CASE STUDY

THE CASSAVA FLOUR DEMAND IN THE PLYWOOD INDUSTRY IN ECUADOR

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PREFACE

This study is done in aid of a CIAT/FUNDAGRO cassava project in the coastal region in Ecuador. The study was an initiative of the economics department of CIAT's cassava programme and has been accomplished mainly at FUNDAGRO in Quito.

CIAT, Centro Internacional de Agricultura Tropical, located near Cali in Colombia, is part of a system of 13 international agricultural research centres that help developing countries produce more food.
One of the primary purposes of CIAT is to develop, together with national agricultural research organizations, plant varieties that produce relatively high yields with minimal use of fertilizers and agricultural chemicals. Small farmers and low-income urban consumers are their main beneficiaries.

FUNDAGRO, Fundación para el Desarrollo Agropecuario, is an Ecuadorean, private, non-profit institution, located in the capital Quito, whose fundamental objective is to contribute to the improvement of the well-being of Ecuadorean people by promoting the development of the agricultural sector.
FUNDAGRO operates by means of commodity programmes in cassava, cattle, coffee, maize and potato.

My thanks for helping me to accomplish this study go out to the economics department of CIAT's cassava programme, especially to Guy Henry and Verónica Gottret, the people working at FUNDAGRO, especially to the head of the cassava programme there, Susan Poats, the Director of Programmes, Julio Chang, the person in charge of the cassava programme in Portoviejo, Carlos Egüez, and the student Juan Carlos Prado, and all the people working at the Unión de Asociaciones de Productores y Procesadores de Yuca (UAPPY) in Portoviejo.
A final, special thanks goes to Aad van Tilburg from the Marketing Department of the Agricultural University Wageningen for getting me in Latin America in the first place and afterwards for his indispensable comments.

Roy Brouwer,

Wageningen, June 1992.

Summary

A few years ago the union of cassava producing and processing associations (UAPPY) in the province Manabí in Ecuador depended for its sales almost entirely on the shrimp feed industry. In order to be able to serve more markets, it started to process more cassava products, among which sifted whole cassava flour, which could be sold to the plywood industry. Sifted whole cassava flour currently substitutes to a certain extent wheat flour in the resin with which sheets of wood are glued together.

The main purpose of this study is to estimate the cassava flour demand in the plywood industry in Ecuador. Therefore we first estimated the final demand, plywood, and next derived the cassava flour demand.

A second purpose of this study is to determine whether the estimated cassava flour demand is sustainable, meaning large enough to stimulate the union of cassava producing and processing associations to keep on providing sifted whole cassava flour to the plywood industry.

For this purpose we estimated cassava flour processing and transportation costs to the plywood companies and used them, together with estimated cassava flour prices, in a break-even analysis.

The estimated total plywood demand and derived of this the cassava flour demand grows from 1992 to 1996 with 17.7 percent. This means for the union of cassava producing and processing associations in Portoviejo that, if its market share in the plywood industry stays the same, it will sell almost 290 ton cassava flour in 1996.

The estimated annual cassava flour amounts sold by the union to the plywood industry are in the next 5 years larger than the estimated annual break-even amounts. Concluded is therefore that the estimated cassava flour amounts sold by the union in the next 5 years to the plywood industry are large enough to stimulate them to keep on providing cassava flour to this industry.

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CHAPTER 1 INTRODUCTION

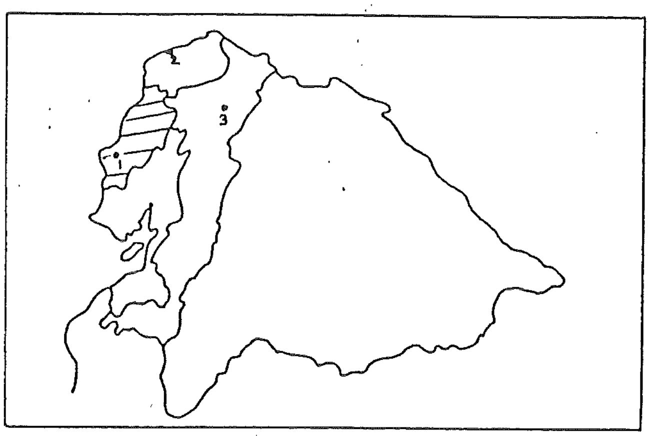
§ 1.1 The cassava project in Ecuador

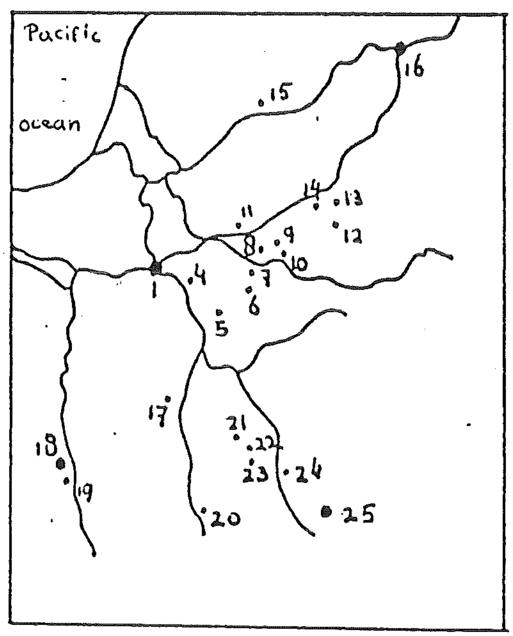
In October 1985 CIAT initiated a cassava project in the province Manabí in Ecuador and later in the province Esmeraldas.

Small cassava producers and processors are organized in "Asociaciones de Productores y Procesadores de Yuca" (APPYs), which are assembled in 2 provincial Unions called UAPPYs. There are 18 associations in Manabí with 360 participating farmers and 3 associations in Esmeraldas with 51 participating farmers.

In this study we will only consider the union and the associations in the province Manabí. Figure 1.1 shows their location.

Figure 1.1 Location of the union (UAPPY) and the associations (APPYs) in the province Manabí





Explanation:

shaded part is the province Manabí

1. Portoviejo
2. Esmeraldas
3. Quito
4. Maconta
5. Mata de Cady
6. San Vicente
7. Bijahual
8. Demonstration centre
9. Cascabel
10. Miguelillo
11. Bejuco
12. El Algodon
13. Las Piedras
14. Tablones
15. El Junco
16. Chone
17. El Chial
18. Jipi Japa
19. Pan y Agua
20. Rio Chico de Noboa
21. La Cuesta
22. Jaboncillo
23. San Miguel
24. Siete de Mayo
25. Olmedo

Legend:

town ●

APPY •

road ~

The main objective of the cassava project is the union of efforts between development institutions involved in agricultural research, extension and education, to establish appropriate technologies for the production, processing and utilization of cassava for small cassava producers (Egüez, 1991).

The objective of the union (UAPPY) is to improve the level of living of cassava producers by means of specific activities carried out together with the associations and supporting institutions (CIAT, FUNDAGRO, INIAP*, Technical University of Manabí, Ministry of Agriculture).

For 1991 an interinstitutional, national study on new markets for cassava products has been planned. The objectives of this national study are, among others, the detection of new cassava markets and knowledge about the use of cassava derivatives as substitutes for other raw materials.

§ 1.2 The processing of cassava

The associations produce and process cassava, while the union commercializes the cassava derivatives. Both the union and the associations operate on a processing year that starts the 1st of July and ends the 30th of June of the next year.

Of the 18 associations, 4 process cassava into starch, 13 produce dried cassava chips and 1 association produces both starch and dried chips.

The processing of cassava into cassava flour starts with the reception of cassava tubers at the associations.

The cassava tubers are transformed into small pieces, chips, with a mincing machine, whereafter these chips are distributed on a drying floor to dehydrate naturally. The chips are turned over every half hour to stimulate uniform drying. This process continues for 2 or 3 days, depending on the available amount of sun.

When the cassava chips have a humidity degree of about 12 percent, they are collected, put in sacks and handed over to the union, who mills the chips into flour, packs and stores the flour and sends it to the market.

Five flour classes can be distinguished:

1) whole cassava flour
2) white cassava flour
3) sifted whole cassava flour
4) sifted white cassava flour
5) cassava flour for human consumption.

* Instituto Nacional de Investigaciones Agropecuarias

Whole cassava flour results from cassava processed with peel, while white cassava flour is processed without peel. A finer cassava flour product is obtained by sifting cassava flour after it has been milled.

Cassava flour for human consumption is processed more hygienicly than the other flours. Cassava is peeled and washed before it is processed and the cassava chips are dried on trays instead of on a cement drying floor.

The by-product from processing cassava chips into flour is bran.

The processing of cassava into cassava starch is completely different from flour processing and requires generally larger plant investments.

§ 1.3 Motive for a national study on new cassava markets

A few years ago the union depended for its sales almost completely on the shrimp feed industry. As can be seen in table 1.1, 96 percent of the total production went to this industry in the processing period 1989-1990. In the next processing period this percentage decreased, but was still almost 70 percent of the total production.

Table 1.1 Sales of the annual production of UAPPY in the different markets

market	% of the total production 1989-1990	% of the total production 1990-1991
shrimp feed	96.0	69.3
cardboard box	-	12.0
plywood	-	13.0
bread	2.0	0.3
pasta and noodles	-	0.4
cattle and swine feed	2.0	5.0
total	100.0	100.0

Source: UAPPY, 1991

The shrimp industry in Ecuador exports the largest part of its total production. These exports collapsed in September 1989 as a result of strong Asian competition and a lack of shrimp larvae.
Consequently the shrimp feed industry in Ecuador, as said the largest buyer of cassava flour from the union, collapsed also and stopped buying cassava flour.

At the end of December 1989 shrimp feed factories began to buy cassava flour again and the union slowly sold off all of its stored production. The union realised, however, that it had to diversify its markets to avoid something like this to happen again.

§ 1.4 Markets for cassava products

The above mentioned national study (§ 1.1) is based on the experience of a similar study conducted in Colombia in 1990 to determine the feasibility of substituting presently used flours in human consumption markets with cassava flour.

In Ecuador three general markets for cassava derivatives can be distinguished:

1) the human consumption market
2) the animal feed market
3) the industrial market.

Within these 3 general markets, again several sub-markets can be distinguished (table 1.2).

Table 1.2 Markets for cassava derivatives

human consumption	animal feed	industrial
1) bread	1) cattle	1) cardboard box
2) pasta	2) poultry	2) textile
3) noodle	3) swine	3) plywood
4) ice	4) shrimp	4) glue
5) starch		
6) flour		
7) etc.		

In the human consumption market cassava flour and starch are used in bread, noodles, paste, ice-cream, etc.

In the animal feed market cassava derivatives are used as a carbohydrate source for cattle, poultry or swine, but also as a natural agglutinant for pellets used to feed shrimps.

In the industrial market cassava starch is used in the cardboard box industry to consolidate boxes and can in the textile industry be used to starch clothes. Cassava flour is used in the plywood industry as a filler in the resin with which sheets of wood are glued together.

§ 1.5 Justification of the study

This year (1991) studies have been planned by the cassava project to estimate the demand for cassava derivatives in the distinguished market types. These studies can be conducted in those markets where the union is already selling cassava products, like the cardboard box industry, the shrimp feed industry, the plywood industry, the pasta and noodle industry, or in industries where cassava products are not used yet, but where they theoretically could be.

A study on the potential of cassava starch in the cardboard box industry was conducted by the Centro de Desarrollo Industrial del Ecuador (CENDES) during the period of slack sales (§ 1.2).
This CENDES-study indicated a large potential for cassava starch in the cardboard box industry and the union sent cassava starch samples to cardboard box companies. In July 1990 one cardboard box company started buying cassava starch, soon followed by some others.

Market potential also seemed to exist in the glue industry, where chemicals are used as raw material to make glues (Mosquera, 1990). The union sent a starch sample to the largest glue company in Ecuador, Borden S.A., but after examinating the sample, this company concluded that cassava starch doesn't contain those product characteristics they are specifically looking for.

The amount of cassava starch that can be used in the textile industry in Ecuador is relatively small, according to the union.
The market potential in this industry depends mainly on the size of the industry (Cock, 1985). The textile industry in Ecuador is controlled by 1 company only, who has disintegrated its whole production process into several smaller functional units in order to avoid the complete shut down of the production line in case of labour troubles (strikes).

The two largest plywood companies in Ecuador, who claim to serve together 90 percent of the national market, are both buying every month considerable amounts of cassava flour* from the union.

* sifted whole cassava flour

Especially the largest of these 2 foresees considerable growth possibilities on short term within the Andean group*.

A future problem may, however, be the available amount of wood needed to produce plywood. All currently used wood originates from Ecuador.

The last decennium the annual deforestation rate in Ecuador was 2.3 percent, while until now no clear reforestation policies exist. Only the two largest plywood companies possess land on which they cultivate their own trees. To what extent this lack of reforestation policies will influence the future plywood production growth is unknown. All plywood companies are convinced that the government will never be able to forbid the production of plywood.

The potential of cassava derivatives in the animal feed market is reasonably well known. Not only does there exist literature** on this subject, the union is also selling already some years to the shrimp, cattle and poultry feed industry and consequently has considerable insight in what the possibilities are in this market segment.

The industries in the human consumption market generally consist of many small, artisanal factories. It will take up a great deal of time to determine the size of all industries involved, while the amount of cassava derivatives (flour or starch) that can be sold to the factories separately may expected to be relatively small.

However, it can be very interesting to explore the human consumption market, when the different sub-industries together make up a considerable potential. To avoid time problems, random samples from each industry can be taken.

Taking into consideration the present knowledge about the animal feed market and the available amount of research-time, the industrial market seems to be most appropriate for further research, not overlooking, however, the possible attractiveness of the human consumption market.

Taking furthermore into consideration that, within the industrial market, an extensive CENDES-study was written about the cassava starch potential in the cardboard box industry, that the glue industry wasn't interested in cassava starch, that the market potential in the textile industry is expected to be small, and that the plywood production is expected to expand, research seems to be most interesting in the plywood industry.

* the (economic) integration of the 5 Andean countries, Venezuela, Colombia, Ecuador, Peru and Bolivia, is described in appendix 1

** the technical potential of cassava derivatives in the animal feed industry has been described by A. Buitrago in his "La yuca en la alimentación animal" (CIAT, 1990)

§ 1.6 Objectives

The main objective of this case study is to estimate the demand for cassava flour in the plywood industry in Ecuador.

Derived of this, we want to demonstrate whether this estimated demand is sustainable, meaning large enough to keep the cassava flour production by the union for the plywood industry profitable.

§ 2.5 Division of the study

We will start in chapter 2 with a lay-out of the research framework, which we used to get to the derivation of the cassava flour demand in the plywood industry.

In chapter 3 we will give a description of the product plywood and take a look at production figures in the world. Chapter 3 ends with a description of plywood production and consumption in and exports from Ecuador.

In chapter 4 the products wheat and cassava flour will be discussed from raw material to final product. Issues dealt with will be the production of wheat grain and cassava tubers, imports, production of wheat and cassava flour and flour prices.

In chapter 5 and 6 we will deal with the factors that influence the plywood and cassava flour demand. The factors influencing the plywood demand were mentioned already in this chapter (§ 2.2).

Factors influencing the cassava flour demand are the product self, the cassava flour price, the distribution of cassava flour and the promotion of cassava flour. These factors correspond to the marketing mix elements of cassava flour.

Chapter 6 ends with an estimation of cassava flour prices.

In chapter 7 we will estimate the plywood demand and the derived cassava flour demand.

Chapter 8 deals with the processing costs of cassava flour. In the final paragraph of this chapter future fixed and variable production costs will be estimated and used in chapter 9, together with the earlier estimated cassava flour prices (chapter 6), in a break-even analysis from which future break-even amounts of cassava flour will result.

These break-even amounts will be compared with the estimated cassava flour demand in order to see whether the cassava flour demand from the plywood industry is sustainable in the future.

In the final chapter we will draw conclusions, discuss shortcomings of this study and make some recommendations.

CHAPTER 2 RESEARCH FRAMEWORK

§ 2.1 The cassava flour use in the plywood industry

Cassava flour is used together with wheat flour in the plywood industry as a filler in the resin with which sheets of wood are glued together (§ 1.4).

Until about 2 years ago, Ecuadorean plywood companies used wheat flour only for this purpose. This wheat flour, originating mainly of imported wheat grain, can be substituted partly by cassava flour by sifting the latter, giving in doing so cassava flour an almost similar grain size structure as wheat flour.

§ 2.2 The final demand

The main objective of this study, the estimation of the cassava flour demand in the plywood industry in Ecuador (§ 1.6), will be pursued by looking at the final product in which cassava flour is used as a raw material.

The demand for cassava flour from the plywood industry depends ultimately on the final demand for plywood. Because plywood is used in house-construction, furniture, floors, doors, etc., it can in its turn also be considered a raw material.

