft facility*–variable is positive and significant in all models except wood and textiles. In fact, informal firms, almost without exception, lack such credit facilities. In addition, African owners are much more common in the informal than in the formal sector. Together, these two variables confirm our previous finding of considerably lower performance of informal firms.

The export variable is positive and significant in the pooled and wood models, but the magnitude and significance is less than expected. The impact of foreign ownership plays a minor role, and takes both negative and positive signs for the various models, but is insignificant at the 5%-level in all estimations.

In several respects, textiles behave different from other sectors, including the negative effects of time, location and age. These effects may be explained by the rushed trade liberalisation in the early 1990s, which resulted in an inflow of second hand clothes and reduced gross output of the sector by almost a half between 1992 and 1993.

4.5. Conclusions about Productivity Determinants

We found a strong positive size-efficiency relationship. The fixed-effects model with constant returns imposed suggests formal firms in the 75-149-worker category to be about twice as efficient as formal firms in the 1-5-worker interval. There is weak evidence that efficiency is somewhat lower for establishments in the 150+ worker category, indicating the possible presence of an inverted ∪-shaped size-efficiency relationship. Such a relationship is evident, and much clearer, with the partial labour and capital productivities which peak in the 25-74- and 75-500-worker categories, respectively. When comparing productivity across sectors, it was found that food is 40-120%, and metal 20-85%, more productive than wood and textiles, depending on model.

The analysis of the determinants for productivity revealed some heterogeneity among sectors, which makes it precarious to draw general conclusions in some cases. Apart from textiles, the location variables indicate positive impacts on productivity by operating in Mombasa or

Nairobi, although this effect is weak and significant only in the pooled model. The age variable fails to explain much of the variation in productivity, as do the dummy variable for growing firms and the investment ratio. However, contracting firms are shown to be less productive in all models, which is consistent with findings from other developing countries in Tybout and Roberts (1997). In line with their reasoning, we may therefore conclude that an increase in the turnover rate of enterprises in Kenyan manufacturing, in which contracting firms cease operations, is likely to raise overall sector productivity. Naturally, higher turnover also implies lower mean age, but since age has no effect, this does not affect overall sector performance according to our results.

Firms with African owners and limited access to credit are less productive, and because these are the main characteristics of informal firms, it appears as if productivity is lower in the informal sector. The skill variable is positive in food but insignificant everywhere else. Further, we find only weak support for the export penetration hypothesis, that exporting imply higher productivity, and no support for the argument that foreign ownership has an influence.

Based on these findings, we believe that two conclusions relevant for policy can be drawn. The first is based on the observation that overall sector productivity may increase with higher enterprise turnover. To encourage such a process, policy need consider measures that stimulate births of new firms, and not generally to support low productive firms with financial problems. A second conclusion is that access to credit (working capital) appears to be a very important determinant of productivity. This suggests that the reforms that improve access to credit by private firms may improve their performance.

5. Summing Up

The question that we have tried to answer in this paper is why the growth of the Kenyan manufacturing sector has been so poor. To start with we should note that what we analyse is a cross-section of Kenyan firms, which means that we are unable to draw conclusions about the impact of some factors that are common to all firms. The first such factor is that there is a high level of economic and political risk. The economy is vulnerable to external shocks, and the weakness of the financial system makes it hard to hedge against those risks. High risks mean that the cost of capital is bound to be high, and this implies that investments will be low. Second, we have not been able to investigate directly the impact of poor infrastructure, although this certainly has reduced returns on prospective investment projects. Third, the government for a long time pursued a control regime with extensive trade restrictions and other barriers to private sector investment. We know that inward oriented policies are particularly costly in small economies such as the Kenyan one. During the period considered in our anlaysis there was a process of deregulation and liberalisation, but we have not attempted to sort out the impact of these changes in this paper. The firms interviewed in the survey were positive to the changes, though. Fourth, the firms were still very critical against the extent of corruption and ad hoc interference with their activities. Although the institutional structure and regulations have been improved, the application of the rules is still often biased (Bigsten, Moene, 1996). The institutional environment thus has a depressing effect on the efficiency of the sector as a whole.16 This is probably a serious constraint on the ability of Kenyan manufacturing firms to become competitive in the world market.

