A tale of industrial stagnation from Africa[1]

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Abstract: Many African economies have experienced rather dismal industrial development since the 1980s. The consensus view is that African firms lack competitiveness in a world with increasing trade openness. What determines competitiveness? A well-known explanation is that resource endowments in Africa favour land not labour, which result in high wages, especially in comparison to 'labour abundant' Asian economies. This paper examines the validity of this view on the basis of the case of Sudan. We demonstrate that the lack of competitiveness of manufacturing industries is not caused by high wages. Assuming a direct relationship between labour productivity and international competitiveness, we argue that acute capacity underutilisation, caused by supply-side constraints, lowers manufacturing productivity which in turn negatively influences competitiveness.

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1. Introduction

Interest in industrial development subsided with the rise of free market economics in the 1980s and 1990s. The era in which industrial development has been de-emphasised has coincided with a notable deterioration or stagnation of manufacturing activities in many African countries (Jalilian and Weiss, 2000, Nourbakhsh and Paloni, 2000). A number of well acknowledged studies in the literature attribute the underdevelopment of the manufacturing sector in Africa, either implicitly or explicitly, to wages being high especially in comparison to some Asian economies such as China and India. This is based on the view that resource endowments of African economies are in favour of land rather than labour.

This paper disputes the arguments that manufacturing wages in African economies are relatively high and that this in itself is an obstacle for industrial development. Taking the relationship between labour productivity and competitiveness as given, we demonstrate that it is not high wages but low productivity levels that place African economies in a disadvantageous position in international as well as in national markets. An important cause of the depressed labour productivity is the acute capacity underutilisation rates in manufacturing. While low capacity utilisation is often associated with business cycles and demand fluctuations, persistent supply-side constraints such as inadequate infrastructure services, finance and skill base are perhaps more important.

The evidence in this paper comes from Sudan, which in many ways is ideal for analysis. It has a large land to labour ratio in comparison to Asian economies. It has been plagued with structural economic constraints as well as civil wars like some other African countries.

The rest of the paper is organised as follows. The next section reviews the literature on the topic and highlights a number of controversial arguments. Section 3 specifies the links between three key indicators: competitiveness, labour productivity and capacity underutilisation. These issues are examined empirically in Section 4 presents an empirical analysis of key manufacturing indicators in three countries: Sudan, India and China. We show that the slow progress in Sudanese manufacturing is associated with low productivity levels but not with high wages. Further, we discuss the determinants of labour productivity in Sudan by using a cross-section regression analysis and demonstrate that a crucial reason for poor productivity is the severe and long-term capacity underutilisation, which is associated with a host of supply-side constraints.

2. What are the causes of industrial underdevelopment in Africa?

The literature on industrialisation can be divided into two distinct strands. The first deals with industrial development in a closed economy context with emphasis on economic structures, resource constraints and endowments (Rosenstein-Rodan 1943, Hirschman 1958, Lewis 1954, Kaldor 1966 and 1967). Complemented by 'the infant industry argument' in international trade, this literature underpinned the crucial role of industrialisation for growth and development. The second strand of the literature is inspired by the comparative

advantage theory of trade, which has stressed efficient allocation of resources and international division of labour in production rather than industrialisation *per se*.

At the level of implementation, both of these perspectives have had limited success in Africa. For the former, financing imported investments and raw materials, identification of sectors or activities to protect, and to what extent and for how long to protect have been problematic. In practice, many countries applied an indiscriminate protectionist diet for prolonged periods, which went far beyond what the term 'infancy' implies. In the absence of monitoring entrepreneurial efforts to grow out of 'infancy', enterprises remained reliant on protection by the state. The second view has also had little success in Africa. Restrictions on access to developed country markets, a more competitive international market for the exports of the developing world (UNCTAD, 2002), supply-side constraints and the importance of non-price factors for competitiveness (Roberts and Thoburn, 2003) are some of the reasons for the failures of the liberalisation programs.

In a world of increasing openness in international trade, industrial development without a competitive edge is a difficult task. This is why most recent studies discuss industrial development in the context of international competitiveness. Survival of firms in different industries in each country requires them to show the ability to, at least, retain and ideally expand their market share in overseas and / or domestic markets in the presence of competing foreign firms. While competitiveness is closely related to the performance of the firms, its aggregation at sectoral or national level can be useful for policy-making purposes since the performance of firms in any country is influenced by a common set of incentives, factor markets, institutions, business cultures and norms (Lall, 1998). Therefore, it is not unusual to observe a generalised failure or success of firms in a particular industry to enter or expand their share in the world and domestic market. Such trends do not only shape the path of industrial development but also the prospects for economic development.