We will assume, however, that those factors brought out in this study to explain the final plywood demand are common factors, explaining the general plywood demand, not the demand for plywood in specific applications.

In figure 2.1 we show the separate steps in this study, leading to the estimation of the cassava flour demand.

The total Ecuadorean plywood demand consists of a national demand and a foreign demand.

The national demand component depends on the national plywood price, the national price of particleboard, which is plywood's local substitute, national income, population growth and urbanization degree ($D_N = F(Pni, Pnj, Yn, U)$ in figure 2.1).

The foreign demand component depends on the export price of Ecuadorean plywood, the world price of plywood, the world prices of plywood's international substitutes, being particleboard and medium density fibreboard, and the national incomes and population growth of the main Ecuadorean plywood importing countries ($D_F = G(Pfi, Pwi, Pfj, Pfk, Yf)$in figure 2.1).

National income and population growth are in both demand components represented in one variable: total gross national income.

The national and foreign plywood demand are estimated by means of linear regression. The number of observations with which both demands are estimated, are very low, namely 10 years (1 year = 1 observation).

Figure 2.1 Research framework

NATIONAL PLYWOOD DEMAND

$D_N = F(Pni, Pnj, Yn, U)$

FOREIGN PLYWOOD DEMAND

$D_F = G(Pfi, Pwi, Pfj, Pfk, Yf)$

TOTAL PLYWOOD DEMAND

$D_T = D_N + D_F = S_T$

TOTAL PLYWOOD PRODUCTION FROM EACH COMPANY

$Si = Xi \cdot S_T$

TOTAL FLOUR DEMAND FROM EACH PLYWOOD COMPANY

$Fi = \alpha i \cdot Si$

CASSAVA FLOUR DEMAND FROM EACH PLYWOOD COMPANY

$Ci = \beta i \cdot Fi$

D_N = national plywood demand
D_F = foreign plywood demand
D_T = total plywood demand
S_T = total plywood production
Si = plywood production from company i (i = 1,2,3,4)
Fi = wheat and cassava flour demand from plywood company i (i = 1,2,3,4)
Ci = cassava flour demand from plywood company i (i = 1,2,3,4)
Pni = national plywood price
Pnj = national particleboard price
Yn = Ecuadorean gross national income
U = urbanization degree in Ecuador
Pfi = export price Ecuadorean plywood
Pwi = plywood world price
Pfj = particleboard world price
Pfk = medium density fibreboard world price
Yf = gross national income of Ecuadorean plywood importing countries
Xi = share in the total plywood production of company i (i = 1,2,3,4)
αi = flour input coefficient of plywood company i (i = 1,2,3,4)
βi = expected cassava flour share in the total flour input by plywood company i (i = 1,2,3,4)

We assume that the total future plywood demand corresponds with the total future plywood production ($D_T = D_N + D_F = S_T$ in figure 2.1). This total future production will be spread over the separate plywood companies according to their present and for the next five years constant assumed shares in the total plywood production ($Si = Xi \cdot S_T$ in figure 2.1).

§ 2.3 The derived demand

The demand for flour (wheat and cassava flour) is derived from the plywood production by looking how much flour is needed to produce one plywood unit (αi in figure 2.1).

A problem is, however, to determine this plywood unit. Plywood, being an odd number of plies glued and pressed together, may consist of between 3 and 21 plies. The more plies a product consists of, the more glue, and consequently flour, is needed.

Every plywood company produces different amounts of different plywood products and considerable differences in the used amounts of flour among companies may therefore exist. The flour demand is considered also for each plywood company ($Fi = \alpha i \cdot Si$ in figure 2.1).

When we have estimated the plywood demand and derived for each plywood company the total flour (wheat and cassava flour) demand, the cassava flour demand can be estimated ($Ci = \beta i \cdot Fi$ in figure 2.1).

Each plywood company uses different amounts of cassava flour (in relation with wheat flour) in its resin. We calculated expected substitution levels for cassava flour for each plywood company (βi in figure 2.1), taking into account present cassava flour shares (in the total flour input) and the by each plywood company different viewed possible maximum shares of cassava flour in the total flour input.

§ 2.4 The sustainability of the cassava flour demand

After we estimated the cassava flour demand in the plywood industry, we will raise the question whether this estimated demand is large enough to stimulate the union in Portoviejo to keep on providing cassava flour to this industry in the future.

Therefore the processing costs of cassava flour* are estimated and used in a break-even analysis to determine the amount of cassava flour that the union has to produce to get at least all costs back. The outcome of this break-even analysis is next compared with the estimated cassava flour demand.

* plywood companies purchase **sifted whole cassava flour** from the union in Portoviejo (see § 1.5)

A break-even analysis determines the quantity that has to be sold to cover all costs incurred in providing a specific product to a specific market.

The derivation of the formula with which this quantity can be calculated is shown below:

1) total revenues (TR) equal total costs (TC): $TR = TC$

2) total revenues consist of an unit price (p) and the total quantity sold (Qd): $TR = p \cdot Qd$

3) total costs consist of total fixed (TFC) and total variable costs (TVC): $TC = TFC + TVC$

4) total variable costs equal the variable unit costs (vc) times the quantity produced (Qs): $TVC = vc \cdot Qs$

5) assuming, among others, that the produced quantity in period t equals the quantity sold in period t ($Q=Qd=Qs$):

   $p \cdot Q = TFC + vc \cdot Q$,

   or: $\mathbf{Q = TFC/(p - vc)}$,

The variable Q represents in this formula the quantity that has to be sold to break even, that is, the amount at which all costs, variable as well as fixed, are covered by the revenues in a specific market.

If future sold quantities smaller are than the break-even quantities, production is unprofitable, while on every product sold above the break-even quantity profit will be made.

Future prices needed in the break-even analysis will be derived of past wheat and cassava flour prices by means of linear regression.

CHAPTER 3 PLYWOOD

In this chapter we will start with a description of plywood and its production process. Next plywood production and exports are discussed from a world level to country (Ecuador) level.

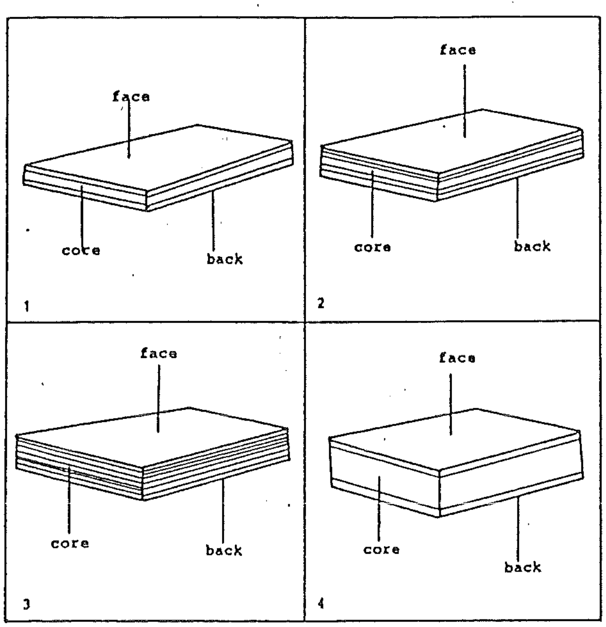
§ 3.1 Plywood

Plywood is, according to the Hardwood Plywood Manufacturers Association (1977), defined as a panel composed of an assembly of layers or plies of veneer joined with an adhesive. A number of wood species are used to make plywood, like Cedar, Balsa, Laurel, Ceiba, Balm, Oak, Teak or Mangrove.

Plywood panels are constructed with an odd number of plies. The core, the innermost part of plywood, may be of veneer, sawed lumber, particleboard, hardboard or some other material. Figure 3.1 shows some typical plywood constructions.

Plywood can be divided into hardwood and softwood plywood. Hardwood plywood is distinguished from softwood plywood in that the former is generally used for decorative purposes and has a face ply of wood from a deciduous or broad leaf tree. Softwood plywood is generally used for construction and structural purposes and the veneers typically are of wood from evergreen or needle-bearing trees (McDonald, 1977).

Figure 3.1 Typical plywood constructions



1: three-ply veneer core construction
2: five-ply veneer core construction
3: multiply veneer core construction
4: three-ply particleboard or lumber core construction

Source: "Hardwood and decorative plywood", Hardwood Plywood Manufacturers Association, 1983

In Ecuador 4 main plywood quality grades are distinguished, being, in order of best quality to worst, A, B, C and D. The best quality classes, A and B, are exported, while the poorer quality classes are sold locally, because of higher quality demands abroad.

Quality grade A is plywood in a perfect state, while quality grade D is plywood with considerable defects, like a damaged face or back or plywood consisting of loose plies.

Every plywood company in Ecuador has besides quality control during the production process, also qualified people, who classify each produced plywood product according to the above mentioned grades.

The technological way in which plywood is produced is the same all over the world, just the values of the technical parametres in the production process differ from country to country and within a country from company to company.

The plywood production process consists of the following steps:

1) reception of the trunks at the plant
2) skinning the trunks
3) laminating the trunks by means of sharp blades on the axis of a lathe
4) drying the resulting sheets
5) shaping the sheets
6) gluing the sheets together
7) assembling the sheets
8) pressing the sheets, resulting in plywood
9) cutting and framing plywood
10) sanding the face of plywood
11) classifying plywood.

In step 6 the raw material of interest enters, the resin with which sheets of wood are glued together and in which, at least in Ecuador, wheat and cassava flour are used. This resin consists furthermore of a chemical glue, water, an insecticide and a katalysator.

In Ecuador almost all plywood companies use the same above mentioned inputs in the resin, but it is unknown whether this is also the case in the rest of the world. The relative quantities of each of these input components in the resin differs in Ecuador from company to company.

§ 3.2 World plywood production and exports

The United States produce most plywood in the world, followed by Indonesia and Japan. The shares of these countries in the total world production in 1989 were 39, 17 and 13 percent respectively. The total world plywood production and the production of countries producing most plywood in the world from 1980 up to and including 1989 are presented in table 3.1.

Table 3.1 Total world plywood production and production of the largest plywood producing countries

production in thousands cubic metres

year	world	USA	Japan	Indonesia	Canada	Brazil
1980	39,383	14,857	8,000	1,011**	2,338	826
1981	40,306	16,300	7,096	1,552**	2,086	902
1982	38,888	14,803	6,742	2,487	1,850	902*
1983	44,083	18,169	7,291	3,138	2,270	902*
1984	44,009	18,425	7,083	3,600	2,050	902*
1985	44,825	18,580	7,033	4,615	2,190	902*
1986	47,679	20,484	6,824	5,750	1,877	902*
1987	48,985	19,450	7,340	6,400	2,221	1,200
1988	50,433	19,280	7,291**	7,733**	2,162	1,300
1989	51,296	19,800	6,707**	8,784**	2,165	1,300*

* FAO estimate
** unofficial figure

Source: FAO Yearbook 1989, Forest products 1978-1989, FAO Forestry Series no.24, FAO Statistics Series no.97, Rome, 1991

Indonesia exports most plywood in the world, followed by the United States and Malaysia. Indonesia exported almost 92 percent of its total production in 1989 and the United States 7 percent (FAO, 1991). Malaysia had a total plywood production of almost 1.1 million cubic metres in 1989 of which 85 percent was exported (FAO, 1991).

In South America, Brazil is the largest plywood producer and exporter with an estimated total production in 1989 of 1.3 million cubic metres (table 3.1), of which 28 percent was exported (FAO, 1991).

§ 3.3 Plywood production in and plywood exports from the Andean countries

The total Andean plywood production in 1989 was 203 thousand cubic metres (see table 3.2), which is only 0.4 percent of the total world production in that same year. Of this amount 9 percent was exported (table 3.2).

While in 1980 Colombia, Ecuador, Venezuela and Peru contributed all in almost the same proportion to the total Andean plywood production, Ecuador had enlarged its share in this total in 1989. Bolivia's share in the total Andean plywood production diminished from almost 3 percent in 1980 to less than 1 percent in 1989.

Colombia, Ecuador, Peru and Bolivia export a part of their plywood production, while Colombia also imports plywood. Venezuela is the largest plywood importer of the 5 Andean countries. In 1989 Venezuela imported 15 thousand cubic metres plywood and Colombia 3 thousand cubic metres (FAO, 1991).

Table 3.2 Plywood production and exports of the Andean countries in thousands cubic metres

year	Colombia P	Colombia E	Ecuador P	Ecuador E	Venezuela P	Peru P	Peru E	Bolivia P	Bolivia E
1980	52	-	59	51	55	49	1	6	2
1981	40	-	65	26	69	40	1	6	3
1982	48	1	65*	26	37	37	1*	6	4
1983	37	-	65*	8	47	22	1*	5	1
1984	37*	2	65*	9	47*	30	1*	1	1*
1985	37*	2*	53	11	34**	20	-	2	1*
1986	37*	2*	60	15	40**	35	-	3	1
1987	37*	6	72	34	40*	43	-	3*	1
1988	37*	5	74	20	53**	40	-	3	4
1989	37*	5	76	13	53*	35	-	2	1

P = production * FAO estimate
E = exports ** unofficial figure

Source: FAO Yearbook 1989, Forest products 1978-1989, FAO Forestry Series no.24, FAO Statistics Series no.97, Rome, 1991

§ 3.4 Plywood production, exports and apparent domestic consumption in Ecuador

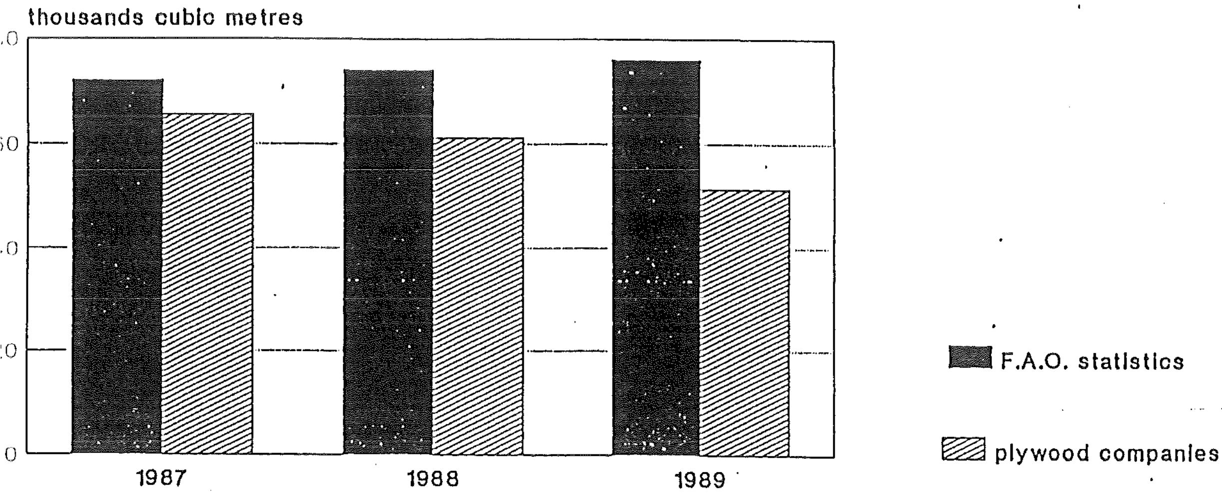
In Ecuador 5 plywood producing companies exist, being Enchapes Decorativos S.A. (ENDESA), Plywood Ecuatoriana S.A., Contrachapados de Esmeraldas S.A. (CODESA), Forestal Esmeraldeña S.A.(FORESA) and BOTROSA. The last company, BOTROSA, however, only produces plies, which are sent to its co-partner ENDESA, who actually glues the plies together to get plywood and who, in doing so, uses an adhesive in which wheat and cassava flour are used. Therefore, BOTROSA will not be considered in this study.

The plywood companies can be grouped according to their owner. ENDESA, and BOTROSA are, as said, co-partners and their mutual owner is the Peña Durini family. Plywood Ecuatoriana and CODESA also belong to the same owner, the family Alvarez Barba. Only FORESA operates alone in the plywood industry in Ecuador. Its owner is called Patiño.

The joint, actual capacity installed of the 4 plywood producing companies is 80,800 cubic metres each year. In 1989 63.5 percent of this capacity was productive and in 1990 70.6 percent.

The total plywood production in Ecuador has already been presented in table 3.2 in paragraph 3.3. But the production figures from 1980 to 1989 in table 3.2 are published by the FAO and show a considerable difference with the available 1987-1989 production figures from the plywood companies themselves. Figure 3.2 shows this graphically.

Figure 3.2 Ecuadorean plywood production figures published by the FAO and plywood production figures provided by plywood companies themselves



In 1987 the total plywood production given by the plywood companies was 90.9 percent of the plywood production given by the FAO. In 1988 this was 82.6 percent and in 1989 67.5 percent.