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[16] The importance of political, economic and legal institutions have been noticed by many, and Barro (1998) notes that “the long-lasting differences in these institutions across countries have proven empirically to be among the most important determinants of differences in economic growth and ivnestmernt.”

Still, what have we been able to say on the basis of our analysis of the RPED data set? The analysis of investment showed that productivity was a major determinant of investment. This means that firms that do well also are more likely to invest, which is positive from an efficiency point of view. It follows from this that improved credit access by itself will have a rather limited impact on manufacturing investment levels, unless it is combined with an expansion of potentially profitable investment opportunities.

Is there a serious credit constraint on investment? It is true in some cases, especially for small producers, but credit availability does not generally seem to be so severe a constraint on investment. Retained earnings is the major source of investment finance, and the reasons given by firms for not applying for credit suggest that many of them are rather close to the financial structure they desire. Thus, investments are mainly constrained by the lack of productive and profitable investment opportunities.

Given this conclusion we went on to investigate what factors constrain productivity. What that analysis show is that productivity is low in contracting firms. A structural rationalisation where these firms exit would therefore increase average productivity in the sector. Since it is also these firms that complain about lack of credit, one should not advocate a general relaxation of credit allocation procedures. Still, a clear result is that firms with access to overdrafts are more productive, but one must be cautious about making too much of this result since there may be an endogeneity problem. The productivity analysis also shows that productivity is higher in Nairobi and Mombasa, which may indirectly support the notion that the quality of infrastructure is important for productivity. It is also clear that African owned firms are less productive, which may be due to a lack of a network of economic contacts or experience. There is also a strong relationship between capacity utilisation and productivity, and many of the firms point to lack of demand as a major constraint on expansion and investment. Firms do not invest unless there is a market for output, and if the domestic market is not growing and the firms are uncompetitive in the foreign market, then there will be little investment.

The argument we try to make in this paper is thus that there are no quick fixes to be found for policy makers that want to stimulate manufacturing growth. Investment is largely determined by the availability of profitable investment opportunities, and the generation of such opportunities requires reforms over a wide spectrum of areas. A domestic economic and political environment that is conducive to long-term investment must be created, and on the basis of this Kenya may also develop its export potential. As of today, Africa's export is heavily concentrated in unprocessed primary products, indicating that this is where Africa has its comparative advantage. Wood (1994) suggests that this is natural, since Africa has an abundance of labour and natural resources, while it is short of physical as well as human capital. Manufacturing production on the other hand requires much human capital and little natural resources. Wood argues that it is likely that Africa's trade pattern will over time come to resemble that of Latin America rather than that of Asia, which is a situation where the abundance of natural resources continues to explain the pattern of trade. However, Kenya has managed to take some steps towards manufacturing exportable production and now manufactured exports constitute more than 20% of total exports. To get further one must continue the efforts to create a market economy with transparency and stability, at the same time as efforts do rehabilitate infrastructure and develop capabilities continue.

References

Aguilar, R., Bigsten, A. (1998), "The RPED Survey 1993-1995", in Bigsten and Kimuyu (eds.).

Barro, R.J. (1998), "Human Capital and Growth in Cross-Country Regressions", mimeo, Economic Council of Sweden, Stockholm.

Battese, G. E., and Coelli, T. J. (1993), "A stochastic frontier production function", Working paper in econometrics and applied statistics no 69, Department of Econometrics, University of New England, Armidale.

Belsley, D., Kuh, E., and Welsch, R. (1980). *Regression Diagnositics: Identifying Influential Data and Sources of Collinearity*. New York: Wiley.

Bigsten, A., Collier, P., Dercon, S., Gauthier, B., Gunning, J. W., Isaksson, A., Oduro, A., Oostendorp, R., Pattillo, C., Söderbom, M., Sylvain, M., Teal, F. and Zeufack, A. (1998). "Investment in Africa's Manufacturing Sector: a Four Country Panel Data Analysis." Mimeo. Centre for the Study of African Economies, Oxford University.

