Long-Term Projections of the Consumption of Paper and Paper Products in Australia

Andrew Edquist and Paul Morris*

In this paper, an examination of the demand for paper products in Australia in the light of product life-cycle theory is provided. Estimates of relative maturity in the market place and of ceilings to consumption are made for the various paper products. In addition to projections based on continuation of current trends, assessment is made of the impact of some more or less likely social and technological developments which have the potential to radically modify future demand patterns. The projections study succeeds in isolating the major factors influencing demand for paper products and brings into sharp focus the uncertainties involved in forecasting demand over a forty-year time span.

1. Introduction

Projections of the consumption of paper and paper products in Australia to 2020 were produced by the Bureau of Agricultural Economics in response to a resolution of the Australian Forestry Council in May, 1982, calling for a national wood production plan. In this paper, the methods used to produce the projections are outlined, the major trends influencing consumption are discussed, and a range of projections is set out. These illustrate the uncertainties involved in a study of this nature (*see also* Wallace 1985).

2. Paper and Economic Activity

Paper and paper products have a wide range of end uses. In broad terms, the roles played by paper and paper products in economic activity consist of the storage and distribution of products, the storage and dissemination of information and entertainment, and household and sanitary use. Minor uses exist for specialty grades of paper. Numerous substitutes exist for each major end use. Plastics can replace paper in wrapping and packaging, electronic media can store information and provide entertainment, and various wipes and cloths are available for household and sanitary purposes.

To be of use to the consumer, paper must often be further processed (as in the printing and publishing industries and in the manufacture of boxes and bags). The cost of paper in some uses is only a small fraction of the final product cost and consequently has little effect on demand for these uses.

The paper industry is characterized by a pronounced business cycle, and buildup and rundown of stock levels can have a marked impact on apparent consumption in the short term (Associated Pulp and Paper Mills Limited 1979; B.A.E. 1984*b*, Figure 4).

3. Nature of Long-term Consumption

Methods for long-term consumption studies differ considerably from those for short-term demand studies. In the long term, everything must be regarded as subject to change. The product itself in terms of quality and material properties, the range and quality of substitutes, and even the perceptions, habits and likely behaviour of the consumer may change. The pervasiveness of change limits the

* Bureau of Agricultural Economics, Canberra. The authors gratefully acknowledge the support and assistance given to this study by Mr B. La Fontaine of the Pulp and Paper Manufacturers' Federation of Australia and Mr B. Coomber of the New South Wales Forestry Commission. The authors also gratefully acknowledge the helpful comments received on an earlier draft of this paper from Mr L. G. Schultz of Australian Paper Manufacturers Limited.

usefulness of the traditional theory of demand, with its underlying framework of a fixed set of consumer utilities and choices. On the supply side, due attention must be given in the long term to what Heikinheimo (1981) termed the 'non-material resource of economic growth', that is, skills, organization, invention and innovation. Further, over the long term the model selected needs to specifically address the adoption pattern of a new product and the effect of technological change on this. These factors are often neglected in traditional approach studies.

A starting point for long-term projections of the consumption of paper and paper products is the delineation of market limits. These arise from the limited range of physical qualities exhibited by each product and from the limited range of prices under which it is likely that the product will be sold. Although social and technological change always has the potential to alter market limits or create new markets (by altering the product, the costs of production, or consumer utilities), these market limits tend to persist for considerable periods of time (which is shown in this paper by the stability of estimated ceiling levels).

In the long run, the consumption of many products would be expected to exhibit an S-shaped curve over time (*see* the left-hand side, Figure 1). Over a longer time span, a bell-shaped curve may result. Causes for this particular pattern of growth, known as the product life cycle, are manifold and tend to reinforce one another. Kotler (1976) and Rogers (1962) focussed on buyer behaviour and consumer familiarity, and the Bureau of Agricultural Economics (1984*a*) has applied the concepts of Kotler and Rogers to analyses of the consumption of fruit. Katz, Levin and Hamilton (1963) drew attention to developments in costs of production and distribution which lead to an S-shaped pattern of growth. Further Batten and Johansson (1984) used the product life cycle theory in their study of Swedish building materials.

A further explanation of the S-shaped growth pattern in consumption is derived from linking consumption to broad social changes (for example, consumption of printing and writing papers may be related to education levels). Such social changes are themselves often characterized by an S-shaped pattern of development. For example, the Food and