Because the FAO is the only information source publishing time series of plywood production in and plywood exports from Ecuador, these production and exports figures from 1980 to 1989 (table 3.2 in § 3.3) will be used in chapter 7 to estimate the national and foreign plywood demand.

We will, however, correct the estimated plywood demand (based on the FAO-figures) with the limited information provided by the plywood companies. According to these companies, the Ecuadorean plywood production was 57,013 cubic metres in 1990.

In order to get a little more insight in the structure of the plywood industry, the production shares of the separate companies are presented in table 3.3.

All information provided by plywood companies has to be treated with most discretion and the companies will therefore be numbered arbitrary in the following as company 1 to 4.

These shares have been reasonably stable during the period 1987-1990. Company 3 has been and still is the largest plywood producer in Ecuador. Company 4 is the second largest, but the difference in production share with company 2 has become almost zero in 1990. Company 1 is the smallest company in the plywood industry.

Table 3.3 Production shares of the plywood companies in the total plywood production from 1987 to 1990

year	company 1 (%)	company 2 (%)	company 3 (%)	company 4 (%)
1987	17.5	21.1	36.4	25.0
1988	16.1	19.8	41.8	22.4
1989	14.4	20.9	41.3	23.3
1990	17.3	21.4	39.8	21.6
average	16.3	20.8	39.8	23.1

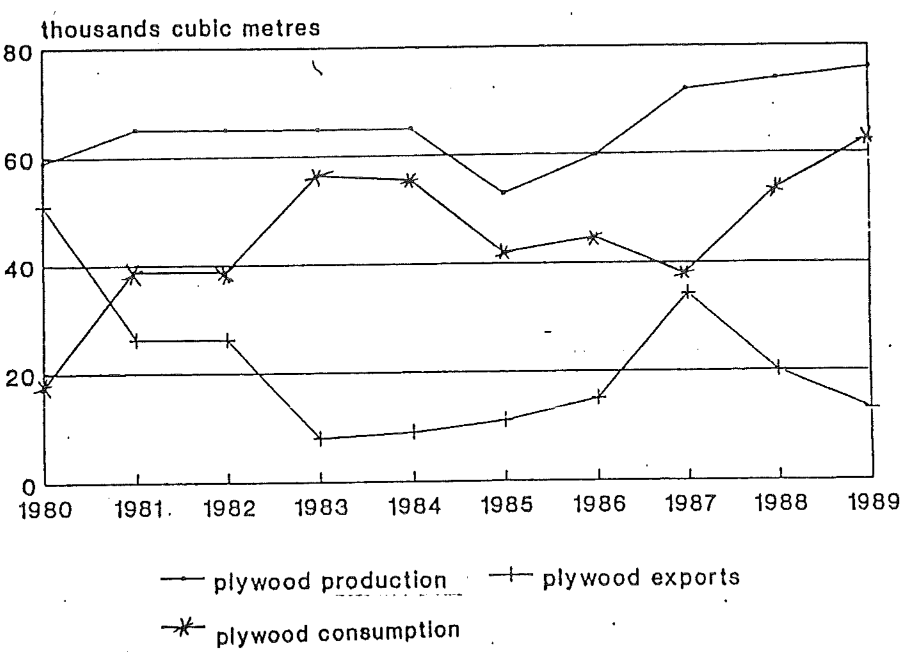
Note: in some years percentages don't add up to 100 because of differences in rounding off

Source: Plywood companies Ecuador, 1991

The exports of Ecuadorean plywood have also been presented in table 3.2 in paragraph 3.3. These exports figures show a fluctuating course, while the total production increased since 1985.

Subtracting the exports from the total production results in the apparent domestic plywood consumption, which we will consider the national plywood demand. In figure 3.3 the total Ecuadorean plywood production, apparent consumption and exports are shown graphically.

Figure 3.3 Production, exports and apparent domestic consumption of Ecuadoran plywood



Since 1984 most Ecuadorean plywood has been exported to the United States. In 1990 67.8 percent of the Ecuadoran plywood panels exports went to the United States, 13.3 percent to Colombia, 11.7 percent to the United Kingdom, 3.4 percent to Peru, 2.3 percent to Canada, 0.8 percent to Sweden and 0.7 percent to Spain (Banco Central del Ecuador, 1991).

As mentioned in paragraph 1.5, one of the major problems faced by the plywood industry in Ecuador is reforestation. All wood used in the plywood industry originates from Ecuadorean forests.

Of the 14,730 thousand hectares existing forest in the 1980's in Ecuador, on average 340 thousand hectares disappeared annually during this decennium, i.e. an average annual deforestation rate of 2.3 percent, while the average annual reforestation in the 1980's was only 6,000 hectares, i.e. an average annual reforestation rate of 0.04 percent (The World Resources Institute, 1990).

Only 2 plywood companies have bought land on which they grow their own trees to ensure future wood supply. A lot of money is involved in these projects, because of the long pay-back time of the invested money and the high interest rates prevailing in Ecuador. Plywood companies see reforestation in the first place as a government task and complain about the lack of clear reforestation policies.

None of the plywood companies thinks that the government will forbid in the future the plywood production. Not only because of the valuta inflow from plywood exports, but also because of the amount of people working in this industry.

CHAPTER 4 WHEAT AND CASSAVA FLOUR

As mentioned in paragraph 3.1, wheat and cassava flour are inputs in the resin which is used to glue sheets of wood together to get plywood. In this chapter we will discuss the production of wheat and cassava flour from raw material to final product.

§ 4.1 Wheat production and imports

Wheat is cultivated in Ecuador, but production has traditionally been smaller than demand, resulting in imports.

The share of the national wheat production in the total supply of wheat diminished from 1975 to 1990 with almost 74 percent. While in 1975 still 24.4 percent of total supply consisted of national wheat, this was only 6.4 percent in 1990 (see table 4.1).

Wheat imports increased from 1975 to 1990 with 216 percent. In 1988 and 1989 imports fell back a little, probably because of the elimination of a wheat import subsidy, in force until then, but in 1990 imports were at a new and never before reached level again (table 4.1).

Table 4.1 Total wheat supply in Ecuador from 1975 to 1990

year	national production (mt)	share (%)	imports (mt)	share (%)	total supply (mt)
1975	64,647	24.4	200,405	75.6	265,052
1976	46,422	15.9	245,947	84.1	292,369
1977	39,800	16.0	209,026	84.0	248,826
1978	28,904	10.2	254,345	89.8	283,249
1979	31,248	10.6	263,659	89.4	294,907
1980	31,113	9.0	314,191	91.0	345,304
1981	41,431	12.0	304,617	88.0	346,048
1982	38,538	11.0	312,845	89.0	351,383
1983	26,914	7.9	312,223	92.1	339,137
1984	25,172	6.1	384,493	93.9	409,665
1985	18,464	5.0	353,979	95.0	372,443
1986	23,277	5.8	378,680	94.2	401,957
1987	17,498	4.4	380,790	95.6	398,288
1988	24,019	6.4	350,055	93.6	374,074
1989	29,069	7.9	336,603	92.1	365,672
1990	29,645	6.4	433,199	93.6	462,844

mt = metric tons

Source: MAG, "Situación y pronóstico del cultivo del trigo en el Ecuador 1990-1991", 1991

Wheat imports originate entirely from the U.S.A.. Since October 1991 the government allowed wheat importers also to buy from Canada, where the wheat price was lower than in the USA (C.Yugcha, November 1991). Permissions to import wheat are granted by the Ministerio de Agricultura y Ganadería.

§ 4.2 Wheat flour

The import of wheat flour is not allowed in Ecuador. All flour is produced nationally. There exist 25 wheat flour mills in Ecuador who have together an estimated capacity of 674,000 metric tons per year (MAG, 1991). The three largest mills in Ecuador are Molinos del Ecuador and Industrial Molinera both located in the province Guayas in the coast and La Unión in the province Pichincha in the sierra. Their shares in the total flour production in the period 1983-1984 was respectively 21.7, 25.1 and 10.6 percent (R.Urriola and M.Cuvi, 1986).

The share of national wheat in the total amount of wheat used by Ecuadoran mills is even smaller than its share in the total wheat supply in Ecuador. In the period 1989-1990 only 3.2 percent of the total wheat input originated from Ecuador, as can be seen from table 4.2, while the share of national wheat in the total wheat supply in Ecuador in 1990, as we saw in table 4.1, was twice as much, namely 6.4 percent.

Table 4.2 Total wheat flour production from national and imported wheat

agricultural year	national wheat (mt)	imported wheat (mt)	flour production (mt)
1975-1976	23,799	200,716	171,034
1976-1977	22,948	223,805	186,271
1977-1978	23,649	245,089	209,727
1978-1979	22,482	262,094	218,526
1979-1980	16,398	277,127	227,018
1980-1981	19,874	311,327	253,370
1981-1982	20,412	319,782	260,803
1982-1983	24,388	315,071	260,879
1983-1984	4,843	342,262	261,894
1984-1985	10,145	357,327	279,005
1985-1986	13,254	374,541	290,400
1986-1987	15,892	367,085	288,032
1987-1988	11,319	398,428	311,113
1988-1989	10,229	346,923	267,864
1989-1990	10,707	327,265	254,087

mt = metric tons

Source: MAG, "Situación y pronóstico del cultivo del trigo en el Ecuador 1990-1991", 1991

Wheat flour is used for different purposes. In 1987 34 percent of the total wheat flour production went to bread-making, cakes and biscuits, almost 25 percent to noodles, 18 percent to balanced food, 21 percent to wholesalers and 1.91 percent to others (see table 4.3). The wheat flour sales to the plywood industry will be included in this 1.91 percent.

Table 4.3 Destination of the total wheat flour production in 1987

	%
bread making, cakes and biscuits	34.37
noodles	24.51
balanced food	18.11
wholesalers	21.10
others	1.91
total	100.0

Source: IMSA and ANDEMOL, 1988

The plywood industry is buying its wheat flour from the following mills:
- Molino Superior S.A.
- Molinos La Unión S.A.
- El Condor.

The last mill, El Condor, sells very small amounts of wheat flour to the plywood industry. Its main target group are breadmaking companies and only in case their production is larger than the sales to this group, they sell their over-production to plywood companies.

The amounts of wheat flour used by plywood companies in their production process in 1990 are shown in table 4.4. Together these companies used 1,392,745 kilograms wheat flour in this year, while the total wheat flour supply in the period 1989-1990 254,087 tons was (table 4.2), meaning that about 0.55 percent* of the total flour production in that period to the plywood industry went.

Table 4.4 Total amount of wheat flour used by plywood companies in 1990

company	wheat flour input (kilograms)
1	256,490
2	347,750
3	443,044
4	345,461
total	1,392,745

Source: plywood industry, 1991

* (1,392,745 kg / 254,087 tons) · 100% = 0.55%

§ 4.3 Wheat and wheat flour prices

Wheat imports have been stimulated by the government, who paid not only the difference between a higher world price of wheat and a by government established referential price for imported wheat to wheat importers, mainly mills, but also importation expenses.

Only in 1977, the beginning of 1978 and the end of 1982 was the world price of wheat lower than the established referential price and had wheat importers to deposit the difference in a special fund of the Ministerio de Industrias, Comercio, Integración y Pesca.

A referential price for imported wheat was first established in October 1973 to stabilize import prices. Since January first 1988 the government abolished the subsidy (a referential price is still maintained) and instead enlarged credit provisions to wheat importers.

The government establishes also a support price for national wheat. This national support price has always been higher than the referential price of imported wheat, except in 1988 and 1989, and was therefore unable to compete with imported wheat. In table 4.5 the prices of national and imported wheat are put together for the years 1976 to 1990.

The government furthermore fixes every three months, together with a referential price for imported wheat and a national wheat support price, a ceiling price (ex-mill) for wheat flour by means of Ministerial Agreements of the Frente Económico. This price is established to protect the consumer (Frente Económico, 1991).

Table 4.5 Average prices of national (support price) and imported wheat (referential price) at mill level

year	support price (Sucres/50 kg)	support price (US dollars/50 kg)	referential price (Sucres/50 kg)	referential price (US dollars/50 kg)
1976	203.5	0.265	174.3	0.227
1977	203.5	0.265	175.0	0.228
1978	275.0	0.358	166.7	0.217
1979	275.0	0.358	151.4	0.197
1980	363.0	0.473	171.9	0.224
1981	363.0	0.473	178.7	0.233
1982	440.0	0.573	250.6	0.327
1983	440.0	0.573	432.8	0.564
1984	770.0	1.003	602.2	0.785
1985	1320.0	1.720	957.2	1.247
1986	1320.0	1.720	1025.6	1.337
1987	1760.0	2.294	1279.0	1.667
1988	2755.7	3.591	2862.6	3.730
1989	5812.1	7.574	6078.7	7.922
1990	8038.4	10.475	8038.4	10.475

average official exchange rate 1990: 1 US $ = S/. 767.36

Source: MAG, "Situación y pronóstico del cultivo del trigo en el Ecuador 1990-1991", 1991

The referential price of imported wheat is based on the import costs of wheat, like freight costs, taxes, customs duties and so on (Frente Económico, 1991). The ex-mill ceiling price of wheat flour is based on the referential and support price of wheat and the processing costs of wheat into wheat flour. This is shown in table 4.6, where the ceiling price of wheat flour is established for the months April, May and June 1991. The costs are in current Sucres. Table 4.7 shows the established wheat flour prices from January 1990 to September 1991.

Table 4.6 Demonstration of the calculation of the ceiling price of wheat flour

1. raw material costs to produce 50 kg of wheat flour:	imported wheat 59.62 kg • S/. 187.61 =	S/.11,185.01
	national wheat 4.49 kg • S/. 250.00 =	1,122.50
minus recovery of by-products: 14.10 kg • S/. 68.00 =		- 958.80
		11,348.71
2. processing costs of 50 kg wheat flour		3,368.27
3. total production costs		14,716.98
4. profit awarded (6%)		883.02
5. ex-mill price per 50 kg		S/.15,600.00

Source: Frente Económico, Acuerdo No. 91-005, August 12th 1991

Table 4.7 Wheat flour prices established by the Frente Económico and actual market prices paid by the plywood industry

		government price		actual price	
year	month	Sucres/50 kg	US $/50 kg	Sucres/50 kg	US $/50 kg
1990	January	12,300.00	16.03	14,550.00	18.96
	February	12,300.00	16.03	14,550.00	18.96
	March	12,300.00	16.03	14,550.00	18.96
	April	12,743.72	16.61	14,550.00	18.96
	May	12,743.72	16.61	14,550.00	18.96
	June	12,743.72	16.61	14,550.00	18.96
	July	15,000.00	19.55	14,550.00	18.96
	August	15,000.00	19.55	14,550.00	18.96
	September	15,000.00	19.55	14,550.00	18.96
	October	15,000.00	19.55	14,550.00	18.96
	November	15,000.00	19.55	14,550.00	18.96
	December	15,000.00	19.55	14,550.00	18.96
1991	January	15,000.00	19.55	14,550.00	18.96
	February	15,000.00	19.55	14,550.00	18.96
	March	15,000.00	19.55	16,200.00	21.11
	April	15,600.00	20.33	16,200.00	21.11
	May	15,600.00	20.33	16,200.00	21.11
	June	15,600.00	20.33	16,200.00	21.11
	July	17,600.00	22.94	16,200.00	21.11
	August	17,600.00	22.94	17,150.00	22.35
	September	17,600.00	22.94	17,150.00	22.35
	October	n.a.	n.a.	17,150.00	22.35
	November	n.a.	n.a.	19,400.00	25.28
	December	n.a.	n.a.	19,400.00	25.28

n.a. = not available
average official exchange rate 1990: 1 US $ = S/. 767.36

Source: Acuerdos del Frente Económico and Molinos La Unión, 1991

The prices of wheat flour, established by the government, don't correspond with the actual prices paid by plywood companies. When a plywood company buys regularly wheat flour in large amounts, considerable discounts are provided. The actual prices paid by plywood companies are presented also in table 4.7.