What determines competitiveness that plays such a crucial role in industrial development? The ingredients that contribute to competitiveness are manifold. For example, the *Global Competitiveness Report* (GCR) (2007-2008) takes into account institutions, infrastructure, health and education, market size, depth of financial markets, technology and innovation. In development economics, a prominent stance on this question was established by Sanjaya Lall (1998). For him, the level of competitiveness and industrial development of nations depended on their technological capabilities which in turn were determined by the amount of investment in research and development and human capital base.

The empirical studies on African industrial development, on the other hand, consider the lack of competitiveness in Africa to be a result of the paradox of high wage-low productivity, stemming from disadvantageous resource endowments. For example, Wood and Berge (1997) and Owens and Wood (1997) argued that the low skill-land endowment ratio in African countries leads to a loss of competitiveness through high wages in manufacturing, which requires more skills relative to land. Similarly, Teal (1999) argued that the failure of African manufacturing in international markets may lie in wages being too high relative to productivity. In a more comprehensive analysis with a structuralist perspective

Karshenas (2001) pointed to the lack of labour surplus relative to land, and he too ended with a similar conviction.

> "In Asia, the non-agricultural sectors have had an access to an abundant supply of wage labour at wage rates that are a fraction of the average product of labour in agriculture, and with a relatively elastic supply. In sub-Saharan Africa, on the other hand, the opportunity cost of labour or the reservation wage for the non-agricultural sector is close to the average product of labour in agriculture." (Karshenas, 2001: 323)

While it is true that manufacturing sectors in Africa are generally not competitive in international markets (Jallilian *et al*. 2000), it is disputable that relatively high wages are at the root of this problem. The point about wages being too high for whatever reason is not particularly enlightening because with low productivity any element of production costs (including capital, raw materials and wages) will appear high in comparison with the total value of output produced. Neither is this point useful for policy making purposes to the extent that it implies a suggestion for a downward wage adjustment to enhance competitiveness in environments where manufacturing wages are already very low.

3. Competitiveness, labour productivity and capacity utilisation: Specifying the linkages

In the literature of economics, various measures are used for competitiveness. These include export shares (Kravis and Lipsey, 1992), total factor productivity, unit labour costs, relative output prices (Rao and Tang, 2004), relative export prices (Durand, et al. 1992), and changes in real exchange rates. The most frequently used measure of competitiveness, however, is productivity, especially labour productivity, especially labour productivity, because:

> 'Prosperity is determined by productivity …which depends both on the value of a nation's products and services, measured by the prices they can command in open markets, and efficiency with which they can be produced…True competitiveness, then, is measured by productivity …[that] supports high wages, a strong currency, and attractive returns to capital … Productivity is the goal, not exports *per se* or whether firms operating in the country are domestic or foreign owned' (*Global Competiveness Report* p. 52)

In this paper, we also consider labour productivity in manufacturing to be a good aggregate measure of competitiveness since the determinants of the latter, no matter how broadly or narrowly defined (e.g. institutional quality, human capital, financial depth or unit production cost), are likely to influence the former.

Labour productivity, on the other hand, is dependent on capacity utilisation rates though it is determined by factors such as skills and technology as discussed under 4.3.1. Consider that productivity is estimated as output per unit of factor input and that outputs and inputs are measured either in terms of quantity (produced or employed) or in constant prices so that we assume away the influence of changes in prices. Assuming that labour and capital markets are not

fully flexible because of: a) adjustment costs, for example, associated with hiring and firing labour and b) uncertainty so that precise timing of such adjustments is difficult for firms.

Under these conditions, capacity utilisation rates decline during economic downturn, taking the form of underutilised labour force or capital stock or both. This will lead to lower output per unit of capital or labour and relatively higher unit costs. Hence, the variation in capacity utilisation rates causes productivity measures to follow a cyclical trend as long as a full adjustment to cycles through variation in input use is not possible. It is well established in the literature that productivity measures show a cyclical pattern (Basu 1996; Hart and Malley 1999) in the manufacturing sectors of developed economies.

What is peculiar, however, is that the causes of capacity underutilisation are not entirely the same in developed and low-income African countries. In the former group, it is associated to a large extent with demand related business cycles, which instigates a cyclical output and labour productivity pattern. In the low-income economies of Africa, on the other hand, capacity underutilisation is likely to be induced not only by demand-side factors but also supply-side factors. Indeed, as argued by Rand and Tarp (2002, p. 2084):

> "…supply-side factors are often the main source of output fluctuations in developing countries, and supply-side models are typically superior in helping to understand business cycle features."

The nature of supply-side constraints faced by African manufacturing firms is quite well established in the literature. For example, Tribe (2000) and Rattsø and Torvik (2003), Lawrence (2005) highlight the role of foreign exchange shortages that limited the capacity of African manufacturing firms to import essential inputs. Bigsten and Söderbom (2005), on the other hand, emphasize how lack of access to credit by African manufacturing firms limits the industrial development process. Others have highlighted inadequate infrastructure (Tribe 2000, Yumkella and Vinanchiarachi 2003), interruptions to the flow of inputs (Cramer 2000), high transaction costs (Collier, 2000) and political instability (Lall, 1995).