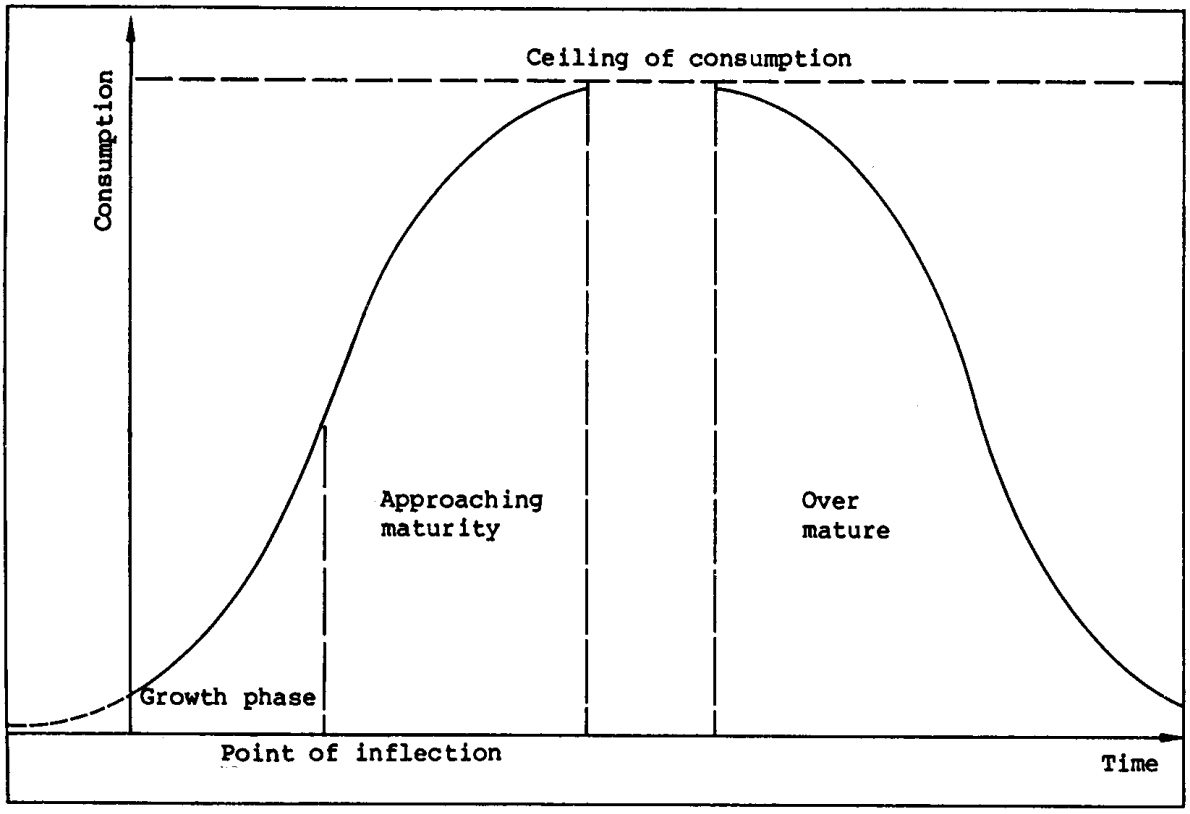

Figure 1—Idealized Pattern of Long-term Consumption of a Product

Agriculture Organization of the United Nations (1977) has estimated that a developing country may take between fifty and ninety years to increase its literacy rate from 15 per cent to 85 per cent of the population. The rate of improvement slows once the literacy rate reaches 50 per cent and declines considerably as complete literacy is approached.

Products become 'over mature' and enter decline when substitutes which more effectively fulfil consumer needs emerge. These substitutes themselves than enter a growth phase in consumption, and consumption of the original product correspondingly declines. Decline may also ensue if the particular consumer need fulfilled by the product is eliminated by social change.

Graff (1983) provides empirical evidence that, with some isolated breaks in trend associated with worldwide recession, world consumption of paper and paper products has quite closely followed an S-shaped curve over time.

As the empirical evidence for the existence of S-shaped patterns of consumption is strong, and as no other theory of long-term consumption is as well developed, the primary aim of this study is estimation of the parameters of the long-term growth curves associated with the various paper products and the estimation of rates of movement along those curves.

If the historical pattern of consumption of an individual product is examined, it is clear that development along an S-shaped curve is subject to disturbance. Disturbances may occur at any time because of the effect of short-run influences on demand. Thus, any estimation of the parameters of the long-run growth curve must take into account the normal factors affecting short-term demand (prices of the product and its substitutes, and consumer income).

Consumer income plays a double role in long-term studies. In addition to the normal impact of consumer income on short-run demand, rising levels of income are intimately associated with broad social changes, which also affect demand. In long-term studies, the latter aspect of consumer income often has the greater effect on consumption (F.A.O. 1977).

Another cause of disturbances to the growth pattern of consumption is technological change. Some changes, such as the changes in costs of production and distribution referred to above, may occur in an orderly and predictable fashion. Other changes are essentially unpredictable and cause marked breaks in trend, accelerated rates of growth or decline, and the like. Entirely new uses for the product may arise, leading to new limits on consumption and the re-establishment of a new growth phase in the long-term consumption curve. The impact of such changes arising from technological development must be identified in the historical record, and careful thought must be given as to their possible impact in the future. This is accomplished in this paper by consideration of an alternative scenario.

4. Specification of the Models

The four categories chosen for analysis are those defined in the B.A.E.'s situation and outlook report on forest products (B.A.E. 1984*b*), namely, newsprint, paperboard, printing and writing papers, and other papers. The 'other papers' category is heterogeneous and, for the purposes of this analysis, was further subdivided into wrapping and packaging papers, household and sanitary tissues, and miscellaneous papers. For these six product groups, consumption was expressed in terms of consumption per dollar of gross domestic product or consumption per person, depending on whether the major end users were industry or individuals.

No trends were evident in the consumption of miscellaneous papers, and consumption in this category was projected on the basis of the historical average consumption per dollar of gross domestic product.

The long-run, S-shaped patterns of consumption for the remaining product groupings were modelled using logistic functions. Variables included in the functions were time, real price and real consumer income. For those categories in which price is an important determinant of demand, imports form a major part of consumption and prices are determined exogenously. In modelling consumption it was also necessary to take into account the impact of specific technological innovations.

Factors affecting the consumption of the various paper products and the appropriate model specifications are as follows.