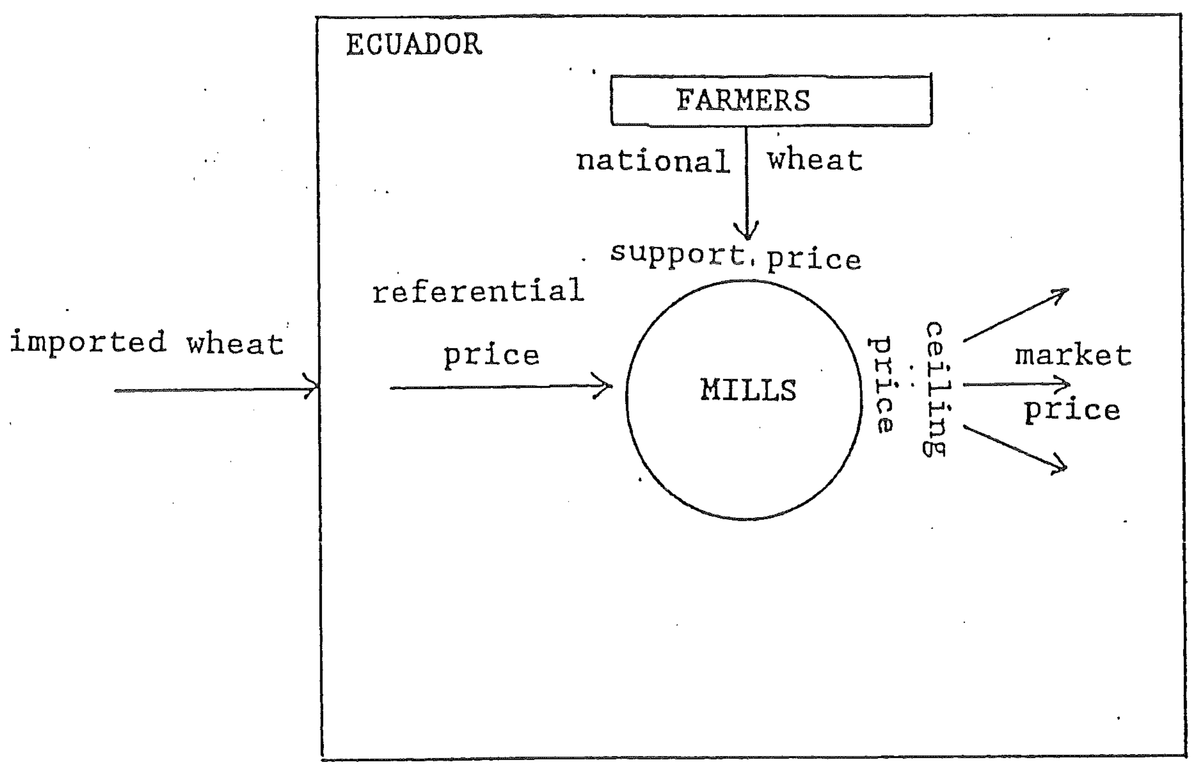
In 1990 the actual (current) price was constant, while it increased with 33 percent in 1991.

The wheat flour price established by the government increased with 22 percent in 1990 and with 17 percent from January until September 1991.

As can be seen from table 4.7, the actual price was higher than the government price from January 1990 to June 1990. Then, from July 1990 up to and including February 1991, the actual market price was lower than the government price. From March until June 1991 the actual price was higher again than the government price. During July, August and September 1991, the government price was higher than the actual market price.

In figure 4.1 we summarized the distinguished wheat and wheat flour prices in a comprehensive scheme.

Figure 4.1 The distinguished wheat and wheat flour prices in Ecuador



§ 4.4 Cassava production in Ecuador

The cassava production diminished with 3 percent in Ecuador from 1966 to 1979 and with 5.9 percent from 1979 to 1989 (CIAT, 1991). In 1990 the total cassava production was 134,245 metric tons, of which 31.7 percent originated from the mountain region, 26.0 percent from the coast region and 42.3 percent from the east region (INEC, 1990).

The province Manabí had the largest area cultivated with cassava in 1990, namely 428 thousand hectares, of which 30 percent in combination with other crops. On this area 15,338 metric tons cassava were produced.

When compared with other Latin American countries, the average cassava yield is low in Ecuador, 5,882 kilograms per hectare in the period 1987-1989, while neighbour countries like Colombia and Peru had average yields of 8,458 and 10,620 kilograms respectively over the same period (CIAT, 1991).

§ 4.5 Cassava chips and cassava flour production by the cassava project in Manabí

As mentioned in chapter 1, the associations in the cassava project in Manabí in Ecuador mince cassava tubers into cassava chips and dry these chips on cement drying floors. The union next processes the dried chips into different cassava flour products.

In the processing period 1989-1990 the available drying area of the associations was 20,130 square metres, consisting of own and rented cement floor and trays, while in the processing period 1990-1991 the total drying area increased to 35,690 square metres, including 600 square metres drying floor at the union's demonstration centre.

In the processing period 1989-1990, 2,971 tons cassava were produced by the members and non-members involved in the cassava project in Manabí, of which 2,703 tons were used to produce 956 tons dried cassava chips.

In 1990-1991 5,135 tons cassava were produced, of which 4,495 tons were processed into 1,346 tons dried chips. The total dried cassava chips production of each association during the processing period 1990-1991 is shown in table 4.8.

The associations differ in the amount of cassava needed to produce one unit dried cassava chips, i.e. the conversion rate of cassava into dried cassava chips. This conversion rate is an efficiency graduator. Raw material is the largest cost item in the production costs of the associations. A favourable conversion rate will therefore lead to lower total production costs (more of this will be discussed chapter 8).

Table 4.8 Dried cassava chips production of each association from July 1990 to June 1991

association	whole pieces (qq)	whole pieces (kg)	white pieces (qq)	white pieces (kg)
Tablones	1,272.15	57,704.72	3,231.83	146,595.81
Bejuco	365.19	16,565.02	1,085.94	49,258.24
Bijahual	1,809.00	82,056.24	686.00	31,116.96
Miguelillo	2,024.00	91,808.64	3,788.00	171,823.68
Maconta	863.24	20,408.83	449.93	20,408.83
Mata de Cady	909.80	41,268.53	951.65	43,166.84
El Chial	915.84	41,542.50	1,578.71	71,610.29
Jaboncillo	594.90	26,984.66	3,364.82	152,628.24
Siete de Mayo	604.72	27,430.10	2,092.24	94,904.00
El Junco	143.74	6,520.05	875.66	39,719.94
Pan y Agua	298.16	13,524.54	374.77	16,999.57
Rio Chico de Noboa	297.45	13,492.33	728.19	33,030.70
La Cuesta	405.66	18,400.74	976.76	44,305.83
El Algodón	121.66	5,518.50	600.53	27,240.04
Demonstration centre	175.32	7,952.52	698.92	31,703.01

qq = quintal = 45.36 kg

Source: UAPPY, 1991

In the processing period 1985-1986, the first processing period of the cassava project, only dried whole cassava chips were produced and sold to the chicken feed industry. In the next processing periods, these whole chips were further processed into flour and sold to the shrimp feed industry.

In the processing period 1988-1989 the union began to produce white as well as whole cassava flour, because of the preference of some shrimp feed companies for white cassava flour.

Since 1989-1990 the total production of these different flour types are distinguished in the union's accounts. In the processing period 1989-1990 the union also began to sift whole and white cassava flour (table 4.9).

Table 4.9 The production of cassava flour products by the union from its first processing period 1985-1986 until the processing period 1990-1991

processing period	cassava flour type: whole flour (mt)	white flour (mt)	sifted whole flour (mt)	sifted white flour (mt)
1985-1986	50			
1986-1987	79			
1987-1988	353			
1988-1989	1,012			
1989-1990	365	565		33
1990-1991	286	982	200	6

mt = metric tons

Source: UAPPY, 1991

The union's flour production in 1990-1991 was sold to different customers. Whole and white cassava flour were sold to the shrimp feed industry, sifted whole cassava flour solely to the plywood industry and sifted white cassava flour to the pasta and noodle industry.

The amounts of sifted whole cassava flour sold to the plywood industry, since this industry began buying cassava flour from the union in February 1990, are presented in table 4.10.

Table 4.10 Amounts of sifted whole cassava flour sold to the plywood industry

year	month	amount (qq)	amount (kg)
1990	January	--	--
	February	300.0	13,608.0
	March	143.0	6,486.5
	April	225.5	10,228.7
	May	412.5	18,711.0
	June	420.2	19,060.3
	July	221.1	10,029.1
	August	407.0	18,461.5
	September	330.0	14,968.8
	October	210.1	9,530.1
	November	365.0	16,556.4
	December	209.0	9,480.2
1991	January	330.0	14,968.8
	February	242.0	10,977.1
	March	370.7	16,815.0
	April	491.7	22,303.5
	May	495.0	22,453.2
	June	165.0	7,484.4
	July	539.0	24,449.0
	August	495.0	22,453.2
	September	495.0	22,453.2
	October	550.0	24,948.0
	November	495.0	22,453.2
	December	495.0	22,453.2

qq = quintal = 45.36 kg

Source: UAPPY, 1991

Two of the 4 plywood companies in Ecuador are buying cassava flour from the union in Portoviejo. From the other 2 plywood companies, 1 is not using cassava flour at all in its production process and the other purchases its cassava flour from cassava flour producers in the towns of Esmeraldas and Santo Domingo.

One of the first 2 companies, who both buy cassava flour from the union, also gets its cassava flour from another cassava flour mill in Portoviejo.

In table 4.11 we can see that plywood company 1 doesn't use cassava flour in its production process, only wheat flour, that company 3 used most cassava flour in 1990 and that company 4 used in 1990 twice as much cassava flour as company 2.

Plywood companies use cassava flour only recently as a substitute for wheat flour. Company 2 and 4 probably used it already before March 1990, when company 3 started to use it.

Table 4.11 Amounts of cassava flour used by the different plywood companies in Ecuador in their production process

year	plywood company	cassava flour input in kilograms
1990	2	30,658
	3	116,956
	4	60,964
1991	2	not available
	3	176,482
	4	69,000

Source: plywood industry, 1991

When we add up the monthly amounts of cassava flour sold by the union to the plywood industry in 1990 in table 4.10 (=147,120.6 kg) and the amounts of cassava flour used by plywood companies in 1990 in table 4.11 (=208,578 kg), we find, after dividing these figures, that 70.5 percent of the total amount of cassava flour purchased by the plywood industry in the year 1990 originated from the union in Portoviejo.

§ 4.6 Cassava flour prices

In paragraph 4.5 we mentioned that the different cassava flour products produced by the union are sold in different markets. The prices the union received for the different flour products are shown below in table 4.12. More further processed cassava flour received a higher price than less further processed cassava flour.

Table 4.12 Average prices received for the different cassava flour products from July 1990 until June 1991

cassava flour product	Sucres/quintal	US dollars/50 kg
whole cassava flour	6,714.0	8.26
white cassava flour	7,826.7	9.63
sifted whole cassava flour	9,013.2	11.09
sifted white cassava flour	10,478.2	12.89

average official exchange rate during this period: 1 US $ = S/. 895.78

Source: UAPPY, 1991

Table 4.13 Current prices paid by the plywood companies for sifted whole cassava flour

year	month	cassava flour price Sucres/quintal
1990	January	---
	February	5,800.00
	March	7,272.72
	April	7,272.72
	May	8,636.36
	June	8,636.36
	July	8,636.36
	August	8,636.36
	September	8,636.36
	October	8,636.36
	November	8,636.36
	December	8,636.36
1991	January	8,636.36
	February	8,636.36
	March	9,090.91
	April	9,090.91
	May	9,090.91
	June	10,909.09
	July	10,909.09
	August	10,909.09
	September	10,909.09
	October	10,909.09
	November	10,909.09
	December	10,909.09

Source: UAPPY, 1991

Unlike wheat and wheat flour prices, cassava and cassava flour prices are not influenced by government interference.

The monthly prices paid by the 2 plywood companies since the union started selling sifted whole cassava flour to them, are presented above in table 4.13. These prices stayed constant for considerably long periods, especially from May 1990 to February 1991 and from June to December 1991.

CHAPTER 5 FACTORS INFLUENCING THE PLYWOOD DEMAND

In chapter 2 we mentioned that the total plywood demand consists of a national and a foreign component. In this chapter we will discuss the factors that have an impact on the national and the foreign plywood demand.

Factors influencing the national plywood demand are the price of plywood, the price of its substitute in Ecuador, particleboard, national income and urbanization degree. These factors will be discussed in paragraph 5.1.

Factors influencing the foreign plywood demand are the export price of Ecuadorean plywood, the world prices of plywood, particleboard and plywood's other international substitute, medium density fibreboard, and the national incomes of those countries that regularly import Ecuadorean plywood. These factors will be discussed in paragraph 5.2.

§ 5.1 Factors influencing the national plywood demand

As said in paragraph 3.4, the apparent domestic plywood consumption, resulting by subtracting the plywood exports from the total plywood production, is assumed to equal the national plywood demand.

The plywood demand rose from 8 thousand cubic metres in 1980 to 63 thousand cubic metres in 1989 (see table 3.4). Although the national demand fluctuates from 1980 to 1989, a clear rise becomes apparent (figure 3.3 in paragraph 3.4).

A product's own price, price(s) of its substitute(s) and income are classical variables explaining a product's demand. If the price of a product rises, other things being equal, consumers may buy less and look for a cheaper substitute. When consumers have more income to spend, demand may increase, other things being equal, and reverse.

§ 5.1.1 The plywood price

A first factor influencing the demand for a product is its own price, in our case the price consumers pay for plywood in Ecuador. Because there exist different plywood types (see § 2.3) with different prices and because prices change during a year, an average annual price per cubic metre has been provided by plywood companies. Later in this paragraph we will demonstrate some present prices for different plywood products.

The current average plywood prices provided by the plywood industry have been made constant to the year 1987 by dividing them by the manufacturing value added deflator of Ecuador (appendix 2).

Because the plywood industry only provided yearly current prices from 1984 to 1990, the number of observations is 6, which is very low. The average plywood price fluctuates considerably during the available observation period (see table 5.1).

Table 5.1 The Ecuadorean plywood demand, the average national plywood and particleboard prices, gross national income and the urbanization degree

year	plywood consumption (1000 m^3)	plywood price (S/. per m^3)	particleboard price (S/. per m^3)	gross national income (10^6 US $)	urbanization degree (%)
1980	8		42,088.6	10,804	46.8
1981	39		44,501.8	10,944	47.7
1982	39		45,341.8	10,650	49.1
1983	57		46,195.6	10,417	50.2
1984	56	41,783.8	37,545.7	10,613	51.3
1985	42	39,966.7	39,177.5	10,994	52.0
1986	45	31,908.3	38,019.1	10,236	52.8
1987	38	41,613.0	36,247.4	9,819	53.5
1988	54	44,350.8	34,904.7	10,677	54.2
1989	63	37,188.1	28,650.9	10,845	54.8

S/. = Ecuadorean Sucres

Sources: - plywood consumption: FAO Yearbook 1989, Forest products 1978-1989, FAO Forestry Series no.24, FAO Statistics Series no.97, Rome, 1991
- plywood price: plywood industry 1991
- particleboard price: particleboard industry, 1991
- gross national income: World Bank, World Tables 1990, 1991
- urbanization degree: Instituto Nacional de Estadisticas y Census, Quito, 1991

§ 5.1.2 The particleboard price

A second factor influencing the demand for a product is the price of its substitute.

The substitutes of plywood are, according to three of the four plywood companies, particleboard and medium density fibreboard. One plywood company mentioned beside particleboard also hard plastic sheets and extra hard pressed cardboard as substitutes.

According to ENDESA, particleboard and medium density fibreboard are only substitutes in some applications not in all. We will consider here only particleboard and medium density fibreboard as plywood's substitutes.

Particleboard is a panel composed of small chips or pieces of wood that are bonded together in the presence of heat and pressure by a synthetic resin adhesive.

Medium density fibreboard is a panel or core product manufactured from lignocellulosic fibres combined with a synthetic resin or other suitable binder. It is manufactured to a density of 31 pounds per cubic foot and to 55 pounds per cubic foot by the application of heat and pressure by a process in which the inner fiber bond is substantially created by the added binder (Hardwood Plywood Manufacturers Association, 1983).

Particleboard is produced and sold in Ecuador. Fibreboard is neither produced nor imported in Ecuador and therefore not considered a competitive product in a national context.

In Ecuador, 2 particleboard producers exist, Aglomerados Cotopaxi S.A. and Novopan del Ecuador S.A.. When grouping these companies according to their owners, Aglomerados Cotopaxi is part of the ENDESA-BOTROSA group and Novopan del Ecuador of the Plywood Ecuatoriana-CODESA group.

Also in the particleboard production is wheat flour an input in the adhesive with which wood pieces are bonded. The total use of wheat flour and consequently the substitution potential of cassava flour in this industry is very small, however. Evidence for this is found in the fact, that in 1990 the total wheat flour input of 1 of the 2 particleboard companies 3,568 kilograms was, while the plywood company with the lowest plywood production in that same year already had a flour input more than 70 times larger.

The production of particleboard in Ecuador showed an increase of almost 55 percent from 1985 to 1989, as can be seen in table 5.2, while this increase was 43 percent for plywood in the same period (table 3.2 in § 3.3).

In 1989 28 percent of the total particleboard production in Ecuador was exported (FAO, 1991).

Table 5.2 Production of particleboard in thousands cubic metres in Ecuador

year	total production (1,000 cubic metres)
1980	26
1981	28
1982	30*
1983	30*
1984	30*
1985	44
1986	45
1987	55
1988	61
1989	68

* FAO estimate

Source: FAO Yearbook 1989, Forest products 1978-1989, FAO Forestry Series no.24, FAO Statistics Series no.97, Rome, 1991

As was the case with the national plywood price, yearly (current) average particleboard prices have been provided by the particleboard industry. But the number of observations is larger, namely 10 years. The average current prices are made constant to the year 1987 again by dividing them by the manufacturing value added deflator (appendix 2).