These constraints explain the peculiar evidence from Africa that the growth of small firms is much slower than the growth of large firms, which contrasts with the evidence in the advanced capitalist economies (Sleuwaegen and Goedhuys 2002, Van Biesebroeck 2005, Frazer 2005). This is because larger firms are likely to have better flow of inputs, better access to finance and foreign exchange and better solutions to the problems associated with infrastructure (e.g. private power generation facilities).

These supply-side problems induce high capacity underutilisation, and hence low productivity and low returns to investment which erode the competitiveness of African firms both in domestic and international markets. Solutions to these problems could improve the acutely low capacity utilisation rates of existing manufacturing establishments. This in turn would increase output per worker for each establishment and improve their surplus over wages and material costs.

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4. The empirical analysis: The Case of Sudan

Manufacturing activities in many African economies have declined since the 1980s. Jalilian and Weiss (2000) provide some evidence for de-industrialisation in a sample of countries across the continent. More recent data from *World Development Indicators* (2007) show that the manufacturing value added (MVA) to GDP ratio has declined or remained stagnant since the mid 1970s in 17 out of 27 countries for which data is available.

The experiments with different development strategies in Sudan have been futile too with little change taking place in the structure of the economy. Overall, the share of manufacturing value added (MVA) in GDP fluctuated around a narrow band of five per cent at the lower end and nine per cent at the top end (World Bank, 2007). *The 2001Comprehensive Industrial Survey* revealed that the share of the sector in total employment is less than two per cent, which is not significantly different from what it was in the early 1970s. This evidence leads us to conclude that long term manufacturing development in Sudan can, at best, be characterised as stagnant.

Table 1. Composition of MVA and Employment in Sudan (per cent)

ISIC	Sector	*Composition of MVA*		*Shares in employment*	
		1971	*2001*	*1971*	*2001*
31	Food, beverages and tobacco	45.8	66.1	37	57.2
32	Textile, clothing & leather goods	26.1	4.2	32.4	9.1
33	Wood and wood products	2.9	0.8	2.8	3.2
34	Paper and printing	3.2	2.8	5.1	1.7
35	Chemicals and products	17.1	16.9	8.2	5.9
36	Non-metallic mineral products	2	2.5	4.1	12.7
37-8	Basic metals and products	2.9	2	10.3	7.9
39	Other manufacturing	-	4	0.1	2.2

Source: Based on World Bank (1987) & *The Comprehensive Industrial Survey* (2001).

Manufacturing activities are concentrated in a small number of urban centres, most prominently in Khartoum and Gezira States. The industry has a trivial presence in South Sudan. Overall, the sector maintained a narrow base with agro processing industries dominating the sector (Table 1). Food and tobacco processing is now by far the most important activity in terms of value added and employment.

4.1. Are wages higher in Sudan relative to low-cost Asian economies?

Are wages too high in Sudan in comparison to low-cost Asian economies such as India and China? What role do their differences in resource endowments play? To answer these questions, three sets of indicators are listed in Table 2. The

first set of data under 'country characteristics' clearly shows that Sudan has the greatest advantage in terms of land per person but a disadvantage in terms of labour surplus. It has the lowest level of development in terms of per capita GDP and per capita manufacturing value added.

As the estimates clearly show, in comparison wages in manufacturing are not particularly higher in Sudan. China has slightly lower wages per worker than Sudan but not India. In fact, the average manufacturing wages given in Table 2 translate into 3 to 3.70 US dollars per worker per day in PPP terms for all three countries. These rates are not far from the international poverty threshold of two dollars a-day.

Table 2. Resource endowments and productivity in Sudan, India and China (US$, constant 2000 prices)*

	Sudan	India	China
Country Characteristics			
Per capita GDP, 2004	448	538	1162
Arable land per person, 2004 (hectares)	0.50	0.15	0.11
MVA per capita, 2004	34	74	350
Manufacturing Wages			
Average wages in manufacturing (per annum)	(1321) 1250	(875) 1335	(-) 1104
Share of wages in MVA (%)	(22.7) 23.4	(35.6) 14.7	(-) 12
Manufacturing wages to AVA per worker (%)	(450) 210	(330) 330	(-) 310
Productivity estimates			
AVA per hectare of arable land used	(118) 300	(302) 627	(556) 1311
AVA per worker (per annum)	(295) 594	(269) 409	(161) 355
MVA per worker (per annum)	(5831) 5351	(2460) 9109	(1442)** 9283
Ratio of MVA to AVA per worker (%)	(20) 9	(9) 22	(9) 26
Labor productivity growth in manufacturing (1971-72 to 1999-01, %)	-8.2	370	644

Source: Estimations are based on data from World Bank (2007) and UNIDO Statistics (2005). MVA and AVA are manufacturing and agricultural value-added, respectively. Figures in brackets are for 1971-72. Figures without brackets are for 2001 unless otherwise stated. (*) Unless otherwise indicated. (**) The figure is for 1977.