4.1 Paperboard

This is used for industrial packaging purposes, and the appropriate unit of consumption is consumption per thousand dollars of gross domestic product. Substitutes include various types of plastic and also other materials. The choice of material by the packager will depend not only on the price of the material, but also on material properties such as strength, water resistance, printability, *etc.* Innovative package design can lower the weight and cost of packaging material per package or otherwise increase the utility of the package to the packager, and this can influence the choice of material.

Since 1962–63, the world price of paperboard in real terms has steadily declined, interrupted only by short-lived price rises following the 1973 oil crisis. Factors contributing to this decline in price have been improvements in pulping technology (Atack 1983; Nielson 1983) and significant increases in the scale of operations (Mandl 1983; Wallis 1983). Australian domestic prices have reflected world prices (with some short-lived fluctuations arising from movements in the Australian exchange rate).

Prices of plastic film and sheet are also likely to have declined with time, with the shift in manufacturing centres from North America and Western Europe to East Asian countries.

Social and technological changes which have led to a long-term declining trend in paperboard consumption per dollar of gross domestic product include improvements in material properties of plastic film and sheet (such as improvements in the strength-to-weight ratio), innovations in package design which have reduced the amount of paperboard required per package, and the decline in the relative contribution of manufacturing and agriculture (the sector producing packageable goods) to each dollar of gross domestic product. A factor which may have affected demand for packaging in recent years is the apparent lowering of inventory demand throughout the economy as a result of high interest rates and computerised inventory systems.

The model chosen to estimate long-term consumption trends for paperboard was a logistic function in paperboard price and time (see Section 5). The coefficient in time was chosen as a proxy for the social and technological trends mentioned above. Inclusion of paperboard price enabled estimation of the own-price elasticity of demand, but the heterogeneous and changing nature of other packaging materials prevented any measurement of cross-price elasticities.

4.2 Newsprint

Newsprint is used for the printing of newspapers. Paper of very similar quality is used for direct mail advertising but this is, as a matter of convention, included in printing and writing papers. However, directory papers, which is a growing market comprising in excess of 30 000 tonnes of paper per annum, is included in this category. There are no direct substitutes for newsprint but consumption is affected by substitutes for newspapers such as direct mail advertising and the various electronic media. Because the level of advertising varies directly with economic activity the measure chosen for estimation was newsprint consumption per thousand dollars of gross domestic product.

Price of newsprint is a minor factor in demand, as there are no direct substitutes and newsprint cost is a small fraction of the total cost of producing a newspaper (F.A.O. 1977). The major feature of newsprint consumption is a marked and steady downward trend with time as newspapers face increasing competition from other media.

The model chosen for estimating the time trend in newsprint consumption was a negative exponential function of time. Estimation as a logistic in time failed to obtain statistically-reliable estimates of the ceiling of consumption, and the declining trend in consumption indicates that estimates of the ceiling are irrelevant.

4.3 Printing and writing papers

This is a heterogeneous category with end uses in books and magazines, office stationery, and catalogue and direct mail advertising (Associated Pulp and Paper Mills 1981). Consumption was measured in terms of consumption per person.

Substitutes for the information storage and entertainment role of printing and writing paper are the various electronic media. However, complementary relationships are also important, such as the impact of computer paper.

The price of printing and writing paper is only a minor factor in demand, as the cost of the paper is a small fraction of the total cost of a printed page (including the cost of producing the information printed). Consumer income has an important influence on demand in the short term, and, in the long term, rising levels of consumer income are intimately associated with social changes affecting consumption.

Social changes which have led to a long-term rising trend in consumption per person include rising education levels and a rise in the relative importance of tertiary industries in economic activity (F.A.O. 1977). Since the mid-1970's, the rate of increase in worldwide consumption has accelerated markedly. This has also been the case in Australia. The accelerated rate of change is associated with a number of technological innovations including the introduction of computer typesetting for book and magazine production, the spread of computers in offices generally, and improved technology for office photo reproduction. There has also been an increase in the use of catalogue and direct mail advertising associated with changes in retailing. These changes in retailing are discussed more fully in relation to wrapping and packaging papers.

The model chosen for estimation of long-term trends in consumption of printing and writing papers was a logistic function of consumer income with provision for the break in trend in the mid-1970's.

4.4 Wrapping and packaging papers

These are used mainly at the retail level, although some are used for industrial purposes (such as sacks for cement) (A.P.M. Limited 1985). Consumption was measured in terms of consumption per person.

Substitutes are other packaging materials, mainly plastic. Price is an important factor in the choice of packaging material, but material properties and package design also influence choice of material. As in the case of paperboard, the real price of paper and its substitutes has declined with time.

Consumer income has an important influence on consumption in the short term through its impact on retail sales. In the long term, rises in consumer income have been associated with, and have stimulated changes in, retailing technology. The spread of centralized retail chains has fostered the achievement of economies of size in packaging, whilst innovative marketing techniques have stimulated new packaging designs. The net effect of these changes has been a long-term rising trend in consumption per person of wrapping and packaging papers. As discussed above, these changes in retailing have also boosted consumption of printing and writing papers through the increased use of catalogue and direct mailing advertising.

The centralization of retail decision making can lead to sharp changes in consumption. For example, the introduction of high-strength plastic bags and their widespread adoption by major retail chains in 1982–83 led to a sharp fall in consumption of wrapping and packaging papers from 400 kt in 1981–82 to 325 kt in 1982–83 (Mr G. Hibble, A.P.M. Limited, Melbourne, personal communication, 1985).