Since 1985 the average particleboard price has been decreasing and was only in 1986 higher than the average plywood price.

Some recent prices of both plywood and particleboard are presented in table 5.3. This table clearly shows, that the highest plywood quality grade, A, is not available in Ecuador, because it is exported (§ 3.1), while of particleboard only the highest quality grade is sold in Ecuador.

Although the units and the quality grades of both products differ and comparison of the prices is therefore actually impossible, table 5.3 does seem to demonstrate that in Ecuador particleboard is on average probably cheaper than plywood.

Table 5.3 Current plywood and particleboard prices

plywood units (feet)	plywood grade	particleboard units (feet)	particleboard grade	plywood price (S/.)	particleboard price (S/.)
4*8*4	B	3*8*4	A	7,315	2,790
4*8*4	C	3*8*4	B	6,743	2,424
4*8*5	B	3*8*6	A	8,657	3,760
4*8*5	C	3*8*9	A	7,986	4,820
4*8*9	B	3*8*15	A	11,914	6,950
4*8*9	C	3*8*19	A	10,971	8,740
4*8*12	B	4*7*9	A	14,939	5,690
4*8*12	C	4*7*12	A	13,743	6,900
4*8*15	B	4*7*15	A	18,676	8,200
4*8*15	C	4*8*6	A	17,181	5,480
4*8*18	B	4*8*9	A	21,022	7,040
4*8*18	C	4*8*15	A	19,343	10,130
		4*8*19	A		12,740
		7*8*6	A		8,800
		7*8*15	A		16,230

Note: prices (S/. = Ecuadorean Sucres) on November 8th 1991 without 10 percent tax
units: width*length*thickness

Source: Large plywood and particleboard distributor in Quito

§ 5.1.3 National income and the urbanization degree

Other factors assumed to influence the national plywood demand are income per capita, population growth and urbanization. The factors income per capita and population growth are represented in the total national income (total national income equals national income per capita times the total population).

Ecuadorean gross national income in constant prices (1987 United States dollars) seems rather stable from 1980 to 1989 (table 5.1). Appendix 3 shows that per capita income decreased continuously from 1980 to 1984, increased a little in 1985, decreased from 1985 to 1987, increased in 1988 and finally decreased a little in 1989. The total Ecuadorean population increased steadily from 1980 to 1989.

The urbanization degree, the urban part of the population divided by the total Ecuadorean population, increases every year gradually (table 5.1). Assumed is that higher urbanization levels will lead to higher plywood consumption. Urbanization results in a larger demand for those products in which plywood may be used as a raw material, like houses, offices, etc.

§ 5.1.4 Correlations

In table 5.4 correlation coefficients of the national plywood demand and the above discussed factors have been calculated. These correlation coefficients are the Pearson correlation coefficients. The absolute value of the correlation coefficient indicates the strength of the linear relationship. A value of zero indicates no linear relationship. Two variables can have a strong association but a small correlation coefficient if the relationship is not linear (Base manual SPSS, 1991).

Table 5.4 Correlation coefficients of the national plywood demand, the national plywood price, the national particleboard price, gross national income and urbanization degree

variable		X1	X2	X3	X4	X5
national plywood demand	(X1)	1.0000 (10) P= .	0.0567 (6) P=.458	-0.4184 (10) P=.114	-0.0515 (10) P=.444	0.6788 (10) P=.015
national plywood price	(X2)	0.0567 (6) P=.458	1.0000 (6) P= .	0.0222 (6) P=.483	0.1180 (6) P=.412	-0.0033 (6) P=.498
national particleboard price	(X3)	-0.4184 (10) P=.114	0.0222 (6) P=.483	1.0000 (10) P= .	0.0701 (10) P=.424	-0.8285 (10) P=.002
gross national income	(X4)	-0.0515 (10) P=.444	0.1180 (6) P=.412	0.0701 (10) P=.424	1.0000 (10) P= .	-0.3361 (10) P=.171
urbanization degree	(X5)	0.6788 (10) P=.015	-0.0033 (6) P=.498	-0.8285 (10) P=.002	-0.3361 (10) P=.171	1.0000 (10) P= .

coefficient / (cases) / 1-tailed significance)
"." is printed if a coefficient cannot be computed
Source: SPSS/PC 4.01

There only seems to be a fairly strong linear association between the national plywood demand and the urbanization degree (r = 0.6788 at a 1.5 percent probability level). As we assumed in paragraph 5.1.3, high urbanization levels go with high levels of the national plywood demand.

Also the particleboard price and the urbanization degree are highly correlated (r = -0.8285 at a 0.2 percent probability level). This may cause multicollinearity when both variables will be used to estimate the national plywood demand.

The negative correlation between the national plywood demand and the national particleboard price (r = -0.4184 at a 11.4 percent probability level) indicates that high national particleboard price levels go with a low national plywood demand. This may point out that particleboard is a complementary good, as opposed to the assumption that it is plywood's substitute. The correlation coefficient is in our opinion, however, not convincingly high enough at the given significance level. After we have estimated the national plywood demand, its relation with the national particleboard price may become more clear.

§ 5.2 Factors influencing the foreign plywood demand

In the first paragraph we discussed the factors that are considered to have an impact on the national plywood demand. In this paragraph we will discuss the factors that are assumed to determine the foreign plywood demand.

The exports of Ecuadorean plywood are taken as the equivalent of the foreign plywood demand. These exports were dealt with already in paragraph 3.3 and 3.4.

§ 5.2.1 The export price of Ecuadorean plywood

The demand for Ecuadorean plywood in the world depends, just like the demand in Ecuador for local plywood, in the first place on the price costumers have to pay for it.

The price paid for Ecuadorean plywood is in this case the export price. The export price of Ecuadorean plywood from 1980 to 1989 is, indexed to the year 1987, presented in table 5.5.

Only in 1982 was the export price higher than the price in the base year 1987. The last two years the indexed export price decreased from 100 to 80 to 70.

§ 5.2.2 The world price of plywood

The substitutes, world wide, of Ecuadorean plywood are not only particleboard and medium density fibreboard (§ 3.2), but is also plywood produced elsewhere in the world.

Table 5.5 The foreign plywood demand, the export price of Ecuadorean plywood, the world prices of plywood, particleboard and medium density fibreboard and gross national income of the main Ecuadorean plywood importing countries

year	plywood exports (1000 m^3)	plywood export price (index)	plywood world price (index)	particleboard world price (index)	medium density fibreboard world price (index)	gross national income (10^9 US $)
1980	51	63.5	111.8	90.6	95.3	7,690.6
1981	26	99.2	103.7	84.4	92.5	8,159.3
1982	26	103.7	95.9	81.5	88.3	8,223.4
1983	8	68.9	91.9	74.9	84.9	8,458.0
1984	9	49.1	83.7	69.3	80.6	8,888.1
1985	11	52.2	86.2	69.7	79.9	9,233.5
1986	15	60.3	84.9	86.3	88.7	9,730.2
1987	34	100.0	100.0	100.0	100.0	10,530.4
1988	20	80.3	104.9	97.5	112.1	11,796.4
1989	13	70.2	100.4	102.2	114.7	12,736.8

Note: the plywood, particleboard and medium density fibreboard world prices are the, to the year 1987 indexed, current average world export prices as they are published in the FAO Forest products yearbook; gross national income is constant in 1987 US dollars

Sources: plywood exports, plywood export price, plywood world price, particleboard world price and medium density fibreboard world price: FAO Yearbook 1989, Forest products 1978-1989, FAO forestry Series no.24, FAO Statistics Series no.97, Rome, 1991
gross national income: World Bank, World Tables 1990, 1991

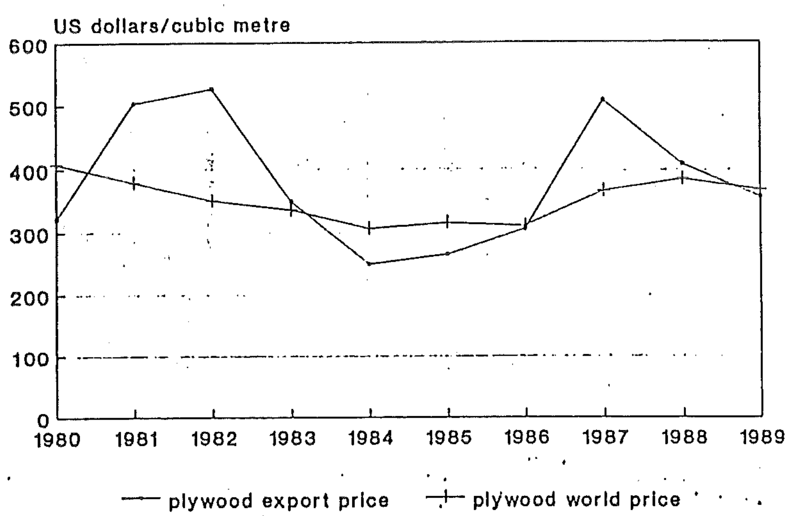
Ecuadorean plywood has to compete in price and quality with plywood products produced in other countries. The world price of plywood is therefore also taken as an explanatory variable of the foreign Ecuadorean plywood demand.

Also the world price of plywood is indexed to the year 1987 and presented in table 5.5. Only from 1982 to 1986 the indexed world price was lower than the base year price. Just like the export price of Ecuadorean plywood, the world index price was lowest in 1984. To what extent the world price of plywood and the export price of Ecuadorean plywood are linearly associated will be seen later when we discuss their correlation coefficients.

Another issue we will deal with here, is whether Ecuadorean plywood producers are able to realise a price abroad that deviates from the world price. Or are they, because of the small contribution of Ecuadorean plywood to the world production, just price takers in the world market?

Figure 5.1 shows the development of the average world price of plywood and the average export price of Ecuadorean plywood from 1980 to 1989.

Figure 5.1 Course of the average world price of plywood and the average export price of Ecuadorean plywood from 1980 to 1989



The average export price of Ecuadorean plywood fluctuates considerably compared to the average world price of plywood. From 1981 to 1983, in 1987 and in 1988 was the average export price of Ecuadorean plywood higher than the average world price of plywood. So, based on figure 5.1, Ecuadorean plywood producers do seem to be capable of realizing their own price abroad.

§ 5.2.3 The world price of particleboard and medium density fibreboard

The prices of the two other substitutes of Ecuadorean plywood are also presented in table 5.5. Like the export price of Ecuadorean plywood and the world price of plywood, these prices have been indexed to the year 1987. Medium density fibreboard only had a higher price compared to the base year in 1988 and 1989 and particleboard only in 1989. Particleboard furthermore had the lowest index price in 1984, just like the export price of Ecuadorean plywood and the world price of plywood.

§ 5.2.4 National incomes of Ecuadorean plywood importing countries

The national incomes of those countries that regularly import Ecuadorean plywood (see appendix 4) is the last factor that is assumed to influence the demand in these countries for Ecuadorean plywood. Together with the price of Ecuadorean plywood and the prices of its substitutes, income is, as said in paragraph 5.1, a classical variable explaining the demand.

From table 5.5 it can be seen that the aggregated incomes increase gradually from 1980 to 1989. The countries that import regularly Ecuadorean plywood can be divided into developed and developing countries. This may be useful later, if the influence of the national incomes on the national plywood demand significant is, to get a better explanation of the the foreign plywood demand, because of possible different demand patterns at higher or lower income levels.

§ 5.2.5 Correlations

In table 5.6 the correlations between the above discussed factors are presented. Only the world price of plywood and the foreign plywood demand are significantly correlated ($r = 0.77$ at a 0.5 percent probability level). Because the linear association between the foreign plywood demand and the world price of plywood is stronger than the linear association between the foreign plywood demand and the export price of Ecuadorean plywood ($r = 0.40$ at a 12.4 percent probability level), the conclusion in paragraph 5.2.2, that the prices, which Ecuadorean plywood producers are able to realise abroad do not seem to be determined by the world price, is rejected here.

The correlation coefficients between the foreign plywood demand and the world price of medium density fibreboard and the aggregated gross national incomes are insignificant ($r = 0.24$ and $r = -0.30$ at respectively 25.3 and 20.2 percent probability levels).

Table 5.6 Correlation coefficients of the foreign plywood demand, the export price of Ecuadorean plywood, the world prices of plywood, particleboard and medium density fibreboard and the gross national incomes of Ecuadorean plywood importing countries

variable		Y1	Y2	Y3	Y4	Y5	Y6
foreign plywood demand	(Y1)	1.0000 (10) P= .	0.4028 (10) P=.124	0.7693 (10) P=.005	0.4497 (10) P=.096	0.2388 (10) P=.253	-0.2972 (10) P=.202
plywood export price	(Y2)	0.4028 (10) P=.124	1.0000 (10) P= .	0.4989 (10) P=.071	0.4485 (10) P=.097	0.3338 (10) P=.173	-0.0029 (10) P=.497
plywood world price	(Y3)	0.7693 (10) P=.005	0.4989 (10) P=.071	1.0000 (10) P= .	0.6810 (10) P=.015	0.6642 (10) P=.018	0.0823 (10) P=.411
particleboard world price	(Y4)	0.4497 (10) P=.096	0.4485 (10) P=.097	0.6810 (10) P=.015	1.0000 (10) P= .	0.9270 (10) P=.000	0.6598 (10) P=.019
m.d.f. world price	(Y5)	0.2388 (10) P=.253	0.3338 (10) P=.173	0.6642 (10) P=.018	0.9270 (10) P=.000	1.0000 (10) P= .	0.7816 (10) P=.004
gross national incomes	(Y6)	-0.2972 (10) P=.202	-0.0029 (10) P=.497	0.0823 (10) P=.411	0.6598 (10) P=.019	0.7816 (10) P=.004	1.0000 (10) P= .

m.d.f. = medium density fibreboard

(coefficient / (cases) / 1-tailed significance)
"." is printed if a coefficient cannot be computed

Source: SPSS/PC 4.01

The world prices of plywood, particleboard and medium density fibreboard are highly intercorrelated, especially the world prices of particleboard and medium density fibreboard ($r = 0.93$ at a zero probability level). When using these factors later to explain the foreign plywood demand, they have to be adjusted in order to avoid multicollinearity.

CHAPTER 6 FACTORS INFLUENCING THE CASSAVA FLOUR DEMAND

In this chapter we will concern ourselves with the factors that have an impact on the demand for cassava flour in the plywood industry in Ecuador, or the substitution potential of cassava flour in this specific industry.

As mentioned in paragraph 4.5, 3 of the 4 plywood companies in Ecuador use cassava flour in their production process. The amount of cassava flour related to the amount of wheat flour in the resin with which the sheets of wood are glued together, depends, according to the plywood companies on 3 factors, to which we will add a fourth.

These factors are:

1. the price relation between cassava and wheat flour
2. the product characteristics (quality) of cassava flour
3. the distribution of cassava flour
4. knowledge of the cassava flour price and the product or quality characteristics of cassava flour.

These factors correspond to the 4 marketing mix elements price, product, distribution and promotion, which we will deal with in the following.

§ 6.1 Price

In chapter 4, in table 4.7 and table 4.13, the prices paid by the plywood companies for wheat and cassava flour were presented. These prices are put together in table 6.1.

The wheat flour price has always been higher than the cassava flour price. The difference between both prices was smallest in June and July 1991, when the wheat flour price was almost 35 percent higher than the cassava flour price.

The courses of the wheat and the cassava flour prices in 1990 and 1991 are shown graphically in figure 6.1. From this figure it appears that the cassava flour price and the wheat flour price show a highly similar course.

We need to keep in mind that the prices paid by the plywood companies for cassava flour are the prices received by the union in Portoviejo and do not include the prices received by the cassava flour mills in Esmeraldas, Santo Domingo and Portoviejo. We saw, however, in paragraph 4.5 that a little more than 70 percent of the total cassava flour input in the plywood industry in 1990 was bought from the union.

The wheat flour prices can be considered representative for all plywood companies, because they are provided by the wheat flour mill that sells most wheat flour to the plywood industry.