The estimates in Table 2 also raise questions about the validity of the view that the opportunity cost of labour for manufacturing is determined by average agricultural incomes (Karshenas 2001). Assuming that value added per worker is the average income in the agricultural sector, real manufacturing wages relative to agricultural value added per worker were much higher in 'labour-abundant' India

and China (over three-fold) than in 'land-abundant' Sudan (around two-fold) in 2001 (the middle row of Table 2). In fact, manufacturing wages in comparison to agricultural wages in reality must be much higher in India and possibly in China than what our estimates in Table 2 suggest. This is because it is likely that agricultural value added per worker reflects the average agricultural incomes in Sudan as most agricultural households derive their incomes from small-scale subsistence farming. On the other hand, the use of wage-labour in agriculture is common especially in India, which implies that wages in agriculture must be much lower than the agricultural value-added per worker. Hence, manufacturing wages relative to agricultural wages are likely to be higher.

If average rural incomes reflect the opportunity cost of labour or the reservation wage for the non-agricultural sector, why are real manufacturing wages relative to agricultural incomes in India and China much higher than Sudan where agricultural value added per worker has been in fact greater? This is probably because the link between agricultural incomes and manufacturing wages is weak. In Sudan, for instance, there was a two-fold increase in agricultural productivity from 1971 to 2001 when in the same period real wages in the manufacturing slightly declined (Table 2). The loose link between incomes in manufacturing and agriculture is not surprising for two reasons. First, manufacturing wages have to reflect the dynamics of urban living costs (including housing, transport and utilities) of which food constitutes only a part. Second, this relationship may have become even flimsier with greater openness to trade in developing economies if some convergence between domestic and international price levels has taken place.

What is indisputable however is that the growth of labour productivity in Chinese and Indian manufacturing has been so fast that in about two decades value added per worker rose by four to six times in these economies while it went down slightly (by about eight per cent) in Sudan (Table 2). On average, Chinese and Indian workers were over 40 per cent more productive in 2001. Hence wage levels in China and India are indeed very low once they are set against this remarkable improvement in labour productivity.

The growth of labour productivity in Sudanese agriculture from 1971 to 2001 does not compare favourably with India or China once the land area is taken into account. In China, arable land per person is only twenty per cent of that in Sudan and yet each agricultural worker produced more than half the value added by a Sudanese farmer. This is mainly because the observed productivity increases in Sudanese agriculture have been due to the extension of the farmed land rather than the employment of modern cultivation methods (Mahran 2000, Ahmed and Sanders, 1998). In India, the proportion of irrigated cropland increased from 19 per cent in 1971 to 34 per cent in 2002, while it went down from 14 per cent to 12 per cent in Sudan in the same period. In 1971, Sudanese farmers consumed only seven per cent of the amount of total fertilizers used in China. Since then, fertilizer use increased by a mere 30 per cent in Sudan while it quadrupled in China and India (World Bank 2007).

4.2. Supply-side causes of high capacity underutilisation

Capacity underutilisation rates in the manufacturing sector are unusually high in Africa. For example, a study of seven African economies shows that capacity underutilisation rates in some of these economies were as high as 55-60 per cent with a mean of 43 per cent and median of 48 per cent (Mazumdar and Mazaheri 2003). In Sudan in some sectors over 90 per cent of installed capacity remained idle for some years (Table 3). Manufacturing of sugar and leather seem to be the only activities where the use of capacity was 60 per cent or more. A survey by the World Bank (2003) showed that capacity underutilisation was prevalent in about 85 per cent of all factories on the largest industrial estate in Khartoum-North.

Table 3. Average capacity utilization rates in Sudan
(Main industries, % of installed capacity)

Sector	*1985*	*1992*	*1995*	*1997*
Textile	30	15.0	8	10
Oil milling	25	5.0	12	19
Beverages	50	7.6	55	50
Sugar	-	64.7	69	74
Flour	-	33.2	29	21
Leather	60	60.0	60	-
Footwear	45	30.0	34	31
Tobacco	-	26.9	18	28

Source: Ministry of Industry

Manufacturing industries in every country, irrespective of the level of development, go through phases of underutilisation as a result of the changes in demand and trade cycles. Undoubtedly, these factors exert similar influences on African manufacturing firms. Nevertheless, given the length and severity of low capacity utilisation rates in some African economies, it is unlikely that they merely reflect business cycles. Supply-side constraints are likely to be more important, as argued by Rand and Tarp (2002). Although Mazumdar and Mazeheri (2003) underplay the impact of supply-side factors on capacity utilisation rates, their definition of what constitutes the supply-side is rather narrow. For example, credit constraints faced by African manufacturing firms, which is indicated to be highly important for capacity utilisation rates in their study, are not considered as part of the supply-side. The study also omits the influence of inadequate infrastructure facilities.

