DEMAND AND SUPPLY OF PAPER IN KENYA: AN ECONOMETRIC ANALYSIS 1976-1985

By

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ABSTRACT

This paper uses quarterly data to model the supply and demand for paper in Kenya. Price and the cost of production of paper are insignificant. Population is a significant determinants of demand. Installed capacity is important determinants of local supply of paper.

Machine breakdowns, shortage of skilled workers, wastepaper, and water cause some idle capacity in paper-making in Kenya. After 1980, water shortages accounted for 50% of the downtime at Highland Paper Mill. Wastepaper recyclers pay import tariffs while PPM is exempted. The wastepaper recyclers, therefore, find it expensive to import spare parts. This hampers recyclers from importing enough spare parts.

Kenya should synchronize the development of forests and forest based-industries. Finally, paper-makers should try to use other fibres (e.g., rice- and wheat-straws, and bagasse). Private organizations and the public should recover more wastepaper.

CHAPTER 1

INTRODUCTION

Paper helps a society develop by enhancing trade and communication. So, it is desirable for countries to be self-sufficient in paper. Paper-making uses 66% of the world's annual output of industrial wood; it creates employment in forestry, paper-making and paper-converting, trade and distribution (FAO 1986).

Kenya started paper-making in 1957. This industry supplies 80% of Kenya's requirement for paper and paperboard. To many paper-convertors, however, local paper costs more than imported ones. Due to high domestic demand for paper, Kenya exports only 2% of its total paper output. The government lacks a decisive policy for the development of paper-making. For example, in 1985, amid conflicting reports, the government stopped a KSh 1 billion paper mill project initiated by Madhupaper International.

This study models the supply and demand for paper in Kenya to project future requirements for paper and the derivative demand for pulpwood. Also, the study examines

current use of capacity to make paper and suggests solutions to some of the industries' problems.

The Problem

In many industries (e.g., printing, publishing, packaging, distribution, hotel, banking, and insurance), paper usually has a small share of cost. However, paper is indispensable to efficient running of these industries (Colon 1978; FAO 1977; Daily Nation 14/5/88: 24). In some countries, per capita paper consumption shows development (FAO 1986: UNIDO 1980). In the United States, for instance, the per capita paper consumption is 200 kg; in Africa it is 30 kg. By FAO's standards, to achieve minimal literacy and communication a country should use at least 40 kg of paper per capita (Pirconell 1983: 3). In Kenya, paper consumption is 7 kg per capita (Pulp and Paper International 1986: 45). Kenyans cannot consume 40 kg of paper per capita unless they make more paper locally. By making more paper, Kenyans can also benefit from economic linkages in paper-making (FAO 1977: 285; Sutcliffe: 41, 51 and 211-212). In Kenya, direct domestic forward and backward linkages in Kenya's paper-making and printing industries are 0.895 and 0.492 (Kenya Govt. 1979).

Demand for paper increases as an economy grows (FAO 1977). For instance, Kenya consumed 25,000t of paper in

1963, 70,000t in 1974 and 122,000t in 1987.[1] Since 1981, total paper exports declined as local demand increased. Kenya exported 19,736t of paper in 1980 and only 457t in 1986. Our problem is to answer the questions: What determines the supply and demand for paper in kenya? Which of these determinants are significant? How can we boost the supply of paper to meet the increasing demand?

Aims of the Study

This study:

- estimates a demand-supply model for paper in Kenya;
- computes the responsiveness of demand and supply to changes in significant variables;
- finds out current usage of capacity in paper manufacturing; and
- suggests policies pertinent to paper-making in Kenya.

Significance of the Study

By knowing the determinants of demand and supply of paper in Kenya, government and entrepreneurs can streamline paper and paper-based industries by eradicating supply/demand gaps. The government requires a long-term development plan for forestry and forest-based industries (Kenya Govt.1984: 190). This study generates information that will help businessmen and the government to make better policies for the development of the paper and paper-based industries.

Outline of the Other Chapters

Chapter 2 reviews literature on paper-making. The chapter examines global paper-making capacity, output, consumption, and trade in 1984. It also reviews studies on demand and supply of paper. Chapter 3 describes paper-making in Kenya: its history, ownership, installed and used capacity, employment, import substitution, exports and the industry's problems. Chapter 4 presents methodology and empirical results. Chapter 5 presents conclusions and recommendations.

CHAPTER 2

PAPER-MAKING: A GENERAL AND EMPIRICAL LITERATURE REVIEW

This chapter reviews general and empirical literature about paper-making in Kenya and in the world. It traces the history of paper-making and describes paper-making including different raw materials and papers. The chapter also examines the use of the world's installed paper production capacity but does not review literature on paper-making technology. Finally, the chapter reviews some studies on demand and supply of paper.

The History of Paper-Making

Use of paper arose from man's desire to communicate. Before the invention of paper, people communicated mainly by speech and art (Hunter 1978: 3). In 105 A.D., Tsai Lun invented paper in China (BPBMA 1950; Clapperton 1952; Hunter 1978). In a mortar containing water, he beat fibre from hemp, rags, ropes, fishing nets and other domestic articles. He spread the pulp on a loosely woven cloth to drain the water and leave a web of fibres. When partly dry, the web dries fully in the air when peeled off the cloth (Clapperton 1952: 1).

imprisoning chinese paper makers. The art spread to Baghdad, Japan, Egypt, Morocco, and Spain during the 12th century (Clapperton 1952: 2). The Japanese improved the art and they still produce the best hand-made papers (Barret 1983). From Spain, paper-making rapidly spread to France, Holland, Germany and the rest of Europe. The growth of printing in Europe and recurrent friction within the handmade-paper makers' guilds motivated Nicholas Robert to make the first paper-making machine in the early 19th century (Hunter 1978: 341). The Foundrinier brothers modified Robert's machine to make more paper. Foundrinier's paper-making machines incorporating modern technology are still common (Hunter 1978: 349).

Paper-Making

Paper is made mainly from wood fibres. Each fibre consists of fibrils of complex cellulose. Conventional paper making depends on the ability of the cellulose fibres to swell and separate from each other when immersed in water, and to adhere together when dried. Each fibre is like a self-adhesive building block. Water rearranges these fibres into a required shape moving freely in a shallow pond called stock. Paper-makers add dyes and chemicals to this stock to ready it for drying. By pouring the fibre suspension onto a moving sieved-belt, water drains leaving a mat of fibres. This mat shifts onto huge steam-heated rollers to be dried

and pressed before rolling out as paper.

Materials for Making Paper

Fibres

Softwood and hardwood trees are the usual sources of fibre. Another source is esparto, a grass grown in Spain and in North Africa. Esparto's fibre is short and weak but as an additive, it yields a close texture, softness and opacity. Other sources of fibre are: bagasse, bamboo, rags, cotton, flax, linen, wheat and rice straws, and hemp. Some make high-class papers, e.g., bank notes and legal papers. Some paper-makers add synthetic fibres (e.g., nylon, glass) to specialty papers (McGill 1980: 3).

Non-fibrous material

Paper-makers add soluble and insoluble non-fibrous materials (e.g., size, alum, starch, mineral fillers and dyes) either in batches or continuously. Size reduces the ability of paper to absorb ink. When dissolved in the stock, rosin--the most common sizing material--precipitates finely on the fibres. To strengthen the paper, starch is added when the paper is fully or partly dry. Alum, also used when the paper is partly or fully dry, precipitates size to fix colours and reduce form. Alum can also be added in the stock (McGill 1980: 4). Mineral fillers or "loadings", e.g., china clay, titanium dioxide and calcium carbonate, are usually

meted out in a fluid. They achieve greater opacity and an even appearance. Loadings increase the paper's weight without strengthening it. Since most dyes are soluble, those used must have a strong affinity for fibres to avoid loss in the drainage (McGill 1980: 4).

Pulps

Paper can be made from two pulps: mechanical (ground wood) or chemical. To make mechanical pulp, forks press logs against a grinding stone as water jets onto the stone to remove pulp. This pulp is stored in silos or taken directly to the pulpers to make paper. Many paper-makers prefer mechanical to chemical pulp because of its cheapness and high yield (95% of the barked wood). Sunlight, however, quickly turns mechanical pulp yellow because of lignin in the pulp (BPBMA 1950: 72). To produce chemical pulp, chipped wood is chemically "cooked" to remove lignin. Chemical pulp is expensive because the chemicals used to cook the chipped wood are costly (BPBMA 1950: 76).