Long-term consumption of wrapping and packaging paper was modelled as a logistic function of paper price and consumer income. A dummy variable was included for the year 1982–83 to account for the changeover to plastic bags on the part of major retail chains.

4.5 Household and sanitary tissues

These have predominantly household use, and the appropriate measure is consumption per person. Substitutes are various non-paper wipes and cloths. By the nature of the product, it is unlikely that the prices of tissue paper or its substitutes are major factors in demand, but rather that perceived convenience of use is the major factor. By the same token, it is unlikely that consumer income has much impact on demand in the short term. In the long term, however, rising levels of consumer income have been strongly associated with the changing lifestyles and the changing perceptions of convenience of use, which seem to have brought about the historical rise in consumption per person.

The model chosen for estimating long-term trends in tissue consumption was a logistic in consumer income (as measured by gross domestic product per person).

4.6 Miscellaneous papers

These have various speciality end uses, such as filter paper, electrical capacitor papers, *etc.* There has been considerable fluctuation but no apparent trend in consumption per thousand dollars of gross domestic product.

5. Estimation

The general equation for the logistic curve is:

$$(1) \quad C = K + (S - K)/(1 + \exp(a - bX)),$$

where C = consumption;
K = consumption floor;
S = consumption ceiling;
X = the driving variable of the logistic; and
a,b are parameters.

For positive b, the curve increases with increasing X, and for negative b, the curve decreases with increasing X. The point of inflection occurs at $X = a/b$, at which point $C = (S + K)/2$.

The driving variable, X may itself be a function of other variables. In the equations for consumption presented below, X is taken as a linear function of time, price and consumer income, and is also affected by technological innovations.

The floor of the logistic was taken as zero in all cases except that of wrapping and packaging papers. Statistical difficulties prevented estimation of the ceiling in the case of newsprint, and the logistic function was replaced by a negative exponential function of time.

The models were estimated using the maximum likelihood method. Stability of the coefficients was tested by dividing each period of estimation into halves and re-estimating separately over two time periods. Stability of the computing procedure (an iterative convergence technique) was tested by re-estimating with differing initial values. An auto-regressive integrated moving average (ARIMA) package was used to test for serial correlation among the residuals (usually a sign of misspecification). No problems of instability or misspecification were evident.

Problems of identification may arise in estimating price effects, as concurrent movements in supply must be taken into account. However, in the cases where product price is a major determinant of demand, imports form a major part of the consumption and prices may be taken as being determined exogenously. Thus, the use of single equation models is appropriate.

As the usual t-tests of the statistical significance of the coefficients are not strictly valid for small samples in a non-linear model, the standard errors were reported.

5.1 Paperboard

The model was estimated over the period 1962–63 to 1982–83. Results are presented below, with standard errors in parentheses.

$$(2) \quad CPPGDP_t = \underset{(12.4)}{31.5}/(1.0 + \exp(\underset{(0.666)}{0.311} + \underset{(0.0043)}{0.0251}*TIME_t + \underset{(0.34)}{1.23}*PRICE_t)),$$

$$R^2 = 0.75,$$

where $CPPGDP_t$ = consumption of paperboard per dollar of gross domestic product in year t (kg/$1,000 in 1979–80 dollars);
$PRICE_t$ = price of paperboard in year t ($'000/$t$ in 1979–80 dollars); and,
$TIME_t$ = 1 in 1949–50, . . . , 34 in 1982–83.

5.2 Newsprint

The model was estimated over the period 1954–55 to 1982–83. Results are presented below, with standard errors in parentheses.

(3)

$$CNPGDP_t = \underset{(0.03)}{\exp}\ (1.98 - \underset{(0.0015)}{0.0161}*TIME_t),$$

$$R^2 = 0.79,$$

where $CNPGDP_t$ = consumption of newsprint per dollar of gross domestic product in year t (kg/$1000 in 1979–80 dollars); and,

$TIME_t$ = 1 in 1949–50, . . . , 34 in 1982–83.

5.3 Printing and writing papers

The model was estimated over the period 1954–55 to 1982–83. Results are presented below, with standard errors in parentheses.

(4)

$$CWPPOP_t = \underset{(17.6)}{47.4}/(1.0 + \exp((\underset{(0.21)}{2.88} + \underset{(6.08)}{15.31}*D_t) - (\underset{(0.069)}{0.359} + \underset{(0.796)}{1.985}*D_t)*GDPPOP_t)),$$

$$R^2 = 0.96,$$

where $CWPPOP_t$ = consumption of printing and writing paper per person in year t (kg per person);

$GDPPOP_t$ = gross domestic product per person in year t ($'000in 1979-80 dollars); and

D_t = a dummy equal to zero prior to 1975-76 and equal to one in and after 1975-76.

5.4 Wrapping and packaging papers

The model was estimated over the period 1962-63 to 1982-83. Results are presented below, with standard errors in parentheses. Stability tests revealed unstable estimates of the standard errors, which may have been attributable to multicollinearity between price and income. However, the coefficients remained stable under a variety of starting values and time periods of estimation.

(5) $$CKWPOP_t = \underset{(4.87}{6.89} + \underset{(1.62)}{57.6}/(1.0 + \exp(-0.406 - \underset{(0.789)}{0.362}*HDIPOP_t + \underset{(1.48)}{3.67}*PRICE_t + \underset{(0.179)}{0.561}*D_t)),$$

$$R^2 = 0.93,$$

where $CKWPOP_t$ = consumption of wrapping paper per person in year t (kg per person);

$HDIPOP_t$ = household disposable income per person in year t ($'000 in 1979-80 dollars);

$PRICE_t$ = price of wrapping paper in year t ($'000/$t$ in 1979-80 dollars); and

D_t = a dummy variable equal to one in 1982-83 and equal to zero in previous years.