Table 6.1 Wheat and cassava flour prices paid by the plywood industry in 1990 and 1991

year	month	cassava flour Sucres/50 kg	wheat flour Sucres/50 kg	difference* (%)
1990	January	---	14,550.00	---
	February	6,393.30	14,550.00	-56.1
	March	8,016.70	14,550.00	-44.9
	April	8,016.70	14,550.00	-44.9
	May	9,519.80	14,550.00	-34.6
	June	9,519.80	14,550.00	-34.6
	July	9,519.80	14,550.00	-34.6
	August	9,519.80	14,550.00	-34.6
	September	9,519.80	14,550.00	-34.6
	October	9,519.80	14,550.00	-34.6
	November	9,519.80	14,550.00	-34.6
	December	9,519.80	14,550.00	-34.6
1991	January	9,519.80	14,550.00	-34.6
	February	9,519.80	14,550.00	-34.6
	March	10,020.80	16,200.00	-38.1
	April	10,020.80	16,200.00	-38.1
	May	10,020.80	16,200.00	-38.1
	June	12,025.00	16,200.00	-25.8
	July	12,025.00	16,200.00	-25.8
	August	12,025.00	17,150.00	-29.9
	September	12,025.00	17,150.00	-29.9
	October	12,025.00	17,150.00	-29.9
	November	12,025.00	19,400.00	-38.0
	December	12,025.00	19,400.00	-38.0

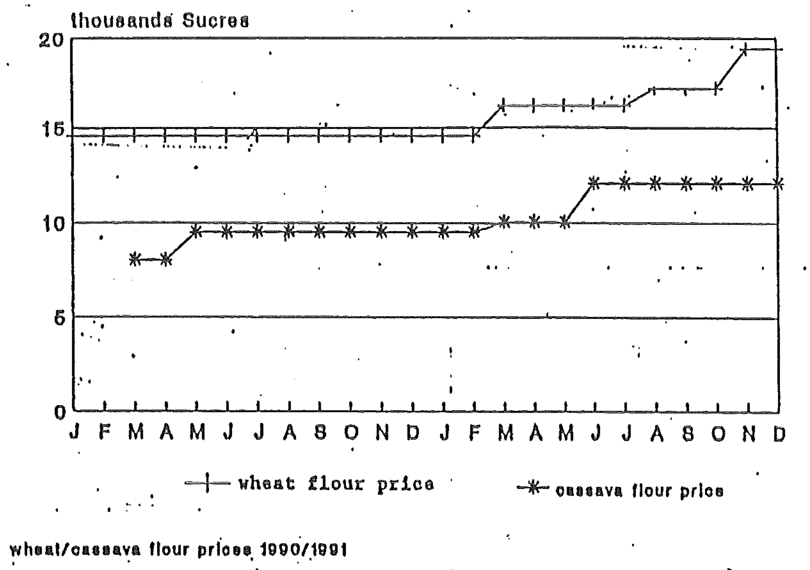
* [(cassava flour price - wheat flour price)/wheat flour price]x100%

Source: cassava flour prices: UAPPY, 1991
wheat flour prices: Molinos La Unión, 1991

The price plywood companies pay for wheat as well as cassava flour are a result of negotiation between the plywood company and the mill involved. But the price plywood companies are willing to pay for cassava flour is always lower than the price they have to pay for wheat flour, mainly because of the inferior product characteristics of cassava flour compared to wheat flour (to be discussed in the next paragraph).

The union has, in this negotiation process, some idea what price the plywood company pays for its wheat flour. They also know that the price they may expect to receive will be a certain percentage of this.

Figure 6.1 Wheat and cassava flour prices paid by plywood companies in 1990 and 1991



The wheat and cassava flour prices are highly and significantly (linearly) correlated, as would be expected from figure 6.1. The (from table 6.1) calculated Pearson correlation coefficient is 0.8205 at a 0.0001 probability level (SPSS/PC 4.01).

In order to see to what extent the cassava flour price is determined by the wheat flour price we'll perform a regression analysis in which the cassava flour price is the dependent and the wheat flour price the independent or explaining variable.

From this regression analysis, presented in appendix 5, the following linear relation between the cassava and the wheat flour price appears:

$$P_{cassava} = -837.18 + 0.705 \cdot P_{wheat}$$

in which $P_{cassava}$ = cassava flour price and
P_{wheat} = wheat flour price.

The slope (significant at a 0.00001 probability level) indicates that, beside an insignificant intercept (significance level of the constant term is 0.63), the cassava flour price 70 percent is of the wheat flour price.

The adjusted R square is reasonably high: 65.7 percent of the variance of the cassava flour price around its mean is explained by the wheat flour price.

In this case, in which there is only one explaining variable, the t and F tests evaluate the same hypothesis. The outcomes are the same and indicate that the linear relation, as specified, significant is.

The Durbin-Watson statistic, a test for first-order sequential correlation of the adjacent error terms, called autocorrelation, finally, indicates positive correlation between the error terms: the Durbin-Watson statistic is smaller than the lower limit at a 1 percent (1-tailed) probability level.

One way of dealing with this positive first-order autocorrelation is to take the first differences of the monthly price observations. The Durbin-Watson statistic does then not reject the hypothesis of non-correlation between the error terms: the Durbin-Watson statistic is larger than the upper limit at a 1 percent probability level.

But when we take first differences of the monthly price observations in order to eliminate first-order autocorrelation, the price relation between cassava and wheat flour is not fit anymore to estimate the cassava flour price, which is the main purpose of the regression analysis. We will therefore continue with the relation between cassava and wheat flour as specified above.

If we are able to estimate wheat flour prices, we can calculate future cassava flour prices with the above presented linear relation. The reason why we would want to know future cassava flour prices was explained already in chapter 2 (§ 2.5): with these future cassava flour prices we will be able to calculate the future amounts of cassava flour the union has to sell to the plywood industry in order to break even.

We estimated an equation in which the wheat flour price is explained by the factor time (appendix 6). The (significant) linear relation is:

$$P_{wheat} = 13,339 + 182.72 \cdot T$$

in which P_{wheat} = wheat flour price and
T = time.

The adjusted R square is 70.7 percent. Both intercept and slope are significant at a 0.00001 probability level (and consequently the linear relation as specified above is significant at the same probability level, because the t and F statistics test the same hypothesis) and the Durbin-Watson test again indicates positive first-order autocorrelation.

As mentioned, first differences of the observations will eliminate this first-order autocrrelation, but as we argued above, the resulting relation between the wheat flour price and the time factor will then not be fitted anymore to estimate the wheat flour price. We'll use therefore the equation above.

We can now calculate future wheat flour prices by expanding the time horizon in the relation. The results of this are presented in table 6.2. The wheat flour prices in this table are the prices in the last month of the next 5 years.

Table 6.2 Future wheat and cassava flour prices

year	month	wheat flour (Sucres/50 kg)	cassava flour (Sucres/50 kg)
1991	December	19,400.00	12,025.00
1992	December	19,917.00	13,204.30
1993	December	22,110.00	14,750.60
1994	December	24,302.00	16,295.70
1995	December	26,495.00	17,841.80
1996	December	28,687.00	19,387.20

Knowing the future wheat flour prices, we can calculate future cassava flour prices by using the first estimated relation between the wheat and cassava flour price. The results of filling future wheat flour prices in in this equation are presented in the second column of table 6.2. Also these cassava flour prices are the prices in the last month of the next 5 years. Table 6.2 will be used in chapter 8 in the break-even analysis.

§ 6.2 Product

As mentioned in paragraph 6.1, the price plywood companies are willing to pay for cassava flour is lower than the wheat flour price, mainly because the product characteristics of wheat flour are better suited for the purpose for which they want to use flour, namely as an additional input in the adhesive with which sheets of wood are glued together.

For this purpose the main product characteristics looked for by plywood companies are viscosity, moisture content, grain size and visual appearance.

Flour is used as a filler in the resin and has, in order to function well as such, to have a certain degree of viscosity or stickiness. This viscosity degree is expressed in the protein and ash content of the flour.

The protein and ash content largely determine the viscosity of a flour. The higher the protein content and the lower the amount of anorganic materials left over after burning flour (ash content), the higher the binding effect will be.

With respect to these two characteristics cassava flour differs considerably from wheat flour: the average protein and ash content of wheat flour are 12.0 and 0.6 percent respectively, the respective average protein and ash content of cassava flour 1.3 and 2.8 percent (Latinreco S.A., 1991). So wheat flour has more favourable average protein and ash contents than cassava flour.

Also the moisture content and the grain size are important product aspects to plywood companies. The average moisture content of wheat flour is 12 percent and of cassava flour 9 percent. Cassava flour is dried outside in the sun and moisture control is therefore harder than in the case of wheat flour, which is processed inside in factories.

As mentioned in chapter 2 (§ 2.1), the union began to sift cassava flour to be able to serve new markets. With respect to wheat flour, sifted cassava flour has a very similar grain size structure, through which it is able to substitute wheat flour to a certain extent in the resin used in the plywood industry to glue sheets of wood together.

Finally, all plywood companies emphasized the importance of the visual appearance of flour. Wheat flour is processed inside, under controlled circumstances and in relatively large factories, while most cassava flour, also the cassava flour from the union in Portoviejo, is processed outside on a relatively small scale in a more or less traditional manner. The chance that filth, like sand, enters the flour during the processing is much more real.

Cassava flour can not contain any filth or be clotty, because this influences its functioning in the resin. Plywood companies regarded the visual appearance of cassava flour for a long time as a first reason not to use it.

With respect to the filthiness aspect, more and more the union and the people working in it realize the importance of continuous quality control. Wheat flour does not contain filth, is perfectly white and not clotty. In order to keep cassava flour competitive, quality control must therefore be the first step.

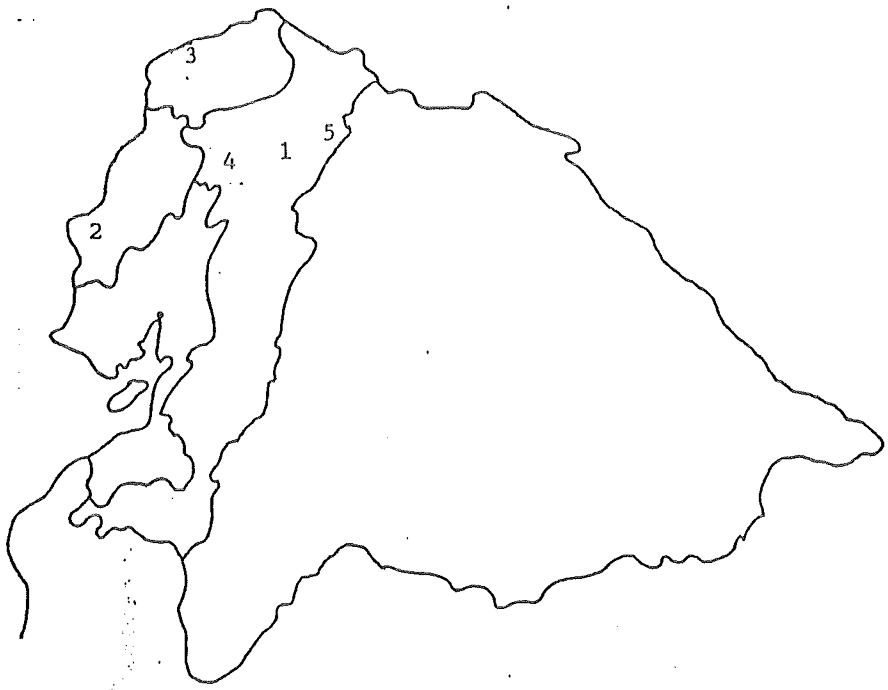
§ 6.3 Distribution

In paragraph 4.5 we calculated that 70 percent of the total cassava flour input in the plywood industry originates from the union in Portoviejo. The rest comes from other cassava flour supplying companies in Esmeraldas, Santo Domingo and Portoviejo. In figure 6.2 the location of plywood companies, cassava flour suppliers and wheat flour suppliers is shown.

The mills supplying wheat flour to the plywood industry are mentioned in chapter 4 (§ 4.2). They are all located near plywood plants and dispose of good transport facilities. Reasonable amounts of wheat flour ordered in the morning are at the plywood plant the same afternoon, according to one plywood company.

Cassava flour purchased from the union in Portoviejo is transported to the two plywood plants in Quito by a private transport enterprise in Portoviejo. The time needed to transport cassava flour from Portoviejo to Quito is about 8 to 9 hours. Cassava flour transport needs considerably more time than wheat flour transport.

Figure 6.2 Location of the plywood companies and the cassava and wheat flour suppliers to these companies



Legend:

1= **Quito** (plywood company 3 and 4 and 2 wheat flour mills)
2= **Portoviejo** (UAPPY and other cassava flour supplier)
3= **Esmeraldas** (plywood company 2 and cassava flour supplier)
4= **Sto.Domingo** (plywood company 1 and cassava flour supplier)
5= **Cayambe** (wheat flour mill)

The plywood company in Esmeraldas doesn't buy cassava flour from the union for this reason: the large distance between the two organizations. They buy their cassava flour in Esmeraldas and Santo Domingo. One of the two plywood companies in Quito buys, beside from the union, also cassava flour from another mill in Portoviejo (§ 4.5).

Furthermore, cassava flour transport costs are considerable: about 10 percent of the total processing costs per unit cassava flour (more about production and transportation costs will be discussed in chapter 8).

So, the union in Portoviejo not only has to compete with more favourable located wheat flour mills, also with cassava flour suppliers located near the plywood plants in Santo Domingo and Esmeraldas. Only the cassava flour supplier in Portoviejo faces the same disadvantages as the union.

§ 6.4 Promotion

One plywood company doesn't use any cassava flour at all in its production process (§ 4.5). The reason for this is mainly that they think that the price difference between wheat and cassava flour is neglectable. As we saw in paragraph 6.1 (table 6.1), this is absolutely not the case.

Plywood companies furthermore still regard cassava flour a poor substitute for wheat flour. To begin with, some plywood companies complaint about the amount of filth found in the past in cassava flour. Considering the attention recently given by the union to the quality aspects of cassava flour, this still existing misunderstanding should be clarified.

Also with respect to the other product characteristics of sifted whole cassava flour, compared to wheat flour (discussed in paragraph 6.2), plywood companies should be better informed.

Concluding, the union should undertake serious steps towards plywood companies to make them understand the advantages and disadvantages of cassava flour compared to wheat flour.
Both product and price aspects should be brought about in these promotion activities.

CHAPTER 7 ESTIMATION OF THE CASSAVA FLOUR DEMAND

In this chapter we will concern ourselves with the estimation of the plywood demand and derived of that, the cassava flour demand. We will use figure 2.1 in chapter 2 as our guideline.

In chapter 5 we discussed the factors that have an impact on the plywood demand. We distinguished a national and a foreign component in the total demand for Ecuadorean plywood. We will use the data in table 5.1 in chapter 5 to estimate the national plywood demand and the data in table 5.5 to estimate the foreign plywood demand.

§ 7.1 Selection of the prediction method

The method you want to use to make predictions depends on (K. Koelemeijer, 1990):

1) the characteristics of the situation in which decisions have to be made, like the time period over which you want to predict, the number of products involved and the phase of a product's life cycle
2) the characteristics of the prediction method
3) the available data.

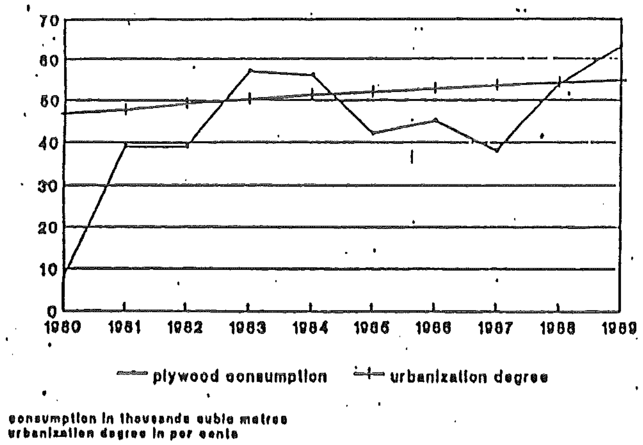
In this study we have chosen for multiple regression to predict the plywood demand. Within multiple regression, several functional forms can be used. Which form you choose depends on the available data. Plotting the data may show which functional form is appropriate. In figure 7.1 the data for the estimation of the national plywood demand are shown graphically and in figure 7.2 the data for the estimation of the foreign plywood demand.

The national plywood demand fluctuates considerably (figure 7.1A), but an increasing trend is slightly visible. Gross national income in 1987 US dollars is very stable (figure 7.1B), while the urbanization degree is clearly linear (figure 7.1A). The national particleboard price seems to fluctuate around a mean (figure 7.1B) and the 6 annual national plywood prices seem to show a decreasing course (figure 7.1B).

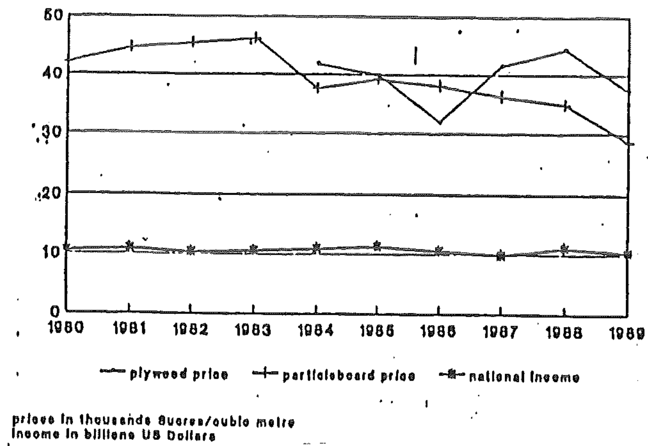
It's hard to find a clear pattern in the foreign plywood demand (figure 7.2A). It seems to have a decreasing trend. The aggregated national incomes show a more linear course (figure 7.2C).