Papers

Paper-makers usually classify paper by weight (grammes) per square metre (gsm). Paperboard weighs at least 180 gsm (Highman 1970: 81). Newsprint weighs 40-57 gsm. It is neither coated nor sized and usually consists of at least 65% mechanical pulp (FAO 1983: Annex 1: 4). Printing and writing

papers--sometimes coated--can be made from either chemical or bleached mechanical pulp. Offset printing paper weighing 60 gsm is a popular grade. Other printing papers are used for computers, duplicating bank notes, labels, envelopes, calculators, books and magazines, photography and lithographing. Printing papers must be opaque and thick but not too heavy for books. Wrappers (e.g., machine finished (MF) kraft liner, unbleached bag kraft, multi-wall natural sack kraft, bleached kraft, linerboard and flutting medium) are made from unbleached mechanical pulp, wastepaper, or both (BPBMA 1950: 32).

Household and sanitary papers (e.g., tissues, napkins, sanitary wads, towels, and wipers) are made from bleached pulp. These papers should be strong so as not to disintegrate while being used (FAO 1983: Annex 1: 5). Specialty papers are for specific uses e.g., maps and securities. Many commercial packers line packing cases with bituminen laminated paper to protect goods from bad weather (BPBMA 1950: 34).

World Pulp and Paper Industry

Global paper-making capacity in 1984 was 219.7 million tonnes but only 86% was used.[2] On average, less developed countries (LDCs) used 75% of their capacity; Africa used just 32% (FAO 1983 and 1986). In 1984, the developed countries

32% (FAO 1983 and 1986). In 1984, the developed countries produced 80% of the global paper and paperboard output of 187.7 million tonnes; LDCs produced 8.8%; (Africa, 0.002%). That year, the developed countries consumed 144.4 millions tonnes of paper; the LDCs consumed 21.3 million tonnes or 31% more than their output. Africa consumed 0.48 million tonnes or 25% more than its output.

Using the 1984 global output and consumption data, FAO (1986) projected a global output of paper and paperboard of 303.9 million tonnes in the year 2000. LDCs will make 9.4% of this while their demand will be 49.4 million tonnes. Africa will make 0.7 million tonnes and consume 1.9 million tonnes. Out of thirteen African countries producing paper, Kenya ranked third producing 60,000t in 1984. Only Morocco (93,000t) and Algeria (77,000t) produced more. Zimbabwe was fourth with 54,000t.

In 1984, total global trade in pulp and paper valued US$ 30 billion or 1.5% of the value of total global exports of goods that year. This trade included 39 million tonnes of paper and paperboard, 21 million tonnes of pulp and 4 million tonnes of wastepaper (FAO 1986: 7). Five Nordic countries including Norway and Sweden exported 66% of the global pulp and paper. Brazil, Chile, China, and Colombia are also big exporters.

Total paper and paperboard trade increased from a million tonnes worth US$ 1.5 billion in 1954 to 39 million tonnes worth US$ 20 billion in 1984. That year, the world imported 21% of the paper and paperboard it consumed; in 1961, it imported 17%. In 1954, 66% of the total paper and paperboard traded globally was newsprint; in 1984, it was 33% (FAO 1986: 8). LDCs imported 60% of their total paper and paperboard in 1954 and only 25% in 1984. That year, they imported 10% of their printing and writing papers against 20% in 1960 (FAO 1986: 10).

Empirical Literature

Rai and Khatkar (1983) analysed demand and supply of forest products including paper in India. They estimated the demand and supply of paper using a transcendental production function. Nominal gross national product was the only explanatory variable in the demand function; nominal investment in forestry was the only independent variable in the supply function. Rai and Khatkar mis-specified their model by excluding price, a variable usually included in demand-supply models. They offered no empirical reason for the exclusion. They also used nominal rather than real income and investment. Ignoring inflation can give erroneous results. The study simplistically assumed zero changes in inventories.

In a similar study, Viswanth and Lokesha (1983) used linear and exponential equations to project the demand and supply of eight forest products including paper in India. Nominal rather than real income determined the demand while the supply varied with time. Use of nominal rather real income is likely to give biased results because of inflation. Viswanth and Lokesha omitted price from their model by merely assuming inelastic demand and supply of forest products. In the supply function, Viswanth and Lokesha omitted the cost of producing paper. Theoretically, cost of production determines supply of a particular good or service.

FAO (1977) studied demand and supply of pulp and paper worldwide. Literacy, per capita income, and the real price of paper determined demand. In LDCs, consumption of printing and writing papers varied significantly with literacy. FAO used the average export price (i.e., f.o.b) as a proxy for the domestic price of paper in paper exporting countries; it used average import prices (i.e., c.i.f.) in the predominantly paper importing countries. F.o.b and c.i.f prices usually do not equal domestic prices. Usually, tariff and non-tariff barriers distorts domestic prices of tradable goods. FAO simply mentioned wood, fuels, labour and capital equipment as important determinants of supply of paper. FAO should have determined empirically the relative significance of these

variables. Data from such regressions can help governments and businessmen to make better policies for paper-making.

In another study, FAO (1986) estimated simultaneously the demand and supply of paper worldwide. In this study, price and gross fixed capital formation (GFCF) determined supply of paper. Time, price, and real income determined demand. FAO (1986) omitted the price of paper from the supply function arguing that the prices of pulp and paper are highly correlated. GFCF had a high positive correlation with the supply of paper. FAO (1986) also used average export price for paper as a proxy for the real price of paper in the predominantly paper-exporting countries; it used the average import price in the predominantly paper-importing countries.

Before excluding the real price of paper from the supply function, FAO (1986) should have shown empirically the collinearity between the prices of pulp and paper. Also, FAO did not correct for serial correlation in its data. Serial correlation can change signs and the magnitude of independent variables. It can also make significant variables insignificant. FAO wrongly assumed a direct causal relationship between GFCF and the supply of paper. A priori, GFCF will neither directly or immediately increase the supply of paper. GFCF has a long gestation. Moreover, GFCF is likely to increase the demand rather than the supply of

paper.

Pirconell (1983) and Keshwani (1983) argued that literacy and scarcity of foreign exchange motivates the LDCs to start manufacturing paper. Skarstein and Wangwe (1986) argued that failure to achieve regional specialization in East Africa stymies the operation of paper mills. Citing Tanzania's Southern Paper Mill, they show that if capacity increases from 30,000t to 100,000t per annum, investment cost per unit of capacity would drop by 48%; labour cost, by 43%. But poor infrastructure in Tanzania also hinders the establishment of big projects.

Literature Overview

Some studies omitted price from their models though it is usually important in demand-supply models. Other studies used nominal rather than real income, prices, and investment. Ignoring inflation can give biased results. All the studies ignored serial correlation inherent in time series. Some used variables that did not have direct or immediate casual relationship with the supply of paper, e.g., investment in forestry.

CHAPTER 3

PAPER-MAKING IN KENYA

Kenya's paper manufacturing industry has six mills: Kenya Paper Mills (KPM), Pan African Paper Mills (PPM), Madhupaper International (MPI), Highlands Paper Mill (HPM), Chandaria Industries Ltd (CIL), and Kenya Matches. Though these mills could produce 400t, they only produce 267t/d, just 80% of domestic demand for paper. Paper-making in Kenya started in 1957 when Lonrho set up KPM at Thika to recycle brown waste paper to make manila and machine-glazed imitation kraft paper. KPM produces 18t/d though it can make 25t/d. The rapid rise in paper imports in the late 60's motivated the government to produce paper locally (see Appendix Table 1.1). In 1972, the government and Birla group of India started PPM at Webuye to produce pulp and paper. PPM started commercial production late in 1974 with a capacity of 31,000t per annum. Now, PPM is expanding its capacity from 66,000t to 96,000t.