5.5 Household and sanitary tissues

The model was estimated over the period 1961–62 to 1982–83. Results are presented below, with standard errors in parentheses.

(6) $$CHSPOP_t = \underset{(0.25)}{8.71}/(1.0 + \exp(\underset{(0.23)}{5.51} - \underset{(0.043)}{0.898}*GDPPOP_t)),$$

$$R^2 = 0.98,$$

where $CHSPOP_t$ = consumption of household and sanitary tissues per person in year t (kg per person); and

$GDPPOP_t$ = gross domestic product per person in year t ($'000 in 1979-80 dollars).

5.6 Miscellaneous papers

This is a heterogeneous category of speciality grades with a wide range of end uses. Average consumption per dollar of gross domestic product over the period is reported below, with the standard deviation of consumption in parentheses.

(7) $$CMCGDP_t = \underset{(0.271)}{0.830},$$

Table 1: Parameters of Consumption of Paper and Paper Products

Product group	Period	Change in variable				Comments
		1 per cent increase in price (*a*)	1 per cent increase in consumer income (*b*)	1 year of time	Ceiling of consumption	
		Change in consumption				
		%	%	%		
Paperboard	1962–63	−0.9	n.e.		32 kg/$1,000 of gross domestic product (*c*)	Consumption declining. Ceiling irrelevant. Paperboard may not retain competitiveness.
	1982–83	−0.6		−2.1		
Newsprint	1982–83	n.e.	n.e.	−1.6	n.e.	Consumption declining. Ceiling irrelevant. Rate of decline may accelerate.
Printing and writing papers	1954–55	n.e.	1.2	n.e.	47 kg per person	Marked acceleration of change after mid-1970's. Ceiling of consumption about twice current consumption. Ceiling reached by end of century. Decline in traditional uses and possible development of new uses.
	1974–75		1.5			
	1982–83		9.3			
	2000–01(*p*)		0.0			
Wrapping and packaging papers	1962–63	−1.6	0.5	n.e.	64 kg per person	Ceiling apparently that of retail packaging sectors as a whole. About two and a half times current consumption. Paper may not retain market share.
	1982–83	−1.5	1.0			
Household and sanitary	1962–63	n.e.	3.3	n.e.	8.7 kg per person	Consumption near ceiling. Possible development of new uses.
	1982–83		1.3			
	2000–01(*p*)		0.1			
Miscellaneous		n.e.	n.e.	n.e.	0.8 kg/$1,000 of gross domestic product (*c*)	No apparent trends. Ceiling of consumption is average historical consumption.

(*a*) Price measured in 1979–80 dollars per tonne. (*b*) Consumer income measured in 1979–80 dollars. (*c*) Gross domestic product measured in 1979–80 dollars. (*p*) Projected. n.e., not estimated.

where $CMCGDP_t$ = consumption of miscellaneous paper per dollar of gross domestic product in year t (kg/$1,000 in 1979–80 dollars).

6. Results

The resulting estimates of the major parameters are set out in Table 1.

An analysis of the results indicates that newsprint and paperboard are "over mature" products in the sense discussed above, with a marked downward trend in consumption per thousand dollars of gross domestic product. The ceilings of consumption are uncertain or unknown with these products, but the trends indicate that the ceilings are irrelevant. The household and sanitary tissues category is "mature", and on current trends little increase in consumption per person is expected. Consumption per person of printing and writing papers is increasing rapidly at present, and current trends indicate that a ceiling to consumption at about twice current consumption may be reached by the turn of the century. Developments in retailing have stimulated the packaging market and there would still seem to be plenty of room for growth in demand for wrapping and packaging papers. However, the packaging market is highly competitive and the ceiling estimated is possibly that of the retail packaging sector as a whole. Thus, the future market share taken by paper as opposed to plastics is uncertain and dependent on the marketing activities of the competitors in the market.

Price was found to be a significant factor affecting the consumption of the industrial and retail packaging categories. Income per person was found to be an important factor in the consumption of household and sanitary tissues, printing and writing papers, and wrapping and packaging papers, but this influence of income on consumption probably comes about in part through social changes associated with rising income.

7. Projections of Current Trends

Projections based on continuation of current trends are set out in Table 2, and Figure 2. The 'low', 'medium' and 'high' projections in Table 2 reflect uncertainty with respect to future population and gross domestic product. However, even if these major determining factors were known with certainty, uncertainty in the projections could still arise because of the statistical uncertainty associated with the estimation of current trends. This uncertainty is expressed in the standard errors of the projections presented in parentheses after the 'medium' projections.[1]

7.1 Projections of population and income

Three projections of population were considered: a low projection and a high projection provided by the Australian Bureau of Statistics (1982), and a medium projection derived by taking the arithmetical average of the low and the high projections. The low and the high projections are the Australian Bureau of Statistics series B and series D, respectively. These projections share common assumptions about the death rate and a return in natural fertility to long-term replacement rates by 1987 and the maintenance of fertility at that level thereafter. The low projection is based on the assumption of an immigration rate of 75 000 a year. The high projection is based on the assumption of an immigration rate of 125 000 a year. As the medium projection is an arithmetical average of the low and the high projection, it corresponds to a projection sharing the same assumptions on death rates and fertility rates but with an immigration rate of 100 000 a year.