The plywood export price and the world prices of particleboard and medium density fibreboard (figure 7.2B) show an almost similar course. Because they are indexed to the year 1987, they are all (the world price of plywood also) 100 in this year. Before 1985 they all show a decreasing trend, after 1985 an increasing trend. The world price of plywood, finally, seems to fluctuate around a constant from 1980 to 1989 (figure 7.2B).

Figure 7.1 Data used to estimate the national plywood demand

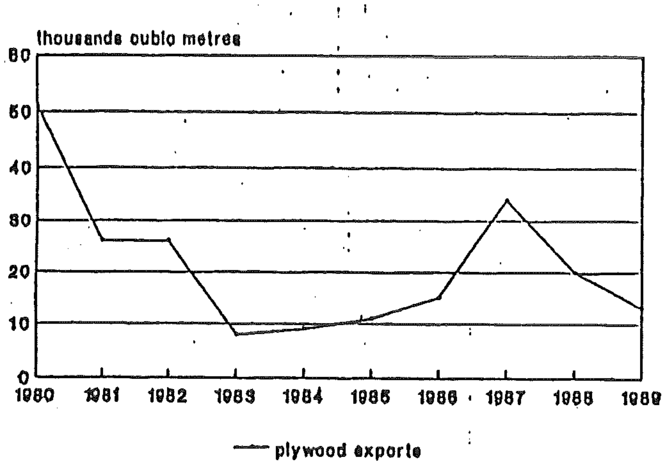


A

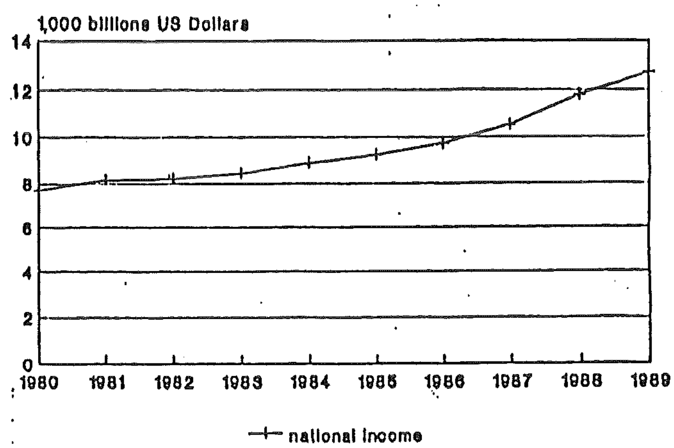


B

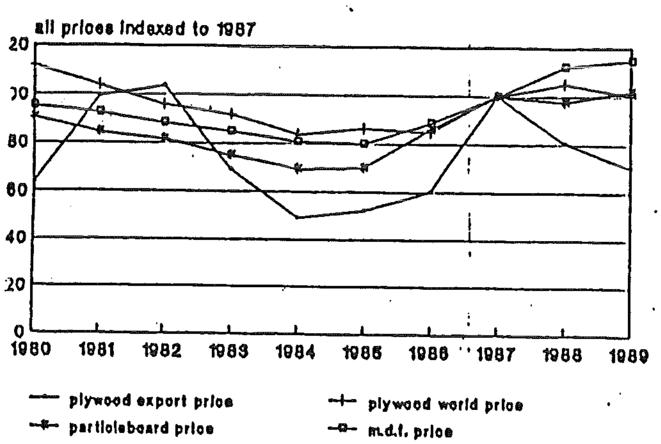
Figure 7.2 Data used to estimate the foreign plywood demand



A



C



B

It is hard to discover a clear visual pattern in the data presented graphically in the figures 7.1 and 7.2. It's therefore not exactly clear which functional form to choose.

Johnston presented a general linear function of which 4 more specific linear functions can be derived (J. Johnston, 1984). This general linear model and the derivation of the 4 specific functions are presented below:

$$Y^{(\delta 1)} = a + bX^{(\delta 2)} + u,$$

$$\text{with } Y^{(\delta 1)} = \begin{cases} \dfrac{Y^{\delta 1}-1}{\delta 1} & \text{if } \delta 1 \text{ does not equal } 0 \\ \ln Y & \text{if } \delta 1 \text{ equals } 0 \end{cases}$$

$$\text{and } X^{(\delta 2)} = \begin{cases} \dfrac{X^{\delta 2}-1}{\delta 2} & \text{if } \delta 2 \text{ does not equal } 0 \\ \ln X & \text{if } \delta 2 \text{ equals } 0 \end{cases}$$

a and b are parametres and u is an error term.

Application of L'Hôpital's rule shows that:

$$\lim_{\delta 1 \to 0}(Y^{(\delta 1)}) = \ln Y.$$

Giving the δ's the value 0 or 1, 4 specific functional forms result:

function 1) $\delta 1=1=\delta 2$: $Y = a + bX + u$

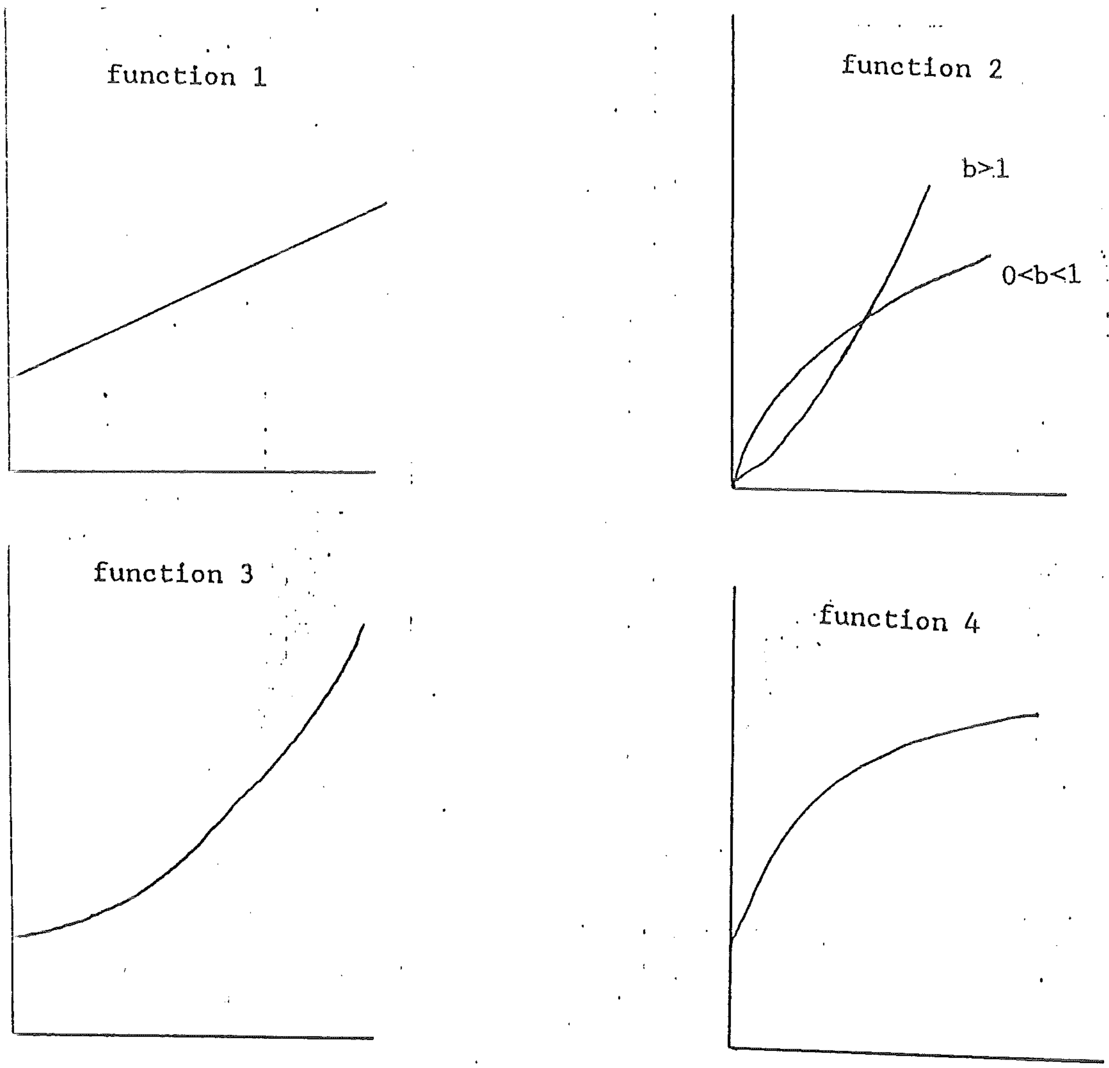
function 2) $\delta 1=0=\delta 2$: $\ln Y = a + b\ln X + u$

function 3) $\delta 1=0,\ \delta 2=1$: $\ln Y = a + bX + u$

function 4) $\delta 1=1,\ \delta 2=0$: $Y = a + b\ln X + u$.

The first function is a simple linear function, the second a double-log function and the third and fourth are semi-log functions. The general shapes of these functions are presented in figure 7.3.

Figure 7.3 General shapes of Johnston's 4 specific linear functions



Source: Johnston, J., "Econometric Methods", 3rd edition, McGraw-Hill International Editions, 1984

The advantage of a double-log function is that the regression coefficients are at the same time elasticities. A disadvantage is that these elasticities are constant.

The regression coefficients in the semi-log functions represent the constant proportionate rate of change in the dependent (function 3 above) and independent variables (function 4 above) per unit change in the independent respectively the dependent variables (J.Johnston, 1984).

In order to be able to make a selection between the 4 linear functions, ideas and opinions about future plywood sales, in Ecuador and abroad, expressed by plywood companies' executives, will be handled as guidelines.

The local plywood market is viewed as saturated. No extreme growth possibilities are expected.

With respect to the future sales abroad, however, considerable growth is expected, especially because of the participation of Ecuador in the process of economic integration of the Andean countries (see appendix 1).

Combining the above presented linear functions with the subjective opinions of plywood companies' executives, we concluded that the simple linear function seems appropriate to estimate the national plywood demand and the semi-log function (function 3) to estimate the foreign plywood demand. The shape of the simple linear function corresponds to the expected trend in sales in Ecuador and the shape of the semi-log function to the expected trend in sales abroad (figure 7.3).

§ 7.2 Goodness of fit measures

The measures we will use to see how well the chosen functional form fits the actual data are:

1) adjusted R square
2) F-test
3) t-test
4) Durbin-Watson test.

These measures were used already in chapter 6 (§ 6.1) to see how well the cassava and wheat flour prices were estimated. We will discuss them briefly below.

The adjusted R square is the R square adjusted for the number of observations less the number of explaining variables (= adjusted for the degrees of freedom). The R square measures the proportion of variance of the dependent variable around its mean explained by the independent variables (Hair et al., 1990).

The F-test tests the hypothesis whether the linear relation between the dependent and the independent variables as specified significant is.

The t-test tests the hypothesis whether a specific explaining variable significantly different from zero is. In case there is only one explaining variable, the F and t-tests test the same hypothesis (M.J. Norusis, 1991).

The Durbin-Watson statistic is a test for sequential correlation of adjacent error terms, called first-order autocorrelation (SPSS manual, 1988). We will test here the hypothesis of positive autocorrelation.

The Durbin-Watson test is only applicable when there is a constant term in the regression equation and the dependent variable is not lagged (J.Johnston, 1984).

In the regression analysis the linear functions will be estimated by means of backward elimination, meaning that first all factors that are assumed to have an impact on the national and foreign plywood demand (chapter 5) will be entered in the analysis and next the factors will be left out with the lowest significance levels.

§ 7.3 Estimation of the national plywood demand

In the regression analysis on the national plywood demand, only the variable urbanization degree appears to have a significant impact on this aggregate, which we suspected already from the correlation table in chapter 5 (table 5.4).

The first regression on the national plywood demand, in which all factors are taken into account, results in a negative adjusted R square and high insignificancy levels for all explanatory variables (appendix 7).

Because the national plywood price not only limits the total number of observations to 6, but is also the most insignificant variable of all, it is eliminated from the analysis.

In the next regression, the adjusted R square is 43.9 percent and only the urbanization degree is significant at a 5 percent probability level (appendix 8). The variable national income is eliminated, because of its lowest significance level (Sig T = 0.25). The Durbin-Watson statistic indicates that no first-order autocorrelation exists (the Durbin-Watson outcome is larger than the 1 percent upper limit (in appendix 22 the used Durbin-Watson tables are presented)).

Also in the regression analysis in which the explanatory variables are the national particleboard price and the urbanization degree, only the latter is still significantly different from zero (Sig T = 0.056). The adjusted R square is 39.2 percent (appendix 9).

Finally, regression on the national plywood demand and the urbanization degree results in an adjusted R square of 0.393 (appendix 10). Both the urbanization degree and the intercept are significantly different from 0 at a less than 10 percent probability level (Sig T = 0.031 and Sig T = 0.077 respectively) and no autocorrelation seems to exist. The significance level of the t and the F-statistic is in this case, where only one explanatory variable is taken into account (§ 7.2), the same.

In paragraph 5.1.4, we saw that the correlation between the national plywood demand and the national particleboard price negative is. We thought then that this might indicate that particleboard is perhaps a complementary product instead of a substitute of plywood.

As we can see in appendices 7, 8 and 9, the influence of the national particleboard price on the national plywood demand was first very slightly negative (appendix 7) and next very slightly positive (appendices 8 and 9) and never significant (at a 10 percent probability level).

So, based on the regression analyses, the influence of the national particleboard price on the national particleboard price is none.

We did find a significant impact of the urbanization degree on the national plywood demand. The adjusted R square of this relation is very low, however: only 39.3 percent.

Nevertheless, it seems justified to use the estimated relation between the national plywood demand and the urbanization degree to forecast the former, because of the found significance levels.

The relation is (appendix 10):

$$D_N = -152.7 + 3.84\ U$$

in which D_N = the national plywood demand
U = urbanization degree.

The future national plywood demand can now be calculated from the relation above by substituting future values for the urbanization degree. We obtained these values by estimating the urbanization degree with a time factor. The resulting relation between the urbanization degree and the time variable is (appendix 11):

$$U = 46.3 + 0.90\ T$$

in which U = urbanization degree
T = time variable.

The adjusted R square is very high (R^2(adjusted) = 0.98) and both the intercept and the time variable are highly significant (Sig T = 0.0000 in both cases). The Durbin-Watson statistic indicates autocorrelation, because it is lower than the 1 percent probability lower limit (appendix 22).

Future urbanization degrees are presented in appendix 12 and the future national plywood demand resulting from this is presented in table 7.1.

Table 7.1 The future national plywood demand

year	plywood demand (m^3)
1989	63,000
1990	63,108
1991	66,564
1992	70,020
1993	73,476
1994	76,932
1995	80,388
1996	83,844

The national plywood demand increases every year with more than 3,000 cubic metres.

§ 7.4 Estimation of the foreign plywood demand

The semi-log function of the foreign plywood demand will be estimated in the same way as the national plywood demand. Appendices 13 to 17 show how the adjusted R square, the significance level of the specific linear relation and the significance levels of the individual explanatory variables change each time the least significant factor has been eliminated from the analysis.

After the first regression on all the variables, the aggregated national incomes appear to be least significant (appendix 13) and are therefore eliminated.
Next only the export price of Ecuadorean plywood appears to be insignificant (together with the intercept) at a 5 percent probability level (Sig T = 0.73). The adjusted R square increases to 78.2 percent (appendix 14).
After we eliminated also the export price of plywood, all other explanatory variables are significant (appendix 15) and the adjusted R square increases even a little more.

But, as we saw in paragraph 5.2.5, the world prices of plywood, particleboard and medium density fibreboard are highly correlated, causing multicollinearity.
In order to avoid this, the world prices of particleboard and medium density fibreboard, which have the largest correlation coefficient ($r = 0.927$; table 5.6 in paragraph 5.2.5), are divided. The resulting lower correlation between the world price of plywood and the divided world prices of particleboard and medium density fibreboard is presented in appendix 16.

The final regression performed on the foreign plywood demand and the two explanatory variables the world price of plywood and the divided world prices of particleboard and medium density fibreboard is presented in appendix 17. Both explanatory variables and the intercept are significantly different from 0 at a 1 percent probability level and also the relation as specified is significantly linear at a 1 percent probability level (Sig F = 0.0016).
The adjusted R square is reasonably high: almost 80 percent of the variance in the foreign plywood demand is explained by the two explanatory variables.
The Durbin-Watson statistic, finally, indicates that there is no autocorrelation.