Orient Paper Mills, a subsidiary of the Birla Group, owns 29% of PPM and manages it for the other owners, i.e., the government (33.9%), International Finance Corporation (28.0%), Industrial Commercial and Development Corporation

and East African Development Bank (3.6%) each, and Development Finance Company of Kenya (1.6%) (PPM 1977). By 1982, PPM was the largest mill in Africa, highly profitable and with modern technology. In only five years, Orient Paper Mills had earned dividends of Rs 11 million on an equity of Rs 41 million; it created additional exports from India of Rs 57 million (Lall 1982: 145-147)

Wastepaper Recycling Factories

In 1977, some local entrepreneurs started MPI in Nairobi to recycle wastepaper to make wrappers, toilet tissues, and exercise book covers. During 1984, MPI produced newsprint using imported and local pulp but stopped because of competition from PPM. MPI's annual output is about 10,000t per annum. That year, the government, Development Finance Company of Kenya, and International Finance set up a wheat-straw based mill (HPM) in Eldoret. The government owns 48%. Construction of HPM was delayed for two and half years causing a cost-overrun of Ksh 2,250,000 or 40% of the initial cost (Commonwealth Secretariat 1986: 1). HPM made paperboard but it could not compete against high-quality imports. To better its boards, HPM resorted to using brown wastepaper instead of wheat-straws. HPM uses only a third of its productive capacity of 6t/d. It operates only one eight-hour shift instead of three shifts per a day. Old machinery and scarcity of funds hinders better use of capacity at HPM.

In 1985, CIL, the oldest paper convertor in Kenya, started a wastepaper recycling plant in Ruaraka, Nairobi to make machine glazed (mg) imitation kraft, toilet tissues, napkins, and hand towels. Though CIL's rated capacity is 6t/d, it produces 9t/d. CIL gets the additional output by specialization, better use of capacity, and reduction of down-time. In 1986, CIL produced 7.2t/d.[3] Frequent plant maintenance and sound spare parts management reduces machine down-time thereby increasing output by 20-25%. Stand-by electricity and water supply reduces down-time when normal supply is interrupted. Specialization increases output by 5-10% by reducing the change-over time. The above three stages can be done in other plants over two to three years to yield 50% more output. Other local paper mills can increase their output by at least 50% if they used the above three steps as CIL has done.

In 1987, Kenya Matches (KM) started a wastepaper recycling plant to make imitation kraft paper. KM produces 11t/d though it could produce 30t/d. Shortage of skilled workers, wastepaper, and spare parts causes underusage of capacity. KM "poached" its production manager from Madhupaper. He trained employees to repair and maintain KM's plant.[4]

Early in 1985, MPI started another mill at Thika. Though the government had approved this mill, it stopped it for lack of sufficient wood. The government was also unwilling to exempt MPI from paying tariffs and sales taxes on imported machinery (Daily Nation 21/11/85: 1 and 28). But the mill would have used thinnings, not clear-felled trees, from Mount Kenya forests. Moreover, the mill was going to recycle wastepaper. MPI later requested to convert those taxes into a loan. The government still refused. Many people believed that stoppage of this project was politically motivated.[5] Yet, it would have created directly 800 jobs, paid the government KSh 1.3 billion, saved Ksh 2.8 billion in foreign exchange over ten years, and earned Ksh 860 million from exports (The Standard, 8/11/85: 31).

Kenya recovers 29% of its total paper and paperboard consumed in a year (Pulp and Paper International 1986: 52). In 1974, OECD countries recovered 45% of their total paper and paperboard consumed in a year (OECD 1976).

Wastepaper Supply in Kenya

Sources of wastepaper in Kenya are: printers, paper-convertors, offices, institutions (e.g., schools) and households. Wastepaper is divided into assorted (mostly from the offices), and brown (mostly from the convertors). Flow-chart 3.1 describes the wastepaper supply system in Kenya.

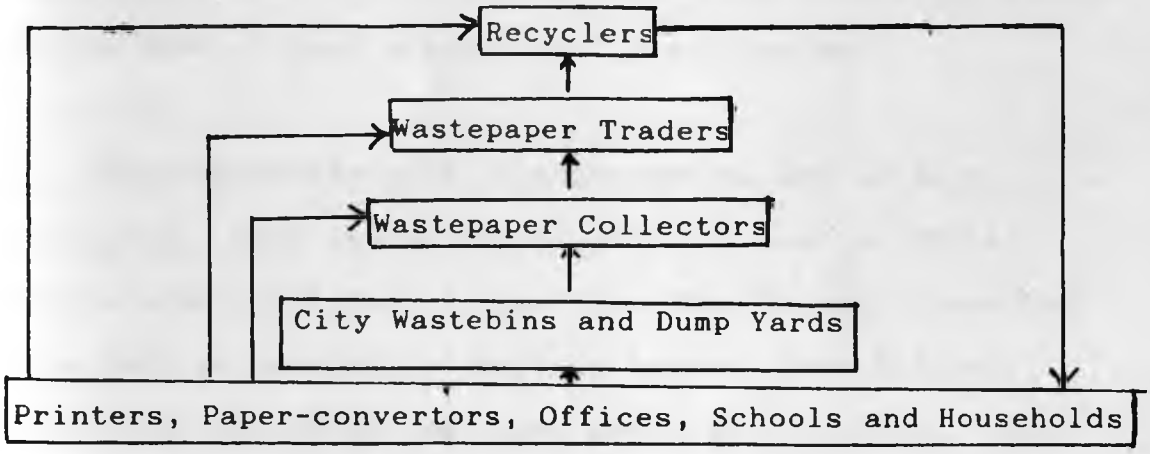
After buying wastepaper from collectors, the traders must remove visible contraries e.g., stones, metals, and laminated papers. They also separate brown and assorted papers and take them to the mills in bales. The traders profit more than the collectors; their price mark-up is 60-125% (see Table 3). Motivated by the need for a reliable supply of wastepaper and a market for their papers, some recyclers contract paper convertors to sell wastepaper to them.

Table 3. Wastepaper Traders' Buying and Selling Prices (Ksh)

Grade	Buying (1)	Selling (2)	Mark-up (2-1/1)
Brown	0.60-0.70	1.00-1.20	66-71%
Assorted	0.80-1.20	1.80-2.00	66-125%

Source: Muraya, M. A. and Gathiaka, J. K. (1987) "Wastepaper Recycling in Kenya". Unpublished Class Report for Economic Policy, Economics Department, University of Nairobi.

Chart 3.1. Wastepaper Supply System in Kenya



Supply of Pulpwood and Other Inputs

The major pulpwoods in Kenya are: pine, cypress and eucalyptus. These trees come from designated government plantations in Kakamega, Uasin Gishu, Bungoma, Kitale and Kericho. To ensure a sustainable supply of pulpwood, the government plants 5,000 ha. of trees in these zones every year. Sometimes lack of funds hinders this afforestation programme. In some years, e.g., 1980 and 1984 drought kills many trees especially in low potential zones. In these zones, the survival rate for new trees is as low as 40%.

Though Kenya has enough pulpwood, the current policy for planting more indigenous than industrial trees can reduce future supply of pulpwood and other industrial trees. In only ten years, PPM had doubled its consumption for pulpwood (see appendix table 1.2). Other uses for forest land (e.g.,

the Nyayo Tea Zones) might also reduce the supply of industrial wood. The Nyayo tea zones now occupy one eighth of the total forest acreage of 1.7 million ha.

Many chemicals used in paper-making are locally available. Alum and sulphuric acid are made at Thika; chlorine and bleaching liquor come from Magadi; limestone, from Mombasa; starch and bailing boards, from Eldoret. Waterproof packaging gum tapes are made in Nairobi. Many dyes are, however, imported.

Contributions of Kenya's Paper-Making

Paper, printing and allied industries employ 4% of all labourers in manufacturing. On average, for each job in paper manufacturing, three exist in the printing, publishing and allied industries (see Appendix Table 1.3). After 1980, increasing domestic demand caused paper exports to decline rapidly. In 1970, Kenya exported 13.7t; in 1980, 19,736t; and in 1986, 457t (see Appendix Table 1.4). In 1975, paper imports were half that of 1974. A worldwide paper shortage combined with PPM's paper output caused the reduction (FAO 1977: 281). This saved Kenya much foreign exchange.

Although Kenya's paper-making meets 80% of its requirements for paper, consumers pay high prices. The Kenya Printing and Converting Association reckons that the prices

of locally produced papers are, on average, 160% that of imports. For instance, in 1983, MPI bought bleached mechanical pulp from PPM at Ksh. 9,000 per ton while the c.i.f. price was only Ksh. 3,240 (see appendix table 1.5). That year, PPM's domestic resource cost ratio for saving foreign exchange equalled six, indicating high inefficiency in resource use (Gray 1983).

Problems and Prospects of Paper-Making in Kenya

Small paper-recycling mills pay high import tariffs while the PPM does not. This discriminatory tariff policy makes it difficult for recycling mills to import spare parts and modern technology. Giving PPM such tariff concessions strengthens its monopoly and ability to charge high prices.