Three projections of income per person were also considered. These projections were based on the average behaviour of gross domestic product per person over the 33 years from 1949–50 to 1982–83. The average growth rate in gross domestic product per person over that period was 1.97 per cent a year. However, this rate conceals considerable fluctuations in growth rates over shorter time periods. For example, the average growth rate over the first half of the time period, 1949–50 to 1966–67, was 2.24 per cent a year, while the average growth rate over the second half of the time period, 1966–67 to 1982–83, was 1.69 per cent a year. On consideration of these average

[1] These standard errors of the projections were calculated on the strict postulate that the projections of future population, income, *etc.*, underlying the 'medium' paper projection would turn out exactly as assumed.

growth rates, it was decided that three projections in the rate of growth of gross domestic product per person would cover most of the likely economic outcomes. These projections of growth rates were:

(a) low projection with a growth rate in gross domestic product per person of 1.75 per cent a year;

(b) medium projection with a growth rate in gross domestic product per person of 2.00 per cent a year; and

(c) high projection with a growth rate in gross domestic product per person of 2.25 per cent a year.

Similarly, three projections of household disposable income per person, using the above growth rates, were adopted.

Projections of total gross domestic product were produced by combining the projections for population with the projections for gross domestic product per person. The high, medium and low projections of population were combined respectively with the high, medium and low projections of the rate of growth of gross domestic product per person, to produce high, medium and low projections of gross domestic product.

Table 2: Projections of Current Trends in Paper Consumption (a)

Product group	1990	2000	2010	2020
	kt	kt	kt	kt
Paperboard—				
low	584	707	812	906
medium	603(±29)	758(±52)	904(±71)	1 048(±109)
high	622	813	1 008	1 209
Newsprint—				
low	556	637	712	789
medium	574(±47)	684(±66)	794(±94)	913(±139)
high	593	733	883	1 053
Printing and writing papers—				
low	729	906	1 002	1 096
medium	760(±126)	934(±226)	1 045(±254)	1 158(±261)
high	787	961	1 088	1 220
Wrapping and packaging papers—				
low	493	778	1 060	1 298
medium	510(±38)	830(±90)	1 147(±130)	1 407(±135)
high	526	883	1 232	1 510
Household and sanitary tissues—				
low	134	163	183	201
medium	138(±5)	169(±9)	192(±11)	213(±13)
high	141	175	200	224
Miscellaneous papers—				
low	123	165	217	282
medium	127(±41)	177(±58)	242(±79)	327(±107)
high	131	190	269	376
Total "other" papers (*b*)—				
low	750	1 106	1 460	1 782
medium	775(±56)	1 176(±107)	1 581(±153)	1 947(±173)
high	798	1 248	1 700	2 110
Total paper and paper products—				
low	2 619	3 356	3 986	4 573
medium	2 712(±149)	3 552(±264)	4 324(±319)	5 066(±359)
high	2 799	3 755	4 679	5 592

(*a*) Figures in parentheses represent standard errors of projections.
(*b*) Comprises wrapping and packaging papers, household and sanitary tissues and miscellaneous papers.

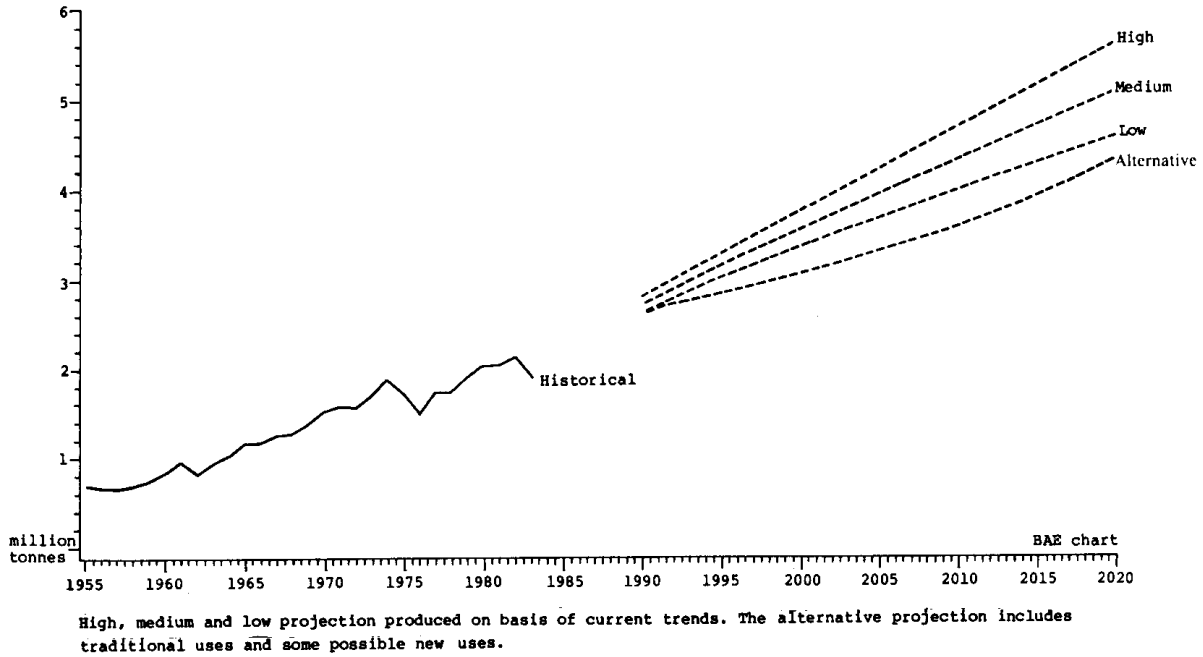

Figure 2: Consumption of Paper and Paper Products Current Trend Projections and Alternative Projection

7.2 Estimation of price trends

In the current trend assessment, prices were projected on the assumption that no future oil crises or similar exogenous shocks would occur. It was thus necessary to discover what the average rates of decline in prices would have been without the price rises.