Understanding the dynamics of capacity utilisation in Africa is of great importance. Our research on Sudanese manufacturing leads us to focus on four important factors. The first is related to input supply problems as discussed extensively by Dagdeviren and Mahran (2004). Persistent scarcity of imported as well as locally produced inputs from the 1970s to the late 1990s led to the emergence of a huge black market for goods, services and foreign exchange. The

black market economy generated its own momentum whereby scarcity fuelled illegal activities and the latter in turn created more shortages.

For example, the textile industry (yarn, fabric, blankets, garment producing units) failed to meet expectations despite enjoying the highest protection rate throughout the period (World Bank 1987). The sector registered a continuous deterioration both in terms of the quantity of output and real value-added since the 1970s. The erratic and inadequate supply of cotton to textile units has been one of the most important reasons behind this decline. No effort was spared at curbing raw cotton exports (representing 75 per cent of total production in the 1990s) in favour of domestic textile units in the face of foreign exchange shortages until the end of 1990s. Furthermore, the price of cotton increased significantly due to poor marketing arrangements, which involved moving cotton from producers to Port Sudan (where firms make their purchases) and from Port Sudan to textile firms. Thus, except for medical cotton producing units, capacity utilisation remained very low in the sector. Of the 219 licensed textile units in Khartoum only 52 were operational in 1998 (UNIDO, 2003). Likewise, input supply was seriously constrained in the edible oils sector by official and illegal exports, which together accounted for 70 per cent of the crop produced. Annual demand in the edible oil sector was around 17 per cent, while actual production was five per cent of the installed capacity in 1993-1994 (MOI and MOF, 1995).

Secondly, the rough and ready information on credit availability suggests that access to credit may be important in alleviating problems with the use of capacity. For example, total domestic credit provided by the banking sector was only 11.5 per cent of GDP in Sudan during 2002-2003. This is very low in comparison with India where it was around 60 per cent of GDP and China where it was about 166 per cent of GDP in the same period (World Bank, 2007). Long term credit provision to the industry is almost non-existent in Sudan. The share of industry (including sectors such as construction in addition to manufacturing) in total commercial credit stock was around 10-11 per cent during 2003 and 2004 (BOS, 2004).

Thirdly, infrastructure bottlenecks have further aggravated the circumstances for capacity utilisation. Northern Sudan is politically more stable and it accommodates around 98 per cent of manufacturing enterprises. Most agro-processing firms experience sharp fluctuations in the supply of raw materials due to inadequate transport links. Poor supply of services such as telecommunications, power and water have had dire consequences for capacity utilisation rates in established industries. The share of production by the electricity and water sectors in total GDP, by far the most important infrastructure services, has remained around two per cent since the 1970s. Power failures have been a prominent cause of capacity underutilisation. Many enterprises have installed their own electricity generation systems in response to frequent power failures. The results of the 2001 Industrial Survey suggest that private power generation for own use accounted for about 21 per cent of electricity used in the manufacturing sector.

Finally, it is important to emphasize the disastrous consequences of the civil war especially in the South Sudan. Discord and hostilities between the people of African descent in the South and Arabs in the North have prevailed since independence with the exception of a peaceful period during 1972-1983. Civil war has led to the complete disappearance of manufacturing activities in the

South. According to the *2001 Comprehensive Industrial Survey*, of the 24 thousand manufacturing establishments only four hundred (or 1.8 per cent of total) are located in the Southern states of Bahr el Ghazal, Upper Nile and Equatoria. The region has no activity whatsoever in 15 of the 22 main industries. The Sudanese government had very limited incentives to invest in civilian infrastructure in the South for it could benefit the rival factions or be destroyed. The roads that linked the North to the South (one from Juba via Malakal and the other via Wau) have been dysfunctional due to land mines, lack of resources on the part of SPLM and incentives on the part of government which has had no control over a large part of the South Sudan. Uganda and Kenya have been the main commercial links in the South. The transport cost of goods from neighbouring countries into South Sudan is around 230 per cent of their cargo-insurance-freight (CIF) value (World Bank, 2005).