In 1983, when the government refused to increase the price of PPM's paper, PPM threatened to:

- declare no dividends that year;
- shut the mill due to apparent cash problems and machine breakdowns; and
- urge printers and paper convertors to import paper.[6]

After this, the government increased the price of paper a few months later. All these concessions should make PPM highly profitable. But PPM paid no income tax between 1975 and 1986.[7]

Paper manufacturing requires highly trained technical staff (FAO 1986: 10). Only PPM has such a staff. Other mills train their employees on the job. This training is expensive since trainees can mishandle sophisticated machinery. CIL, for instance, does not allow its trainees to work on complicated machinery before training for at least two years. Four expatriates work at CIL. Their total pay equals that of 40 local trainees.[8] Since Kenya does not train technical personnel for paper-making, some mills "poach" trained staff from others. For instance, production managers at MPI, KM and HPM initially worked for PPM. HPM sometimes sends its employees to train at PPM.

Though paper-making is water intensive, most mills have enough water. In HPM, however, water shortages cause most of the downtime. This problem is not unique to HPM. Eldoret lacks water even for other industries. Shortages of wastepaper and interruptions of electric power supply also cause downtime at HPM. The high cost of oil increases the cost of producing paper thereby raising its price to the consumers.

PPM and CIL are expanding their capacities. PPM will increase its capacity from 66,000t to 96,000t per annum creating directly 300 jobs.[9] CIL is building another mill at Sagana to recycle wastepaper and rice- and wheat-straws to

make unbleached kraft paper. Later, this mill will also make printing and writing papers. When fully operational, this mill will produce 100t/d and employ 500 people directly (see Daily Nation 27/5/88: 1 and 6). MPI is on sale after being under receivership for two and half years. The three other mills aim to enhance their capacity utilization.

CHAPTER 4

METHODOLOGY AND DATA ANALYSIS

This chapter defines the variables the study used to analyse the supply and demand for paper in Kenya. It shows, for instance, the derivation of quarterly population- and gross-domestic-product. The chapter also presents the regression model, its results, and the mills' responses about capacity utilization. I interviewed all the six paper mills in the paper-making industry (see the questionnaire at the appendix).

Variables

Q_{ij} = the total supply of paper by the six local paper mill during the j^{th} quarter of the i^{th} year from the first quarter of 1976 to the end of 1985.

X_{ij} = paper exports in the j^{th} quarter of the i^{th} year.

M_{ij} = paper imports in the j^{th} quarter of the i^{th} year.

D_{ij} = aggregate quarterly demand for paper equalling $Q_{ij} + M_{ij} - X_{ij}$.

S_{ij} = aggregate quarterly supply of paper which equals D_{ij}.

POP_{ij} = population in the j^{th} quarter of the i^{th} year. Due to lack of quarterly population data, I converted the annual data using an exponential growth function. I

assumed a population growth rate of 4% per annum. $Pop_t = (POP_{t-1})e^{rt}$ where, POP_t = population at time t; POP_{t-1} = population in the previous quarter; e = the natural logarithm; r = annual population growth rate; and t = time in months e.g., in the first quarter, t = 3/12 = .25 and in the fourth quarter, t = 12/12 = 1.

CAP = total installed capacity between 1976 and 1985 for each quarter.

FX = a dummy to indicate foreign-exchange constraint. I computed a running average for three quarters foreign exchange-reserves in 1976 and got KSh 1502.4 million. I defined this average as the minimum foreign exchange reserves the government should maintain to be able to pay for any quarter's total imports. Therefore, any quarter with less KSh 1502.4 million of foreign exchange showed a foreign exchange constraint and took a value of 1. Quarters with foreign exchange more than KSh 1502.4 million took a value of 0 to show no constrain.

CPI = the consumer price index for the middle income group in Nairobi. A consumer price index for the entire population would have been better but it does not exist. A consumer price index for the middle-income

earners of Nairobi covers a fraction of Kenya's population. Moreover, the government excludes the cost of newspapers, books and stationary while computing CPI.

P_{ij} = real price of paper (i.e., nominal price of paper deflated by the consumer price index for the middle income group in Nairobi). P_{ij} is the weighted average of prices for printing and writing papers, newsprint, and packaging and wrapping papers. The weights were calculated from the tonnage in each group:

		weights
Newsprint	12,289t/122,893t	= 0.10
Printing and writing	46,607t/122,893t	= 0.33
Packaging and wrapping	31,952t/122,893t	= 0.26
Total		= 0.74

Prices of printing and writing, and packaging and wrapping papers are averages of the different grades in each of these categories.

RC_{ij} = weighted nominal cost of producing a tonne of paper deflated by the implicit GDP deflator. RCij is weighted by the share of each mills' output to total output.

$Prof_{ij}$ = P_{ij}/RC_{ij}, a proxy for the profitability of making paper.

GDP_{ij} = real gross domestic product in the j^{th} quarter of the i^{th} year. Since no annual GDP data exists, I used business expected enquiry (BEE) data to break annual GDP into quarters: GDP_{ij} = (BEE_{ij}/sum of BEE_{ij}) * (GDP for year i).

y_{ij} = GDP_{ij}/POP_{ij} = per capita income.

q_i = quarterly adjustment dummies with the 4th quarter as the base. So, i = (1, 2, and 3).

The Model

The study uses a demand-supply framework (Koutsoyiannis 1976 and Lawler 1986). The model for the Kenyan paper industry has simultaneous equations with supply equaling demand. The model posits exports and imports as residuals, zero inventory changes, and a competitive market. Symbolically, the model is:

$$D_{ij} = f(P_{ij}, GDP_{ij}, POP_{ij}, q_1, q_2, q_3) \quad ..(1)$$
$$(-) \quad (+) \quad (+) \quad (?) \quad (?) \quad (?)$$

$$Q_{ij} = f(P_{ij}, RC_{ij}, CAP, FX) \quad ..(2)$$
$$(+) \quad (-) \quad (+) \quad (-)$$

$$S_{ij} = Q_{ij} + X_{ij} - M_{ij} \quad ..(3)$$

$$D_{ij} = S_{ij} \quad ..(4)$$

Signs below the arguments show the hypothesized relationships between dependent and independent variables. Quarterly adjustment dummies can be positive or negative. Our model differs from FAO's (1986). FAO excluded population from the demand function and used f.o.b. or c.i.f. prices as a proxy for the price of paper; I used the real domestic price of paper. FAO (1986) used annual data; this study uses quarterly data.

Estimation Procedure

A simultaneous equation model must fulfill rank and order conditions for identification to be estimatable (Pinddyck and Rubinfeld 1976: 132-145). A model can be under-, just-, or over-identified. Only just- and over-identified models can be estimated. Under-identified models

cannot be estimated because of their statistical ambiguity (Koutsoyiannis 1984: 351). Indirect least squares (ILS) or the reduced-form method yields better results for just-identified models. The ILS method applies to one equation at a time. However, it yields ambiguous coefficients in over-identified models (Koutsoyiannis 1984: 373).

Two stage least squares (TSLS) yields unique coefficients in over-identified models. TSLS also eliminates the simultaneous bias caused when endogenous variables are the explanatory variables in an equation (Koutsoyiannis 1984: 384). Since our model was over-identified (see Appendix 4), I estimated it by tsls. This study tried both linear and log-linear regressions to fit the data best. The study corrected serial correlation by the Cochrane-Orcutt procedure (Pinddyck and Rubinfeld 1976: 111).

Regression Results

Demand function

Several equations were tried and rejected. The first regression described aggregate demand for paper as:

$$(1) \quad \text{LogD} = -36.3 + 4.85\text{LogP} + 1.41\text{LogPOP} + 3.89\text{LogGDP}$$
$$(-2.62) \quad (2.58) \quad (0.81) \quad (2.17)$$

$$- 0.098q_1 - 0.23q_2 - 0.33q_3$$
$$(-0.89) \quad (-2.12) \quad (-3.14)$$

$R^2 = 0.23$, SER = 0.214, DW = 1.34, AR = 1, n =38

The t-statistics are in parentheses.

Income is significant and positively related to the demand for paper. This result tallies with our expectations. Though not significant, population is also positively related to demand for paper. Autonomous demand for paper is significantly negative. All the quarterly adjustment dummies except q_1 are significantly negative. The demand for paper is cyclic, moving in consonant with the tempo of the economic activities in a year.

Equation 1, however, does not well represent the demand for paper in Kenya. The coefficient of determination of this equation indicates that the independent variables explain only 23% of the variations in aggregate demand for paper. This is too low.