Bigsten, A., Kimuyu, P. (eds.) (1998*), Structure and Performance of Manufacturing in Kenya*, mimeo, Gothenburg.

Bigsten, A., Moene, K-O. (1998), "Growth and Rent Dissipation: The Case of Kenya", *Journal of African Economies,* 5(2), 1996

Caudill, S. B. and Ford, J. M. (1993), "Biases in frontier estimation due to heteroscedasticity", *Economic Letters* 41, 17-20.

Deaton, A. (1997) *The Analysis of Household Surveys. A Microeconometric Approach to Development Policy.* The John Hopkins University Press.

Denny, K. and Nickell, S. J. (1992). "Unions and Investment in British Industry." *The Economic Journal*, 102 (July), pp. 874-887.

Easterly, W., and Levine, R. (1995). "Africa's Growth Tragedy." Mimeo. The World Bank.

Farrell, M.J., (1957), "The measurement of productive efficiency", *Journal of the Royal Statistical Society*, vol 120, 253-290.

Greene, W. H., (1993), "The econometric analysis to efficiency analysis", in Fried, H. O., Lowell C. A. K. and Schmidt S. S. (Eds), *The measurement of productive efficiency*, Oxford University Press, New York, 68-119.

Greene, W. H. (1993). Econometric Analysis. Macmillan Publishing Company.

Heckman, J. (1976). "The Common Structure of Statistical Models of Trunctation, Sample Selection, and Limited Dependent Variables and a Simple Estimator for Such Models." *Annals of Economic and Social Measurement,* 5, pp. 475-592.

Heckman, J. (1979). "Sample Selection Bias as a Specification Error." *Econometrica,* 47, pp. 153-161.

King, R. G., and Levine, R. (1993). "Finance, Entrepreneurship and Growth: Theory and Evidence." *Journal of Monetary Economics*, 32, pp. 513-542.

Knox Lovell, C. A. (1993), "Production frontiers and productive efficiency", in Fried, H. O., Lowell C. A. K. and Schmidt S. S. (Eds), *The measurement of productive efficiency*, Oxford University Press, New York, 3-67.

Leung, S. F., and Yu, S. (1996). "On the Choice Between Sample Selection and Two-part Models." *Journal of Econometrics,* 72, pp. 197-229.

Lundvall, K., Manaundu, M., Hjalmarsson, L. (1998), "Technical Efficiency and Productivity", in Bigsten and Kimuyu (eds.).

McKinnon, R. I. (1973). *Money and Capital in Economic Development.* Brookings Institution, Washington D.C.

Nelson, F. (1984). "Efficiency of the Two-step Estimator for Models with Endogenous Sample Selection." *Journal of Econometrics*, 24, pp. 181-196.

Nickell, S. (1978). *The Investment Behaviour of Firms*, Cambridge University Press.

Pagan, A. and Vella F. (1989). "Diagnostic Tests for Models Based on Individual Data: A Survey." *Journal of Applied Econometrics,* 4(4), pp. S29-S59.

Ramsey, J. B. (1969). "Tests for Specification Errors in Classical Linear Least-squares Regression Analysis." *Journal of the Royal Statistical Society*, Series B, 31, pp. 350-371.

Roberts M. J. and Tybout J. R. (eds), 1997, *Industrial evolution in developing countries: Micro patterns of turnover, productivity, and market structure*, Oxford university Press, London

Stiglitz, L. and Weiss, A. (1981). "Credit Rationing in Markets with Imperfect Information." *American Economic Review*, 71:3, pp. 393-410.

Söderbom, M. (1998). "Investment Behaviour", in Bigsten and Kimuyu (eds.).

Tauchen, G. (1985). "Diagnostic Testing and Evaluation of Maximum Likelihood Models." *Journal of Econometrics*, 30(1/2), pp. 415-443.

Wood, A. (1994)_North-South Trade, Employment and Inequality: Changing fortunes in a skill-driven world, Clarendon Press, Oxford.