Prices were modelled as negative exponential functions of time, with a dummy variable to represent the effects of the oil crisis. Estimation was by ordinary least squares, with the logarithm of price as the dependent variable over the period 1962–63 to 1982–83. The results are presented below with t statistics in parentheses.

$$(8)\quad LREALBB_t = \underset{(3.14)}{0.14} - \underset{(10.78)}{0.024} * TIME + \underset{(5.47)}{0.15} * D75$$

$$\bar{R}^2 = 0.89$$

where $LREALBB_t$ = logarithm of price of paperboard in year t ($'000/t in 1979–80 dollars);

$TIME$ = 1 in 1949–50, ..., 34 in 1982–83; and

$D75$ = a dummy equal to zero prior to 1975–76 and equal to one in and after 1975–76.

$$(9)\quad LREALKW_t = \underset{(4.49)}{0.22} - \underset{(6.99)}{0.018} * TIME + \underset{(4.18)}{0.13} * D75$$

$$\bar{R}^2 = 0.75$$

where $LREALKW_t$ = logarithm of price of wrapping paper in year t ($,000/t in 1979–80 dollars).

The results of the estimations were that the oil crisis was responsible for a 15 per cent rise in the price of paperboard and a 13 per cent rise in the price of wrapping and packaging papers. The underlying rate of decline in the price of paperboard was 2.4. per cent a year, while the underlying rate of decline in the price of wrapping and packaging paper was 1.8 per cent a year.

The somewhat greater underlying rate of decline in paperboard prices when compared with wrapping and packaging paper prices may be attributable to the use of wastepaper in the manufacture of paperboard.

Given current projections of slowing consumption growth in developed countries worldwide, and apparently ample sources of raw material for pulp and paper, it is not unreasonable to expect the worldwide price trends to continue. If Australian exchange rates remain stable in real terms over the long term, these world price trends will be reflected in Australian domestic price trends.

7.3 Results of current trend projections

The projections indicate that if current trends were to continue, annual domestic consumption of paper and paper products would rise from the current 2.1 million tonnes to between 3.4 and 3.8 million tonnes by 2000, and to between 4.6 and 5.6 million tonnes by 2020, depending on future population and income growth. Uncertainty associated with estimation of current trends could amount to the order of 0.4 million tonnes by 2020.

8. An Alternative Scenario

Although the projections of current trends outlined above must remain the "best bet" (at least until hard evidence emerges that trends have altered), it would be unrealistic to assume that current trends will necessarily continue indefinitely. The alternative set of projections set out in Table 3 examines the consequences of some developments which were judged to more or less likely.

The expected increase in housing densities in future (Roseth 1983) could change the relative utilities of washable versus disposable products and may lead to an increase in consumption of tissue products such as disposable nappies. Comparison with European countries indicates that such a development could increase tissue consumption by about 10 kg per person per year.

The packaging paper sectors may not be able to maintain the rates of decline in price achieved historically. This might be the case if difficulties were encountered in expanding capacity worldwide for, say, environmental reasons, or if Australia's exchange rates depreciated over the long term.

The rate of decline in the consumption of newsprint per dollar of gross domestic product may accelerate under the impact of progressive improvements in the variety and quality of electronic media.

The rapid increase in the information storage capabilities of electronic media may lead to a decline in the traditional uses of printing and writing papers. However, new uses in this sector, such as video to paper reproduction, may arise.

It is difficult to assess the probabilities of occurrence of the individual developments referred to above. Thus, the alternative scenario should not be viewed as a firm prediction of the future but as a guide to possible outcomes.

Details of the assumptions underlying the alternative scenario are set out below. The assumptions represent the most realistic range of possibilities.

8.1 Assumptions underlying the alternative scenario

Paperboard: Price is assumed to remain constant in real terms at the 1983 price, rather than declining at historical rates.

Wrapping and packaging paper: Price is assumed to remain constant in real terms, rather than declining.

Newsprint: The rate of decline in relative consumption is assumed to double to 3.2 per cent a year after 1990.

Table 3: Projections of Total Consumption Under the Alternative Scenario

Product group	1985	1990	2000	2010	2020
	kt	kt	kt	kt	kt
Paperboard	526	563	630	682	729
Newsprint	521	574	580	572	558
Printing and writing papers—					
traditional	501	760	743	707	667
new uses	0	43	77	164	428
total printing and writing	501	804	820	871	1 095
Total other papers(*a*)	578	702	1 034	1 472	1 950
Wrapping and packaging papers	347	419	610	867	1 178
Household and sanitary tissues—					
traditional	117	138	169	192	213
new product	8	19	78	172	232
total household and sanitary tissues	125	156	247	363	445
Miscellaneous papers	106	127	177	242	327
Total paper and paper products	2 126	2 643	3 064	3 597	4 331

(*a*) Comprises wrapping and packaging papers, household and sanitary tissues and miscellaneous papers.