The Durbin-Watson statistic indicates serious positive serial correlation for the explanatory variables. Population is a likely cause for the serial correlation in equation 1. In computing the quarterly population data, I used a population growth rate of 4% for all the years. Since population in the current quarter determined the population in the next quarter, the estimation errors in all the quarters are correlated to one another. The annual population data used to get quarterly population data is also a possible cause for the serial correlation in equation 1. This data is prone to computational error.

Equation 1 also fails to explain the demand for paper because the coefficient for the price of paper is significantly positive. This contravenes the law of demand. Control of the price of paper may be a cause for the positive relationship between the price and demand for paper. The controlled price may not reflect the market well.

The next demand equation, omitted population and q_1 since they were insignificant:

$$\text{(2)}\quad \underset{\quad(-3.07)}{\text{LogD} = -39.18} + \underset{\quad(2.89)}{5.08\text{LogP}} - \underset{\quad(-2.09)}{0.18q_2} - \underset{\quad(-3.13)}{0.28q_3} + \underset{\quad(3.85)}{4.85\text{LogGDP}}$$

$$R^2 = 0.29, \quad SER = 0.22, \quad DW = 1.6, \quad AR = 1, \quad n = 38$$

GDP is still significant and has the correct sign. The quarterly adjustment variables are also significant. However, the constant and the price coefficient are still perverse though significant. The Durbin-Watson statistic now shows less positive serial correlation. This result confirms suspicions that population caused serial correlation in equation 1. The R^2 improved, albeit slightly. Hence both equations 1 and 2 fit the demand function poorly.

To improve the results, I included time as an explanatory variable. In a preliminary regression, population and GDP were negatively related to demand. Due to this and their possible serial correlation with time, GDP and population were dropped:

$$(3) \quad \underset{}{\text{LogD}} = \underset{}{1.16} + \underset{(2.09)}{0.48}\text{LogP} + \underset{(2.22)}{0.35}\text{LogT} - \underset{(7.77)}{0.13}q_2 - \underset{(-3.08)}{0.23}q_3 - \underset{(-5.62)}{}$$

$R^2 = 0.85$, SER = 0.10, DW = 1.9, AR = 1, n = 38

Equation 3 is superior to equations 1 and 2. Autonomous demand is now positive and significant at 95%. The R^2 trebles and the Durbin-Watson statistic indicates no serial correlation. All the determinants are significant and have the right signs except price which is still positively

related to the demand for paper. This result can be interpreted to imply that demand for paper depends not on its price, but on the price for goods and services using paper. This supposition is likely to be true since paper is an intermediate input in virtually all economic and non-economic activities.

Since no price exists for all the goods and services using paper as an input, I chose the real wage index as a proxy for that price. This index measures consumers' ability to purchase goods and services. For example, if the index were falling, the prices of goods and services would be rising faster than nominal wages. So, the demand for paper should rise if the real wage index is rising and fall if it is falling.

The regression results of the demand equation with real wage index instead of price were, however, no better than when the price is included. The real wage index was negatively related to price contrary to what was expected. If real wages determined demand for paper, the relationship should have been positive.

Time improved significantly the results of equation 2 (see equation 3). However, time is amorphous and has no theoretical basis for explaining the demand for paper better

population would. So, in the next equation, time is excluded; only population and q_3 are included. GDP is omitted because of its high collinearity with the population.

(4) $$\text{LogD} = -0.90 + 1.41\text{LogPOP} - 0.19q_3$$
$$(-1.44)\ (6.41)\qquad (-3.73)$$

$R^2 = 0.61$, SER = 1.21, AR = 0, DW = 1.22, n = 38

Though the Durbin-Watson statistic indicates much serial correlation, equation 4 fits the demand function better than equations 1 to 3. Autonomous demand is negative, but insignificant. This can be ignored since population is significantly positive. The R^2 and the standard error of the regression are fairly strong showing that equation 4 explains much of the variation in the demand for paper in Kenya. Equation was corrected for serial correlation but the coefficients only changed marginally. For instance, the Durbin-Watson statistic was 1.25, R^2, 0.62, population, 1.46 and the autonomous demand, -1.04. I, therefore, chose equation 4 to represent the demand for paper in Kenya.

Production function

The production function analysed here is neither classical Cobb-Douglas or CES. It is only a log-linear expression relating domestic paper output to its determinants

e.g., price of paper, production cost and installed capacity. Unlike the demand equations, the best production equations were linear. Equation 5 presents the results of the first regression:

$$(5) \quad Q = 23.0 + 0.086CAP - 11.2PROF + 1.05q_1 + 0.45q_2$$
$$(8.12)(6.39) \quad (-5.19) \quad (1.85) \quad (0.72)$$

$$R^2 = 0.76, \quad SER = 1.31, \quad DW = 0.63, \quad n = 38$$

The autonomous output, installed capacity, and profitability are significant at 99%. q_2 is not significant though it has the correct sign. The Durbin-Watson statistic indicates serious positive serial correlation. Profitability of paper-making is negatively related to paper output. Possibly this is because the government controls the price of paper. By so doing, the cost of producing paper rises faster than its price. But despite this perverse relationship, paper output was increasing. This suggests that paper-makers have been making profits. It is possible that the cost of production used in this study is higher than the actual cost paper-makers incur to produce a tonne of paper. If so, paper-makers in Kenya might be practicing transfer pricing for imported inputs.

Equation 6 below corrects for serial correlation in equation 5. It also omits q_2 because it is insignificant.

$$(6) \quad Q = 22.2 + 0.07CAP - 10.04PROF + 1.08q_1$$
$$(10.07) \quad (4.89) \quad (-6.54) \quad (3.02)$$

$$R^2 = 0.84, \quad SER = 1.07, \quad DW = 1.2, \quad AR = 1, \quad n = 38$$

The Durbin-Watson statistic and the R^2 statistic increased it significantly. The other variables are still significant bu the profitability of paper-making is still negative.

Production of paper is negatively related to its real price and profitability of paper-making. This result apparently contradicts the economic theory of a firm. However, there might be an explanation for this. There is some evidence that PPM may practice transfer pricing (Hopcraft 1979). If so, the econometric results would still be consistent with economic theory.

With transfer pricing, reported costs are artificially inflated. The reported profitability per tonne could be declining while the actual profitability was increasing.[10] This may well have been the case since PPM was increasing it engineering efficiency i.e., using less pulp per tonne of output. The econometric results showed less output as

reported profitability declined. But paper-makers are motivated by the real profitability of production per tonne, not including the extra "costs" due to transfer pricing. Thus, supposing large transfer pricing, the econometric results may not really contradict economic theory if the real profitability had been increasing while reported profitability declined. Moreover, if real costs were declining faster than the real price of output, of course, one would expect the firm to want to increase production. Thus the negative correlation between output and the real price of output would not be surprising. Nevertheless, these are tentative, not definitive explanations.

For this our final equation for production did not include profitability:

(7) $Q = 8.92 + 0.12CAP + 0.45q_1$

$\quad\quad\quad (6.72)\ (0.01)\quad\ (0.69)$

$R^2 = 0.68,\ \ SER = 1.49,\ \ DW = 1.21,\ \ AR = 1,\ \ n = 38$

This equation was corrected for serial correlation.

Causes of Idle Capacity in Paper-Making

The industry had a capacity to produce 94,000t of paper yearly as of 1987. Its rate of capacity utilization has been very high e.g., 96% in 1984 and 90% in 1985. Nevertheless,

there are differences between plants in the industry. For instance, PPM uses virtually all its capacity whereas the paper recyclers use three-quarters of their capacity (see Appendix Table 2.2).

Demand and supply constraints sometimes cause idle capacity in industries. The paper-makers ranked the causes for idle capacity in their mills (see Table 4.1). In 67% of the mills, machine downtime is a major cause for idle time. Demand constraints rarely cause idle capacity in paper-making partly because the government prohibits importation of paper. In two paper recycling mills, shortage of wastepaper, skilled personnel, and infrastructural inputs is a serious problem.

PPM reported no problems. PPM, unlike other mills, imports its inputs and machinery duty-free. Though the domestic market for paper is protected from imports, PPM is the major beneficiary of this protection since it controls 80% of the local market for paper. Being a subsidiary of a rich multinational corporation--the Birla Group of India--PPM can effect innovations in paper-making better. Other local mills are constrained by lack of funds.