An important question in this context is why the supply side problems we described above have caused capacity underutilisation rather than lack of capacity? Part of the answer to this question lies in the government policies pursued during the 1970s and early 1980s when it actively invested in manufacturing. The private sector has also invested in periods of relative political stability. Every manufacturing unit must meet a minimum scale of production for it to be economically viable. This is partly why, for example, the installed production capacity was approximately five times greater than the level of domestic demand in the edible oils sector (MOI and MOF 1995). Once established, the liquidation of the existing assets in the face of high capacity underutilisation is difficult for investors and the government. Finding buyers for facilities that operate at low capacity is difficult unless investors accept considerable undervaluation in their assets. Operating at lower capacity with a low level of profitability may be a better option than asset fire sales. However, new capacity creation in the 1990s has been very limited. On average around ten per cent of gross fixed investment was directed to the manufacturing sector in this period while over 65 percent went in to real estate (World Bank 2003). In fact, the 2001 industrial survey data indicate that new investment undertaken in that year was not sufficient for replacement of the depreciated capital stock in 55 out of 82 industries.

Adjustment to supply side constraints can also be difficult through variation in labour use as well. While use of causal labourers, for example, may be a way of dealing with, say, power interruptions or input supply problems, the effectiveness of such practices in terms of capacity utilisation rates may be limited where the sector is dominated by micro firms that often employ family labour as in Sudan. According to the 2001 survey, 36 per cent of the manufacturing value added is created by sectors with less than 5 workers, including family workers.

4.3. Causes of poor productivity in Sudanese manufacturing

In the previous section, we argued that depressed labour productivity is a crucial weakness in Sudanese manufacturing. Knock on effects of poor productivity on competitiveness in the domestic as well as world markets are likely to be restraining the overall development prospects of the manufacturing

sector. Our purpose in this section is to identify the determinants of productivity in Sudanese manufacturing through an econometric regression analysis.

4.3.1. Method of estimation

Labour productivity estimations are often derived from a Cobb-Douglas production function (i.e. $Y_{it} = A_i K_{it}^{\alpha} L_{it}^{\beta}$) and it is determined by capital intensity or capital-labour ratio. However, this approach suffers from some unrealistic assumptions. Most important is the assumption that capital and labour are perfect substitutes, implying that fixed capital is malleable, labour markets are flexible and the production technology could be changed easily. Estimates based on this functional form imply implausible relationships between key variables. For example, as shown by Rowthorn (1999), unemployment is found unaffected by investment, technical change or change in labour supply when estimations are based on Cobb-Douglas function. Changing the functional form to assume that the elasticity of substitution is less than unity, he shows that the equilibrium unemployment is affected by all the factors above. Moreover, growth accounting derived from Cobb-Douglas or Constant Elasticity of Substitution (CES) functions provide limited information about factors such as technical change, which usually is proxied either by a time dummy or the intercept in econometric analysis.

In this paper, we have estimated the determinants of labour productivity in Sudan on the basis of the well-known Verdoorn's Law, which is known to be a less restrictive method with no ambivalence with respect to issues such as elasticity of substitution between factors of production, returns to scale and technology which predicts a positive and stable relationship between labour productivity and cumulative output. This approach does not impose a unitary elasticity of substitution between capital and labour, and it allows for economies of scale and technical progress (Verdoorn 1980). This technique provides a 'roundabout solution', as Katz (1968) puts it, to the question of technological progress by using expansion in output to reflect the impact of economies of scale and division of labour in production. As output grows, the role of these factors grows too. This method has been widely used in the literature and the coefficient on output growth was often found positive. For application of Verdoorn's Law, see Kaldor (1966), McCombie and Ridder (1983), Boulier (1984), Michl (1985), Jefferson (1988), Wells and Thirlwall (2003).

The Verdoorn's equation can be derived from a Cobb-Douglas production function (see, Rowthorn 1979) or from a CES production function (Katz 1968). Following Verdoorn (1980) the relationship between labour productivity and output can be written as:

$$p_{it} = \alpha + \beta\, q_{it} + \varepsilon_{it} \qquad (1)$$

where p is growth of labour productivity, q is growth of output, α is a constant, β is the coefficient on output growth which is expected to be greater than zero and ε is the error term.

This original Verdoorn equation, however, needs to be modified in view of developments in the literature of growth accounting. For example, Rowthorn

(1979) criticised the Verdoorn Law on the basis that it did not take into account the contribution of physical capital and associated technical progress. The emerging literature in the following years recognised the validity of this critique and included a capital stock variable in applications (Michl 1988, McCombie and Ridder 1983, Jefferson 1988).

Neither does equation (1) make an allowance for the influence of learning by doing and education. Siginificance of these have been discussed by scholars of different persuasion both from theoretical and empirical points of view (Arrow 1962; Becker 1962 and 1992; Denison 1967; Bahk and Gort 1993; Cörvers 1997; Engelbrecht 1997; del Barrio-Castro et al. 2002 and Moretti 2004).