Household and sanitary tissues: A major new use is assumed to emerge, with consumption in this new use amounting eventually to 10 kg per person per year. In Sweden, current per person consumption of disposable nappies amounts to several kilograms per year (McLean 1983). The growth pattern for the new tissue product is assumed to follow a logistic curve with time, with consumption per person of the new product amounting to 0.5 kg in 1985 and 9.5 kg in 2020.

Printing and writing papers: It is assumed that, after 1990, traditional uses of printing and writing papers will start to decline, while new end uses within the sector will emerge. The growth pattern for the new printing and writing product is assumed to follow a logistic path. Consumption per person is assumed to be 2.5 kg in 1990 (about five per cent of total printing and writing paper consumption in that year), and the rate of growth in consumption per person for the new product is assumed to be initially 1.5 times the rate of growth in income per person. This rate of growth accelerates over time, reaching five times the rate of growth of income per person by the year 2020. Consumption of printing and writing papers in traditional uses is assumed to start declining in the year 1990. The rate of decline in consumption per person in these traditional uses is assumed to be 1.6 per cent a year (equal to the current rate of decline in relative consumption of newsprint).

The alternative scenario is somewhat pessimistic, as it is based on the assumption that some factors tending to decrease the consumption of paper will come into play immediately, whereas increases in consumption as a result of new product development are assumed to play a minor role until well into the next century.

The projections for total consumption of the various product groups arising from the new set of assumptions are set out in Table 3 and Figure 2.

When the baseline projection and the alternative scenario are compared, it is seen that the assumed loss of competitiveness in the packaging sectors, the assumed accelerated decline in newsprint, and the assumed decline in traditional uses of printing and writing papers would lead to a collective drop in consumption, relative to the 'medium' current trend projections, of 18 per cent by the year 2000 and 28 per cent by the year 2020. This relative drop in consumption is only marginally offset during the projection period by new product developments in the tissues and printing and writing sectors. Consumption attributable to these new product developments amounts to four per cent of the baseline projection of total consumption by the year 2000, and 13 per cent by the year 2020.

9. Conclusion

The analyses presented in this paper, covering a wide range of possibilities, indicate that consumption of paper in Australia by the year 2020 is unlikely to be much below 4.3 million tonnes or much above 5.6 million tonnes. It should be remembered, however, that transition from estimation of final product consumption to estimation of, say, levels of plantation establishment that can profitably be sustained is not straightforward. Possibilities for trade exist at every stage of production. For example, Australia currently exports wood chips, imports pulp, and both imports and exports paper products. In addition, pulpwood logs are not the only source of fibre for the pulp and paper industry, as both sawmill residues and waste paper are also used.

References

A.P.M. LIMITED (1985), *Annual Report 1985,* Matraville, N.S.W.

ASSOCIATED PULP AND PAPER MILLS LIMITED (1979), *Annual Report 1979,* Melbourne.

——(1981), *Annual Report 1981,* Melbourne.

ATACK, L. (1983), The current status of mechanical pulping. Paper presented to the Outlook for Australia's Natural Fibres Conference, Canberra.

AUSTRALIAN BUREAU OF STATISTICS (1982), *Projections of the Population of Australia,* Cat. No. 3204, Canberra.

BATTEN, D. F. AND JOHANSSON, B. (1984), Industrial dynamics of the building sector, product cycles, substitution and trades specialization. Paper presented to an International Workshop on the Building Sector, Boston University Science Centre.

BUREAU OF AGRICULTURAL ECONOMICS (1984*a*), *Economic Potential of Selected Horticultural Crops: Overview,* Occasional Paper No. 87, A.G.P.S., Canberra.

——(1984*b*), *Forest Products: Situation and Outlook 1984, A.G.P.S.,* Canberra.

FOOD AND AGRICULTURE ORGANIZATION OF THE UNITED NATIONS (1977), *World Pulp and Paper Demand, Supply and Trade,* Vol. 1, Rome.

GRAFF, P. (1983), 'Paper consumption—a global forecast', *Pulp and Paper International,* May.

HEIKINHEIMO, L. (1981), 'Material constraints on the forest industries in Finland', *Proceedings of the XVII World Congress of the International Union of Forest Research Organizations, Kyoto, Japan, Division 4,* I.U.F.R.O. Secretariat, Vienna.

KATZ, E., Levin, M. L. and Hamilton, H. (1963), 'Traditions of research on the diffusion of innovation', *American Sociological Review,* 28, 237–52.

KOTLER, P. (1976), *Marketing Management,* Prentice-Hall, New Jersey.

MCLEAN, G. R. (1983), Dry forming techniques and product market development. Paper presented to the Outlook for Australia's Natural Fibres Conference, Canberra.

MANDL, G. (1983), 'Likely development of the U.K. industry', *Paper,* June.

NIELSON, P. F. (1983), The development of AQ Pulping. Paper presented to the Outlook for Australia's Natural Fibres Conference, Canberra.

ROGERS, E. M. (1962), *Diffusion of Innovations,* The Free Press, New York.

ROSETH, J. (1983), Residential densities of the future. Paper presented to the Conference of Forest Economists, Sydney.

UNITED STATES BUREAU OF CENSUS (1981), *Statistical Abstract of the United States: 1981* (102nd edition), Washington, D.C.

WALLACE, M. (1985), "Long-term projections of wood-based panel consumption in Australia", *Review of Marketing and Agricultural Economics* 53(3),

WALLIS, S. D. M. (1983), The economic future of lignocellulosic crops in Australia. Paper presented to the Outlook for Australia's Natural Fibres Conference, Canberra.