Table 4.1. Causes of Idle Capacity in Paper-Making in Kenya

Mill	Demand Constraints		Supply Constraints				
	Local Market	Imports	R.M.	MB/D.	Per.	Ind.S.	Others
PMM	4	4	4	4	4	4	0
MPI	2	4	3	2	3	3	2
KPM	3	4	4	2	3	3	3
HPM	2	4	2	2	2	2	2
KM	3	4	2	2	2	4	3
AIL	4	4	4	4	3	3	3
percent severe or very severe	33.3	0	33.3	66.7	33.3	16.7	33.3

Notes: 1 = very severe; 2 = severe; 3 = a small problem; 4 = not a problem; R.M = raw materials; MB/D = machine breakdowns; Per. = personnel; Ind.S = industrial inputs e.g., water, electricity, oil and other fuel; Others = other problems e.g., politics, foreign exchange, and strikes.

CHAPTER 5

CONCLUSIONS AND RECOMMENDATIONS

This study uses quarterly data to model and analyse the aggregate demand and supply of paper in Kenya. The study also examines the usage and causes of idleness of capacity in paper-making.

The real price of paper apparently does not influence either the demand or the supply of paper. So, the demand and supply of paper could be analysed independently ignoring the identification problem. Also, the demand for paper does not depend on real-wages. Though these results contravene the theory of demand, the study explains this.

The demand for paper derives from the demand for goods and services using paper. So, the demand for paper is inelastic with respect to its price. Also, since paper has no close substitute, consumers have no alternative but to use it whether or not their real wage is falling or increasing. This is why population is very significant in the demand function.

The price controller should determine the local price of paper on another basis e.g., import price parity. Or, at least before using PPM's costs, the price controller should always check for transfer pricing by comparing PPM's costs of inputs against other suppliers' prices.

The capacity installed in the paper industry determines the local production of paper. The capacity utilization rate in the industry is high (90%). This is a contrast to the low capacity utilization in many industries in Kenya. In some wastepaper recycling mills, however, the capacity utilization is low (33%). This is due to shortages of wastepaper, skilled personnel, and spare parts. Five paper mills in Kenya recycle wastepaper to make toilet and kraft paper. These mills produce 20% of total domestic supply of paper but they are capable of supplying more.

Wastepaper recyclers pay import tariffs while PPM is exempted. The government should exempt wastepaper recyclers from import tariffs to enable them to import spare parts and increase their capacity utilization.

Locally produced paper costs 60% to 125% more than the c.i.f. price of imported paper. PPM also uses local resources inefficiently. The government should expose PPM to domestic and foreign competition to improve its efficiency.

Endnotes

Computed from Annual Trade Reports and the 1986 total
nestic paper output data.

Practical maximum capacity is the annual output of paper,
perboard, or pulp produced when the mills operate with
equate labour, and raw materials and when the demand is
gh. No allowance is made for losses due to strikes,
nporary lack of power, etc, which decrease output but not
oductive capacity (FAO 1983: Annex 1: 1).

K.L. Joglecker, the production manager of Chandaria
dustries, explained these three stages.

Interview with A. Lalani of Kenya Matches, Kisumu, 24
rch 1988.

Interview with Dr F.N. Ngaru of Madhupaper International,
irobi, 16 March 1988.

Price control Division, Kenya Ministry of Finance.

See Kenya Gazette, Legal Notice No. 167 of 1972; and PPM
nual Report and Accounts since 1975.

Interview with K.L. Joglecker of Chandaria Industries, 25
rch 1988.

Interview with A. M. Gatimbu of Pan African Paper Mills
buye, 23 March 1988.

. If PPM's cost of production used by the price controller
determine the local price of paper is usually inflated by
ansfer pricing, the price controller's targeted profit for
per-makers would be exceeded.

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APPENDICES

Appendix 1

Appendix Table 1.1. Kenya's Paper Importation by Category 1963-1985 (tonnes).

Year	Total	Newsprint	Printing	Packaging	Others
1963	24,507	2,686(10.9)	5,623(22.9)	8,791(35.9)	7,407(30.2
1964	26,972	2,562(9.50)	6,135(22.7)	12,787(47.4)	5,488(20.2
1965	34,302	3,128(9.10)	6,203(10.1)	17,285(50.4)	7,686(22.4
1966	38,749	3,811(9.80)	6,970(17.9)	18,639(48.1)	9,329(24.1
1967	41,994	4,185(9.90)	6,834(16.3)	21,201(50.5)	9,079(23.0
1968	39,446	4,932(12.5)	7,159(18.1)	18,278(46.3)	9,079(23.0
1969	50,641	4,060(8.00)	10,101(19.9)	26,064(51.5)	10,413(20.5
1970	54,892	5,122(9.30)	8,594(15.7)	26,922(48.7)	14,457(26.3
1971	66,221	6,167(9.30)	12,687(19.2)	31,004(46.8)	16,363(24.6
1972	58,591	5,266(8.90)	11,151(19.0)	30,129(51.4)	12,005(20.6
1973	70,055	6,025(8.60)	12,648(18.1)	31,800(45.4)	19,582(27.9
1974	78,682	5,536(7.00)	15,897(20.2)	37,081(47.1)	20,168(35.6
1975	35,748	4,207(11.8)	3,259(9.1)	19,033(53.2)	9,197(35.7
1976	20,577	4,178(20.3)	1,582(7.7)	2,519(12.2)	12,298(59.8
1977	26,479	4,777(18.0)	1,958(7.4)	5,216(19.7)	14,528(54.9
1978	27,707	5,846(21.1)	1,618(5.8)	2,313(8.30)	17,930(64.7
1979	39,640	8,409(21.2)	2,048(5.1)	54(0.14)	29,129(73.5
1980	33,640	7,891(23.2)	1,886(5.5)	28(0.08)	22,626(66.6
1981	33,988	7,802(24.1)	1,082(3.3)	55(0.17)	22,560(75.7
1982	32,348	2,610(12.5)	1,439(6.9)	145(0.70)	15,849(75.7
1983	20,949	926(7.7)	1,367(10.4)	4(0.03)	10,806(82.5
1984	13,840	1,081(7.8)	1,321(9.5)	46(0.33)	10,558(76.3
1985	27,444	2,553(9.3)	2,212(8.0)	865(3.20)	21,814(79.5

Source: Government of Kenya, Statistical Abstract (various years).

Note: Figures in parentheses indicate the percentage of each category in total importation.

e 1.2. PPM'S Total Logging, Paper Output, and Wood Consumption Ratio (WCR) 1976-1985.

gging M^3	change since 1976 (%)	Paper Output (tonnes)	WCR (M^3/t)
,000	-	35,921	4.23
,000	56	44,247	5.36
,000	84	51,116	5.49
,000	90	50,275	5.75
,566	80	51,289	5.33
,571	68	54,476	4.69
,124	80	58,166	4.69
,674	84	57,075	4.90
,843	141	62,307	5.87
,084	121	66,585	5.05
,476	100	62,396	4.88

Report and Accounts, (various years).
Wood-Consumption Ratio.

e 1.3. Employment in Paper, Printing, Publishing and Allied industries versus Employment in the Manufacturing Sector 1976-1985.

nd.	Print, Publi. & allied ind. (2)	(1+2) (3)	Manufac-turing (4)	(1/2) (%)	(3/4) (%)
	4,647	6,010	108,257	29.3	5.6
	3,807	5,350	117,425	40.5	4.5
	3,693	5,363	129,549	45.2	4.1
	4,143	5,795	137,907	39.9	4.2
	3,903	5,542	140,479	42.0	3.9
	3,909	5,649	145,176	44.5	3.9
	4,387	6,104	146,255	39.1	4.2
	4,590	6,688	148,219	45.7	4.5
	5,740	7,320	153,145	27.5	4.8
	6,598	8,288	158,763	25.6	5.2

of Kenya, Statistical Abstract, (various years).

Appendix Table 1.4. Kenya's Total Paper Exports 1970-1986

Year	Tonnage
1970	13.7
1971	46.6
1972	46.8
1973	73.3
1974	814.0
1975	4,543.0
1976	15,362.6
1977	13,467.9
1978	13,820.0
1979	18,582.0
1980	19,736.0
1981	4,710.9
1982	6,546.0
1983	2,794.0
1984	2,022.9
1985	872.8
1986	457.4

Source: Government of Kenya. Annual Trade Report, (various years).