Moreover, as discussed under Section 3 and Section 4.2, the estimates of labour productivity are influenced by capacity utilisation rates. Jefferson (1988), for example, tested the effect of capacity utilisation on labour productivity in his application of Verdoorn's Law and found it to have a positive and significant impact. To reflect on these considerations, a generalised form of equation (1) can be written in the following way:

$$p_{it} = \alpha + \beta_j \Sigma X_{ijt} + \varepsilon_{it} \qquad (2)$$

where X is the vector of j number of variables that influence labour productivity. For empirical estimations, this, then, can be transformed into:

$$p_{it} = \alpha + \beta_1 q_{it} + \beta_2 k_{it} + \beta_3 s_{it} + \beta_4 u_{it} + \varepsilon_{it} \qquad (3)$$

where k, s and u reflect the impact of capital-labour ratio, skills and capacity utilisation rate on labour productivity, respectively. All coefficients are all expected to have positive signs.

4.3.2. Data, Estimations and Results

The estimations are based on the *2001 Comprehensive Industrial Survey* with ISIC groupings. The survey covered all regions of Sudan, including the South. All companies with 10 and more workers and a sample of companies with less than 10 workers were included in the survey. Estimations are based on four digit industry classification with 83 industries altogether. The manufacture of 'medical appliances and instruments for measuring checking testing and navigating' had to be excluded as the survey had no capital stock data for this industry. This reduced the number of observations to 82.

Estimations are carried out at levels because the database does not include a time series element. All variables are in natural logarithms. Labour productivity is measured as value-added per employee. The estimate of the Verdoorn effect is based on cumulative industrial output at four-digit level. Capital-labour ratios are based on capital stock data at the end of the year and the number of persons engaged in each industry.

The industrial survey does not include any information on job experience or education. Instead, we used a proxy variable to measure the influence of learning by doing and education. Assuming a positive association between wages and skills, firm level or sectoral wage differentials are likely to reflect the differences in education and experience. We used the difference in the average wages

between individual sectors and the highest paying sector in order to avoid zero or negative values when logarithmic transformation is used. Therefore, the series used in estimations reflect the extent of unskilled labour used in production. In other words, the higher is the wage differential for a particular sector the lower is the amount of skills used. Hence, the coefficient on *s* is expected to be negative.

The survey does not include a measure of capacity underutilisation, either. A number of methods are devised in the literature to measure capacity utilisation rates. For example Basu (1996) used the variation in material inputs on the grounds that material inputs do not have variable utilisation rates as factor inputs. This approach is impractical for our purposes as it requires panel data that permits the estimation of variation in material inputs. Another estimate for capacity utilisation is based on the proportion of actual output against potential output. While this is a more appropriate measure of capacity utilisation rate, the industrial survey did not report the installed capacity or potential output levels either. Therefore, we estimated the potential output levels using capital-output ratios assuming that a lower capital-output ratio reflects a higher capacity utilisation. We categorised establishments according to their industry. Potential output for those with similar capital intensities have been estimated with reference to the lowest capital output ratio in the same group. One problem with this measure of capacity utilisation is that it may capture the effects of efficiency with which capital is used. However, this is likely to be the case if the firms operate closer to full capacity utilisation. In circumstances where most firms suffer from low capacity utilisation levels this measure is likely to be a good proxy.

Table 4 reveals the results by Ordinary Least Squares method of estimation. Four different regression equations are run. The first equation reflects the original Verdoorn approach. In this, the coefficient on cumulative output is quite large and highly significant with the expected positive sign. However, the coefficient of determination (R^2) is very low indicating that if cumulative output is capturing the effects of economies scale or learning by doing it only does so for a limited extent. A good proportion of labour productivity remains unexplained by the original Verdoorn Equation.

Equation 2 includes capital stock per worker to test for the contribution of capital stock and embedded technology to labour productivity. The results show that this variable has quite a large and statistically significant influence on the labour productivity. Its inclusion improves the explanatory power of the equation for labour productivity as reflected by the increased R-squared. The size of the coefficient of output has gone down as one might expect. This is likely to reflect that in the previous equation it partially captured the influence of capital stock per worker.

Equation 3 includes the variable that measures the extent of the unskilled labour used in production. Inclusion of this variable substantially improves the size of the coefficient of determination and the explanatory power of the regression equation. Improving the labour quality by ten per cent through enhancement of skills would increase the labour productivity by seven per cent.

Table 4. Estimated parameters of labour productivity in Sudan

Independent Variable: *Value added per worker*		Verdoorn's productivity functions		
		Equation 1	Equation 2	Equation 3
Coefficients on regressors				
C	*Intercept*	3.77	6.94	3.81
		(4.97)	(9.93)	(3.58)
q	*Cumulative output*	0.50	0.10	0.07
		(4.20)	(1.58)	(1.18)
k	*Capital-labour ratio*		0.39	0.49
			(8.71)	(9.94)
us	*Use of unskilled labour*		-0.73	-0.65
			(-9.51)	(-8.85)
u	*Capacity utilisation rate*			0.55
				(3.71)
	R^2	0.21	0.77	0.81
Diagnostic test statistics				
	Hausman spefication test (t-statistics on residuals)	-	1.58	0.83
	Heteroskedasticity (1)	0.76	0.67	0.87
	p- value, Jarque-Bera (2)	0.34	0.62	0.77
	Eigenvalues condition no. (3)	-	2.57	4.4

(1) Breusch-Pagan-Godfrey statistics for heteroskedasticity. X^2 critical values at 95% significance are 3.84 for df. 1 and 5.99 for df. 2.