Appendix Table 1.5. PPM Ex-Factory Price Versus the c.i.f Price

Year	Paper/pulp	PPM ex-factory price KSh/ton	C.i.f. Mombasa Price Ksh/ton	Variance (%)
1980	Bleached wood pulp	6,257	3,240	93
1982	Bleached wood pulp	8,800	3,522	149
1981	Flutting medium	5,200	3,643	43
1982	Newsprint	12,130	4,429	174
1982	Writing paper	11,525	6,778	70
1982	Printing paper	11,100	5,256	111
1982	Sack kraft	8,060	4,480	80

Source: Price Control Division, Ministry of Finance.

Appendix 2

Conditions For Identification of a Simultaneous model

These conditions pertains to equations 1 and 2 in the model.

The order condition

An equation fulfills the order condition if the total number of variables excluded from it is at least equal to the number of equations in the system minus one (Koutsoyiannis 1984: 352). Letting:

G = the number of equations, equal to the number of endogenous variables;

K = the number of exogenous and endogenous variables in the model;

M = the number of endogenous and exogenous variables included in a particular equation; the order condition is: $(K - M) \geq (G - 1)$.

If $(K - M) = (G - 1)$, an equation is exactly identified; if $(K - M) > (G - 1)$ the equation is over-identified; and if $(K - M) < (G - 1)$ the equation is under-identified. In our model, G = 3, and K = 11.

In the demand equation, M =7. So:

$(K - M) > (G - 1)$, i.e., $(11 - 7) > (3 - 1)$, $6 > 2$.

The demand equation is, therefore, overidentified.

The production equation has M = 5. Therefore,

$(K - M) > (G - 1)$, i.e., $(11 - 5) > (3 - 1)$, or $6 > 2$.

The Production equation is also over-identified.

Order condition is only necessary but not sufficient.

The rank condition

Rank is a neccesary and sufficient condition. In a system of G equations, an equation is identified by constructing at least one non-zero determinant of order G - 1 from the coefficients of the variables excluded from that equation but included in other equations of the model (Koutsoyiannis 1984: 352). Rearranging the equations yields:

$$0 = D_{ij} + 0Q_{ij} - f(P_{ij}, GDP_{ij}, POP_{ij}, q_1, q_2, q_3)$$

$$0 = 0D_{ij} + Q_{ij} - f(P_{ij}, RC_{ij}, CAP, FX)$$

$$X_{ij} - M_{ij} = D_{ij} - Q_{ij} + f(0P_{ij}, 0GDP_{ij}, 0POP_{ij}, 0RC_{ij}, 0CAP, 0FX, 0q1, 0q2, 0q3)$$

The structural parameters and coefficients of the model are:

Var.	D_{ij}	Q_{ij}	P_{ij}	GDP_{ij}	POP_{ij}	RC_{ij}	CAP	FX	q1	q2	q3
Eqn. 1	1	0	-a	-b	-c	0	0	0	-d	-e	-f
2	0	1	-g	0	0	-h	-i	-j	0	0	0
3	1	-1	0	0	0	0	0	0	0	0	0

The variables and coefficients excluded from the demand equation are:

Q_{ij}	RC_{ij}	CAP	FX
1	-h	-i	-j
-1	0	0	0

These coefficients form three non-zero determinants $|D|_i$ of order $(G - 1) = (3 - 1) = 2$:

$$|D|_1 = \begin{vmatrix} 1 & -h \\ -1 & 0 \end{vmatrix} = -h \neq 0$$

$$|D|_2 = \begin{vmatrix} 1 & -i \\ -1 & 0 \end{vmatrix} = -i \neq 0$$

$$|D|_3 = \begin{vmatrix} 1 & -j \\ -1 & 0 \end{vmatrix} = -j \neq 0$$

So, since $(K - M) > (G - 1)$, the demand equation is over-identified. The variables and coefficients excluded from the supply equation are:

D_{ij}	GDP_{ij}	POP_{ij}	q_1	q_2	q_3
1	-b	-c	-d	-e	-f
1	0	0	0	0	0

These coefficients form five non-zero determinants:

$$|D|_1 = \begin{vmatrix} 1 & -b \\ 1 & 0 \end{vmatrix} = -b \neq 0$$

$$|D|_2 = \begin{vmatrix} 1 & -c \\ 1 & 0 \end{vmatrix} = -c \neq 0$$

$$|D|_3 = \begin{vmatrix} 1 & -d \\ 1 & 0 \end{vmatrix} = -d \neq 0$$

$$|D|_4 = \begin{vmatrix} 1 & -e \\ 1 & 0 \end{vmatrix} = -e \neq 0$$

$$|D|_5 = \begin{vmatrix} 1 & -f \\ 1 & 0 \end{vmatrix} = -f \neq 0$$

Since (K - M) > (G - 1), the supply equation is also over-identified. So, the model is over-identified.

ppendix Table 2.1. Papers made by PPM, 1988.

achine 1. Unbleached Grades

kraft	60-70 gsm
nbleached bag kraft	70-95 gsm
ultiwallnatural sack kraft	70 gsm and above
raft liner	125 gsm and above
kraft paper	130 gsm and above
olour cover	90 gsm and above

achine 2. Bleached Grades

F Computer, and computer bank T 102	48.0 gsm
F Newsprint	48.8 gsm
F White and coloured bank	50.0 gsm
F Printing	60.0 gsm
F White and coloured bond	60.0 gsm
G White offset printing sized	60.0 gsm and above
F Gravure printing	68.0 gsm
F White and coloured duplicating deluxe	70.0 gsm and above
F White bond T 102 sized	70.0 gsm and above
F White offset cartridge	100.0 gsm
F White pulp board	180.0 gsm
F Coloured manila board	180.0 gsm

Source: PPM's 1988 price list.

Appendix Table 2.2: Production and Capacity By Mills 1976-1987

		1976	1977	1978	1979	1980	1981	1982	1983	1984	1985	1986	1987
PPM	Production	36.0	44.0	51.0	50.0	51.0	54.0	58.0	57.0	68.0	63.0	67.0	69.0
	Capacity	40.0	40.0	40.0	40.0	40.0	66.0	66.0	66.0	66.0	66.0	66.0	66.0
KPM	Production	4.0	4.0	3.8	4.2	5.1	5.3	5.7	5.4	5.6	5.8	6.4	6.9
	Capacity	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5	7.5
MPI	Production	0.0	7.0	8.1	8.0	8.3	10.0	11.0	11.8	11.6	11.6	9.0	8.7
	Capacity	0.0	9.0	9.0	9.0	9.0	9.0	15.0	15.0	15.0	15.0	15.0	15.0
HPM	Production	0.0	0.0	0.0	0.0	0.0	0.30	0.31	0.40	0.33	0.37	0.50	0.6
	Capacity	0.0	0.0	0.0	0.0	0.0	0.90	0.90	0.90	0.9	0.9	0.9	0.9
CIL	Production	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.4	3.0	3.0
	Capacity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0	2.0	2.0
KM	Production	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.0
	Capacity	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	7.5
Total	Production	40.0	55.5	62.9	62.2	64.0	69.6	75.0	74.6	85.5	83.2	85.9	90.2
	Capacity	47.5	56.5	56.5	56.5	56.5	83.4	89.4	89.4	89.4	91.4	91.4	98.9
Capacity Usage(%)		84.2	98.2	111.0	110.0	113.2	82.7	83.9	83.4	95.6	91.0	93.9	91.2

Source: Own Survey

QUESTIONNAIRE

A. General Information
Firm:
Year of Establishment:
Interviewee:

B. Paper Production
1. Please give data on cost of production of paper in your firm as per table 1 below.

Table 1. Monthly Total Cost of Production (K '000).

Year	J	F	M	A	M	J	J	A	S	O	N	D
1976												
1977												
1978												
1979												
1980												
1981												
1982												
1983												
1984												
1985												
1986												
1987												

2. Please give monthly total paper output in table 2a, and total monthly output for Newsprint, Printing and Writing, and Packaging and Wrapping Paper in tables 2b, 2c, and 2d.

Table 2a. Monthly Total Paper Output (Tonnes).

Year	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													

Table 2b. Newsprint.

Year	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													

Table 2c. Printing and Writing Paper.

Year	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													

Table 2d. Packaging and Wrapping Paper.

Year	J	F	M	A	M	J	J	A	S	O	N	D	TOTAL
1976													
1977													
1978													
1979													
1980													
1981													
1982													
1983													
1984													
1985													
1986													
1987													

3. Please indicate variations in installed annual capacity in your firm during 1976-1987 by filling table 3 below.

Table 3. Annual Installed Capacity 1976-1987.

Year	Installed Annual Capacity
1976	
1977	
1978	
1979	
1980	
1981	
1982	
1983	
1984	
1985	
1986	
1987	

Installed capacty means maximum paper output achievable in a yea assuming that: (1) the mill operates for a reasonable maximum hours with allowable mechanical breakdown and maintenance, (2) the demand for paper is high, and (3) inputs are readily available.

C. Constraints to Capacity Utilization

1. Rank each of the answers below as either: 1. Very severe
2. Severe
3. A small problem
4. Not a problem

Supply Constraints

- Raw material availability [ ]
- Machine breakdown [ ]
- Availability of skilled personnel [ ]
- Supply of electricity, oil, and water [ ]
- Others. (Specify and rank) [ ]
[ ]
[ ]

Demand Constraints

- Size of the domestic market [ ]
- Competition from imported paper [ ]
- Others.(rank and specify) [ ]
[ ]
[ ]

2. Suggest solutions for the above constrains.
Solutions to supply constraints

Solutions to demand constraints

Do you think:

(a) Kenya's Paper Industry has the ability to meet the increasing demand for paper?

(b) the Industry can use use local available rice-, and wheat-straws, bagasse, and other non-conventional raw materials to make paper?

Thank you very much for answering my questions.

DATA

The study used the data presented in the next few pages.

	D	POP	GDP	RP
	11.40000	14.00000	525.1000	10.08231
	11.30000	14.20000	522.6000	9.456739
)	9.100000	14.30000	544.7000	9.381237
)	15.20000	14.40000	589.1000	9.270216
1	17.10000	14.50000	522.6000	9.107807
2	16.40000	14.60000	596.9000	8.941607
3	15.10000	14.80000	602.8000	8.611599
4	21.10000	14.90000	620.7000	8.506945
1	19.30000	15.00000	605.9000	8.710218
2	18.40000	15.10000	640.6000	8.580857
3	15.30000	15.30000	623.7000	8.400645
4	23.40000	15.50000	660.9000	8.346709
.1	20.10000	15.60000	615.5000	9.235669
.2	19.80000	15.80000	632.7000	8.868502
.3	17.70000	15.90000	664.0000	8.761330
.4	26.00000	16.10000	715.6000	8.442504
.1	19.40000	16.20000	646.3000	8.486563
.2	18.80000	16.40000	674.7000	8.321775
.3	16.30000	16.60000	678.4000	8.108108
.4	24.90000	16.70000	709.3000	7.843137
.1	24.50000	16.80000	685.3000	8.662420
1.2	22.50000	17.00000	690.4000	8.323134
1.3	23.90000	17.10000	720.3000	7.990600
1.4	26.90000	17.40000	780.5000	7.120419
2.1	24.70000	17.50000	802.0000	7.300000
2.2	22.60000	17.70000	847.1000	6.886793
2.3	23.60000	17.90000	810.6000	6.835207
2.4	27.40000	18.00000	854.3000	6.465900
3.1	27.50000	18.20000	864.2000	6.308610
3.2	20.50000	18.30000	874.1000	6.202850
83.3	22.30000	18.50000	859.3000	7.040914
83.4	24.20000	18.80000	894.0000	5.901117
84.1	23.10000	18.90000	877.1000	6.535433
84.2	23.90000	19.10000	904.3000	6.389531
984.3	23.70000	19.30000	949.8000	6.212575
984.4	23.40000	19.50000	967.0000	6.014493
985.1	27.70000	19.70000	999.0000	6.122449
985.2	24.20000	19.90000	1030.300	6.016597
985.3	20.50000	20.00000	1034.600	5.930470
985.4	25.10000	20.30000	1010.300	5.656697

obs	Q	CAP	RC	PROF
1976.1	10.50000	56.50000	6.900000	1.461204
1976.2	9.500000	56.50000	6.200000	1.525281
1976.3	10.90000	56.50000	7.200000	1.302950
1976.4	10.70000	56.50000	7.000000	1.324317
1977.1	14.10000	56.50000	7.200000	1.264978
1977.2	12.90000	56.50000	6.500000	1.375632
1977.3	14.70000	56.50000	7.600000	1.133105
1977.4	14.80000	56.50000	7.600000	1.119335
1978.1	16.10000	56.50000	8.100000	1.075336
1978.2	14.70000	56.50000	7.300000	1.175460
1978.3	16.80000	56.50000	8.900000	0.943893
1978.4	16.80000	56.50000	8.500000	0.981966
1979.1	15.80000	56.50000	7.500000	1.231423
1979.2	14.40000	56.50000	6.700000	1.323657
1979.3	16.40000	56.50000	7.900000	1.109029
1979.4	16.50000	56.50000	7.900000	1.068671
1980.1	16.50000	56.50000	6.900000	1.229937
1980.2	15.10000	56.50000	6.200000	1.342222
1980.3	17.10000	56.50000	7.300000	1.110700
1980.4	17.20000	56.50000	7.300000	1.074402
1981.1	17.10000	89.40000	6.600000	1.312488
1981.2	15.70000	89.40000	7.000000	1.189019
1981.3	17.80000	89.40000	7.000000	1.141514
1981.4	17.90000	89.40000	7.100000	1.002876
1982.1	18.30000	89.40000	6.500000	1.123077
1982.2	16.60000	89.40000	5.800000	1.187378
1982.3	18.90000	89.40000	6.800000	1.005178
1982.4	19.00000	89.40000	6.800000	0.950868
1983.1	17.90000	89.40000	5.800000	1.087691
1983.2	16.30000	89.40000	5.100000	1.216245
1983.3	18.60000	89.40000	6.000000	1.173486
1983.4	18.60000	89.40000	6.100000	0.967396
1984.1	20.10000	89.40000	5.900000	1.107700
1984.2	21.10000	89.40000	6.300000	1.014211
1984.3	21.40000	89.40000	6.400000	0.970715
1984.4	19.70000	89.40000	5.800000	1.036981
1985.1	20.90000	93.40000	5.500000	1.113173
1985.2	18.10000	93.40000	4.600000	1.307956
1985.3	18.10000	93.40000	4.600000	1.289233
1985.4	21.40000	93.40000	5.500000	1.028490

bs	q_1	q_2	q_3	CPI
76.1	1.000000	0.000000	0.000000	0.486000
76.2	0.000000	1.000000	0.000000	0.497000
76.3	0.000000	0.000000	1.000000	0.501000
76.4	0.000000	0.000000	0.000000	0.507000
77.1	1.000000	0.000000	0.000000	0.538000
77.2	0.000000	1.000000	0.000000	0.548000
77.3	0.000000	0.000000	1.000000	0.569000
77.4	0.000000	0.000000	0.000000	0.576000
78.1	1.000000	0.000000	0.000000	0.597000
78.2	0.000000	1.000000	0.000000	0.606000
78.3	0.000000	0.000000	1.000000	0.619000
978.4	0.000000	0.000000	0.000000	0.623000
979.1	1.000000	0.000000	0.000000	0.628000
979.2	0.000000	1.000000	0.000000	0.654000
979.3	0.000000	0.000000	1.000000	0.662000
979.4	0.000000	0.000000	0.000000	0.687000
980.1	1.000000	0.000000	0.000000	0.707000
980.2	0.000000	1.000000	0.000000	0.721000
980.3	0.000000	0.000000	1.000000	0.740000
980.4	0.000000	0.000000	0.000000	0.765000
981.1	1.000000	0.000000	0.000000	0.785000
981.2	0.000000	1.000000	0.000000	0.817000
981.3	0.000000	0.000000	1.000000	0.851000
981.4	0.000000	0.000000	0.000000	0.955000
982.1	1.000000	0.000000	0.000000	1.000000
982.2	0.000000	1.000000	0.000000	1.060000
982.3	0.000000	0.000000	1.000000	1.068000
982.4	0.000000	0.000000	0.000000	1.129000
983.1	1.000000	0.000000	0.000000	1.173000
983.2	0.000000	1.000000	0.000000	1.193000
983.3	0.000000	0.000000	1.000000	1.051000
983.4	0.000000	0.000000	0.000000	1.254000
984.1	1.000000	0.000000	0.000000	1.270000
984.2	0.000000	1.000000	0.000000	1.299000
984.3	0.000000	0.000000	1.000000	1.336000
984.4	0.000000	0.000000	0.000000	1.380000
985.1	1.000000	0.000000	0.000000	1.421000
985.2	0.000000	1.000000	0.000000	1.446000
985.3	0.000000	0.000000	1.000000	1.467000
1985.4	0.000000	0.000000	0.000000	1.538000