(2) Jarque Berra normality test statistics. Figures in brackets are X^2critical values at 95% significance.

(3) This is estimated as the ratio of maximum to minimum Eigenvalue. The statistic is used to test for multicollinearity. If between 100-1000 it reflects moderate multicollinearity amongst the regressors.

The inclusion of the capacity utilisation rates in the final equation further improves the overall explanatory power of the equation and reduces the size of the Verdoorn coefficient. The new variable has a positive and statistically significant impact on labour productivity. A ten per cent rise in capacity utilisation rate increases labour productivity by 3.3 per cent. The most striking result is that controlling for the effects of capacity utilisation increases the contribution of capital stock per worker by around 50 per cent from 0.37 to 0.56. Summing up the direct affect of capacity utilisation on labour productivity with its indirect affect exerted through capital stock we obtain 5.2 per cent improvement in labour productivity for every ten per cent improvement in the capacity utilisation rates. This is quite a significant result and comparable to the contribution of capital stock or skills alone.

Going back to Table 2, it was reported earlier that the manufacturing value added per worker was 5351 US$ per annum in Sudan and 9283 US$ in China. If the parameters in equation four are considered, Sudan has to achieve a 50 per cent simultaneous improvement in the availability of capital stock per worker, in its

skill base and capacity utilisation rates in order to catch up with labour productivity levels in China.

While these results confirm our earlier analysis, there may be some biases in our estimations. One problem with the Verdoorn Law is the possibility of simultaneity bias known as the identification problem. That is, the possibility that output level is determined by labour productivity not vice versa. This issue has been pointed out very often in the literature (Rowthorn 1979, Michl 1985, Jefforson 1988). Indeed, regressing output on labour productivity produces a statistically significant positive coefficient (albeit with low coefficient of determination), signalling a cause for concern. Therefore, we applied the Hausman procedure to test for simultaneity problem that confirmed the existence of this problem in Equation 2. However, this problem disappears in Equations 3 and 4 as the t-statistics on residuals turns insignificant.

The diagnostic test statistics show that all four equations are well-behaving functions. Statistically, cross sectional data are known to be prone to heteroscedasticity. We used Bresuch-Pagan-Godfrey method to test for unequal variance in the error terms. The test statistics show that the disturbances of all four equations are homoscedastic. The diagnostic test results do not reveal any violation of the normality assumption either.

A further problem in our estimations could be the presence of multicollinearity, that is, there may be a linear correlation amongst some or all of the regressors included in each equation. We estimated Eigenvalues for each equation and the results show that we can safely reject the null hypothesis that there exists multicollinearity amongst the regressors.

5. Conclusions

The discussion and results in this paper reveal two important issues. Labour costs are not particularly high in Sudan even in comparison with low-wage Asian economies such as India. Hence, it is unlikely that they explain the lack of manufacturing competitiveness in Africa as argued by some scholars. The real problem in Sudan is very low levels of productivity in the manufacturing sector.

Our regression estimations of labour productivity underline several crucial issues. Firstly, the estimates confirm the validity of our argument that capacity utilisation is an important channel through which labour productivity levels are determined. According to our estimates 10 per cent rise in the level of capacity utilisation rate leads to a 5.2 per cent increase in labour productivity through its direct and indirect effects. This suggests that unless factors that cripple capacity utilisation rates are tackled in Sudan the development of the sector will remain a far-fetched dream. Remedies to acute underutilisation problem can improve the competitiveness of Sudanese manufacturing sector significantly.

Secondly and unsurprisingly the parameter for the skills variable has the biggest size in comparison to other parameters. This suggests that improving the skills of the labour force would have considerable positive impact on labour productivity.

Finally, labour productivity in Sudanese manufacturing is positively related to the amount of capital stock available to each worker. While this reinforces the proposition that enhancement of labour productivity requires an appropriate

capital-labour mix the implications of this finding should be explored by further research. For example, the dilemma for Sudan, as for some other countries in Africa, is that it is neither a labour-surplus nor a capital-abundant economy. Is there any conflict between the predominance of micro and small enterprises in the manufacturing sector and the absence of 'unlimited labour supply' as indicated by the land-population ratio? Is there a need for greater economies of scale in manufacturing? The success of sectors with large scale units –most notably the sugar industry– provides some, but not conclusive, evidence.

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