So, the relation we will use to calculate the future foreign plywood demand is (appendix 17):

$$\ln D_F = -6.98 + 0.042\ P_{wi} + 0.064\ P_{fj}/P_{fk}$$

in which $\ln D_F$ = (natural logarithm of the) foreign plywood demand
P_{wi} = world price of plywood
P_{fj}/P_{fk} = world price of particleboard divided by the world price of medium density fibreboard.

The world price of plywood has a small, but significant impact on the foreign plywood demand, as we already suspected in paragraph 5.2.5 (correlation table 5.6), where we saw that only the world price of plywood was considerably correlated with the foreign plywood demand (r = 0.77 at a 0.005 significance level). The relation between the world prices of particleboard and medium density fibreboard has a slightly larger impact on the foreign plywood demand (regression coefficient = 0.064), as we can see from the relation above.

The regression coefficient of the world plywood price (coefficient = 0.042) represents the proportionate rate of change in the foreign plywood demand per unit change in the world plywood price (§ 7.1).

In order to be able to calculate the future foreign plywood demand, we first have to estimate the world prices of plywood, particleboard and medium density fibreboard. This is done in appendices 18, 19 and 20.

In addition to an explanatory time factor, a one year lag is introduced to estimate the world prices. Prices in one year are assumed to be influenced by prices in the year before.

Only in the case of the world price of medium density fibreboard is the adjusted R square very reasonable: 85 percent of the variance in this world price is explained by the time factor and the lag (appendix 20).

In almost all cases are the explanatory variables (the time factor and the lag) significantly different from 0 at a 10 percent probability level, except the time factor in the estimation of the world plywood price (Sig T = 0.188 in appendix 18).

The particleboard and medium density fibreboard world price estimations are furthermore significantly linear at a 5 percent probability level (Sig F = 0.037 and Sig F = 0.001 respectively in appendix 19 and 20), while the world plywood price significant is at a 10 percent probability level (Sig F = 0.072 in appendix 18).

The Durbin-Watson statistics can't be used here, because of the presence of a lag in the equations (§ 7.2).

The calculated future world prices are presented in appendix 21. The future foreign plywood demand resulting from these calculated future prices is presented in table 7.2.

Table 7.2 The future foreign plywood demand

year	plywood demand (m^3)
1989	13,000
1990	18,383
1991	18,302
1992	18,221
1993	18,453
1994	18,806
1995	19,414
1996	20,041

As opposed to what is expected, no extreme growth in the foreign plywood demand appears from table 7.2 for the next 5 years. It may be, however, that this growth will show up after this period, because of an increasing growth rate from 1994 to 1996.

Now that we estimated the national and the foreign plywood demand, we assume that they equal together the future total plywood production (figure 2.1 in chapter 2).
As was mentioned already in paragraph 3.4, the FAO-figures used to estimate the national and foreign plywood demand don't correspond with the limited amount of figures of the total plywood production provided by the plywood industry self.
According to the plywood companies, the total plywood production in 1990 was 57,013 cubic metres (§ 3.4), while we estimated the total production in that year to be 81,491 cubic metres.
The actual production is 70 percent of the estimated production. The estimated plywood production will therefore be corrected by taking 70 percent of it as the definitive prediction (table 7.3).

Table 7.3 The total estimated plywood production

year	estimated production (m^3)
1990	57,013
1991	59,406
1992	61,769
1993	64,350
1994	67,017
1995	69,861
1996	72,720

The estimated total plywood production increases every year with a little more than 2,000 cubic metres.

§ 7.5 Derivation of the future cassava flour demand

In this paragraph we will first of all assign the total future plywood production to the separate plywood companies and next derive the future wheat and cassava flour demand of each one of them (figure 2.1 in chapter 2).

The total future production is assigned to the separate plywood companies by assuming that their future production shares will stay constant. These production shares have already been dealt with in paragraph 3.4 (table 3.3).

Taking the average share of each company in the total plywood production from 1987 to 1990 (table 3.3) together with the estimated total plywood production (table 7.3), results in the future plywood production of each company presented in table 7.4 (figure 2.1).

Table 7.4 Future plywood production of each plywood company

year	company 1 (m^3)	company 2 (m^3)	company 3 (m^3)	company 4 (m^3)
1990	9,293	11,859	22,691	13,170
1991	9,683	12,356	23,644	13,723
1992	10,068	12,848	24,584	14,269
1993	10,489	13,385	25,611	14,865
1994	10,924	13,940	26,673	15,481
1995	11,387	14,531	27,805	16,138
1996	11,853	15,126	28,943	16,798

Note: the production figures in the year 1994 of the separate plywood companies don't add up to the total production figure presented in table 7.3 because of rounding off errors.

In paragraph 4.2 and 4.5 we already dealt with the amounts of wheat and cassava flour used every year by each plywood company. Here we will present the rest of the available information about the annual wheat and cassava flour input of each plywood company and relate these amounts to their annual production in order to get an idea of the amount of (wheat and cassava) flour needed to produce a plywood unit (table 7.5).

From table 7.5 company 3 appears to need the lowest amount of flour to produce 1 cubic metre plywood, assuming that company 1 uses on average between 22 and 30 kg/m^3, which is 26 kg/m^3.

But the differences in the flour input coefficients (= amount of flour per plywood unit) between the plywood companies may also be caused by the fact that the plywood companies produce different plywood products and consequently need more or less flour (§ 2.3).

Table 7.5 Annual average (wheat and cassava) flour input per plywood unit produced by each plywood company

year	input company 1 (kg/m^3)	input company 2 (kg/m^3)	input company 3 (kg/m^3)	input company 4 (kg/m^3)
1980			24.81	
1981			24.42	
1982			24.53	
1983			24.61	
1984	22-30		24.87	
1985	22-30		24.36	
1986	22-30		24.56	
1987	22-30		24.73	32.06
1988	22-30		24.62	35.04
1989	22-30	30.75	24.98	36.08
1990	22-30	31.06	24.72	33.03
average*	26	30.91	24.66	34.05

* this average corresponds to the αi in figure 2.1 in chapter 2

Source: plywood industry, 1991

Company 3 also has the most constant flour input coefficient of all plywood companies.

In order to be able to calculate the **total** future flour demand of each plywood company, that is, the demand for wheat as well as cassava flour, the averages of the flour input amounts per cubic metre plywood are taken and assumed constant for the next 6 years. These averages are presented also in table 7.5.

The future total flour demand of each plywood company, calculated by multiplying the constant total flour input coefficient with the in table 7.4 presented future plywood production of each plywood company is shown in table 7.6 (figure 2.1).

Table 7.6 The future total flour demand of each plywood company

year	company 1 (kg)	company 2 (kg)	company 3 (kg)	company 4 (kg)
1992	261,768	397,132	606,241	485,859
1993	272,714	413,730	631,567	506,153
1994	284,024	430,885	657,756	527,128
1995	296,062	449,153	685,671	549,499
1996	308,178	467,545	713,734	571,972

In paragraph 4.5 in table 4.11 we presented the amounts of cassava flour used by each plywood company in 1990 and 1991 and in paragraph 4.2 in table 4.4 the amounts of wheat flour used in 1990. We furthermore know that the amounts of wheat flour used by plywood companies 3 and 4 in 1991 were respectively 760 and 460 thousand kilograms. Together these amounts give the total flour input of each plywood company.

If we divide the amount of cassava flour by the total amount of flour, we get a **cassava flour input share**, which we need to derive the future cassava flour demand from the future total flour demand in table 7.6. The cassava flour input shares in 1990 and 1991 are presented in table 7.7.

Table 7.7 The share of cassava flour in the total flour use

year	company	cassava flour input share (%)
1990	1	0.0
	2	8.1
	3	20.9
	4	20.0
1991	1	0.0
	2	n.a.
	3	23.2
	4	15.0

n.a. = not available

Source: plywood industry, 1991

Plywood companies 2 and 3 are satisfied with the amounts of cassava flour they currently use in relation to the amount of wheat flour. Company 4 lowered its input share from 20 percent in 1990 to 15 percent in 1991. None of the plywood companies has, however, the intention to lower its current cassava flour input share.

All plywood companies were asked for the maximum amount of cassava flour they are willing to use together with wheat flour in the resin. The responded maximum cassava flour input shares are respectively 20, 30, 45 and 20 percent for company 1, 2, 3 and 4.

Knowing that company 1 already is at the minimum amount of cassava flour they can use in their production process, namely none, that company 2 and 3 don't have the intention to lower their input shares (8.10 and 23.22 percent respectively) and that furthermore company 4 will also not lower its input share below 15 percent, we have a cassava flour input range for each plywood company.

We will now set up 3 cassava flour input share scenarios, based on these input ranges, for each plywood company and attach probabilities to each of these scenarios in order to be able to calculate the expected cassava flour input shares. This is demonstrated in table 7.8.

Table 7.8 The cassava flour input possibilities of each plywood company, the attached probabilities, and the expected cassava flour input shares

company	scenario 1	scenario 2	scenario 3	expected cassava flour input share
1	0.0 (0.5)	20.0 (0.2)	10.0 (0.3)	0.5· 0.0 + 0.2·20.0 + 0.3·10.0 = 7.0
2	8.1 (0.6)	30.0 (0.1)	19.1 (0.3)	0.6· 8.1 + 0.1·30.0 + 0.3·19.1 = 13.6
3	23.2 (0.4)	45.0 (0.2)	34.1 (0.4)	0.4·23.2 + 0.2·45.0 + 0.4·34.1 = 31.9
4	15.0 (0.8)	20.0 (0.1)	17.5 (0.1)	0.8·15.0 + 0.1·20.0 + 0.1·17.5 = 15.8

Note 1: the probability attached to each scenario for each plywood company is mentioned between brackets
Note 2: scenario 3 is the mean of scenario 1 and 2

Company 3 is expected to have the largest cassava flour input share and company 1 the smallest, because it is unknown whether this last company will use cassava flour at all in the future. Company 4 is expected to use in the next years the same cassava flour input share as in 1991.

The final step in our analysis is the calculation of the future cassava flour demand (figure 2.1). This is presented in table 7.9.

Table 7.9 The estimated cassava flour demand

year	company 1 (kg)	company 2 (kg)	company 3 (kg)	company 4 (kg)
1992	18,324	54,010	193,391	76,766
1993	19,090	56,267	201,470	79,972
1994	19,882	58,600	209,824	83,286
1995	20,724	61,085	218,729	86,821
1996	21,572	63,586	227,681	90,372

Company 3 is and will be by far the largest cassava flour consumer of all plywood companies, followed by company 4.

In the next chapter we will look whether the predicted amounts of cassava flour demanded by company 3, who purchases all its cassava flour from the union in Portoviejo, and company 4, who purchases a part of its cassava flour from the union, will suffice to stimulate the union to keep on providing sifted whole cassava flour to these companies.

CHAPTER 8 THE PROCESSING COSTS OF CASSAVA FLOUR

In this chapter we will discuss the processing and transportation costs of cassava flour produced by the union of cassava producing and processing associations (UAPPY) in Portoviejo for the plywood industry. This flour is processed at the demonstration centre of the union just outside Portoviejo in the province Manabí, from where it is transported to the 2 plywood companies in the capital Quito.

After a discussion of the production costs, we will make estimations of them for the next 5 years and use these estimations in the break-even analysis in chapter 9.

We will start in the first paragraph with a brief discussion of the processing costs of the cassava producing and processing associations, of whom the union purchases the cassava chips, which are processed into cassava flour.

§ 8.1 Processing costs of dried whole cassava chips

Of the 18 associations, who currently produce and process cassava, 14 produce dried cassava chips, 3 only cassava starch and 1 both dried chips and starch. We are only interested in the dried chips producers, because they provide the raw material that the union further processes into flour (§ 1.2).

The dried chips are sold to the union at a by the union fixed price per unit. This same price is paid to all 14 associations.

Because every association has different processing costs per unit dried chips (because of different size, geographical location, etc.), some have a positive, others a negative financial result at the fixed price paid to them. The average processing costs of each association of 1 quintal dried whole chips during the processing period 1990-1991 are shown in table 8.1.

The price the associations received from the union from July 1st to December 31st 1990 for 1 quintal dried whole cassava chips was 4,700 Sucres and from January 1st to June 30th 1991 6,300 Sucres.

At a price of 4,700 Sucres only 4 of the 14 associations have a positive financial result per quintal produced dried chips (table 8.1). At a price of 6,300 Sucres all the associations have a positive financial result. Taking the mean of both prices, 5,500 Sucres, 3 of the 14 associations have a negative result.

Table 8.1 Average processing costs of 1 quintal dried whole cassava chips in current Sucres

association	fixed costs (S/.)	variable costs (S/.)	total costs (S/.)
El Algodon	987	3,948	4,935
Pan y Agua	631	4,457	5,088
Jaboncillo	322	4,106	4,428
Siete de Mayo	361	4,201	4,562
Tablones	371	4,125	4,523
Rio Chico de Noboa	703	4,415	5,118
Bijahual	412	4,892	5,304
El Chial	434	4,707	5,141
Miguelillo	305	4,224	4,529
Bejuco	586	4,562	5,148
Mata de Cady	465	4,720	5,185
La Cuesta	524	5,033	5,557
El Junco	512	5,421	5,933
Maconta	444	5,169	5,613

S/. = Sucres

Source: INIAP, 1991

The fixed costs of the associations consist of the items administration, maintenance, depreciation and interest. The variable costs, which make up 90 percent on average of the total costs of all associations, consist for 80.6 percent of raw material costs. Other variable cost items are labour, combustibles, sacks, strings, transport and handling.

The raw material costs equal the average price paid for 1 unit cassava times the amount of cassava needed to produce 1 unit dried cassava chips. This amount, called the conversion rate, differs among the associations, as can be seen from table 8.2. The main reasons for this are the geographical location of the associations (and derived of that the climate circumstances) and the efficiency with which each one of them operates.

The smaller the conversion rate, the smaller also the total production costs will be, because of the large share of raw material in these total costs. The association Jaboncillo had an average conversion rate of 2.71, which is rather low, when compared with the average conversion rate for all associations of 2.94 (table 8.2). This association also had the lowest average processing costs per quintal dried whole chips in the processing period 1990-1991 (table 8.1).

Table 8.2 The average conversion rates of cassava into dried whole cassava chips of each association in the processing period 1990-1991

association	average conversion rate
El Algodon	2.50
Pan y Agua	2.56
Jaboncillo	2.71
Siete de Mayo	2.73
Tablones	2.80
Rio Chico de Noboa	2.82
Bijahual	2.95
El Chial	2.96
Miguelillo	2.97
Bejuco	3.00
Mata de Cady	3.02
La Cuesta	3.27
El Junco	3.40
Maconta	3.42

Source: INIAP, 1991

The association Maconta had the highest average conversion rate (table 8.2) and almost the highest average processing costs per quintal dried cassava chips (table 8.1).

§ 8.2 Processing costs of sifted whole cassava flour

As mentioned in the introduction of this chapter, the union mills purchased dried chips at the demonstration centre. The resulting flour is next sifted to obtain a finer flour product, which is sold to plywood companies. We will first discuss the fixed costs of this flour (§ 8.2.1), next its variable costs (§ 8.2.2).

§ 8.2.1 Fixed costs

The total fixed costs of the production of sifted whole cassava flour consist of the items administration (including commercialization costs), maintenance, depreciation and interest costs. Because the union doesn't make a distinction in its accounting between costs incurred for whole and white flour, the administration, maintenance and interest costs of whole cassava flour are calculated from the total costs made for whole and white flour. These total costs are allocated to white and whole cassava flour by means of the respective total amounts of white and whole cassava flour production. How this is done, is shown in table 8.3.

Table 8.3 Calculation of the total administration, maintenance, interest and depreciation costs of whole cassava flour in the processing period 1990-1991

white cassava flour production:	928.45 tons	(66.2%)	
whole cassava flour production:	473.39 tons	(33.8%)	+
total cassava flour production:	1,401.84 tons	(100.0%)	

item	total costs (current Sucres)	white flour (current Sucres)	whole flour (current Sucres)
administration	3,134,695 (100%)	2,075,168 (66.2%)	1,059,527 (33.8%)
maintenance	1,764,775 (100%)	1,168,281 (66.2%)	596,494 (33.8%)
interest	3,659,000 (100%)	2,422,258 (66.2%)	1,236,742 (33.8%)

depreciation costs: $\frac{5,000,000}{10} + \frac{1,750,000}{8} = 500,000 + 218,750 = 718,750$ Sucres

item	(current Sucres)
administration	1,059,527
maintenance	596,494
interest	1,236,742
depreciation	718,750
total fixed costs	3,611,513

The last fixed cost item, depreciation costs, are calculated for the mill and the sifter, which are installed in the demonstration centre. In this calculation, the depreciation of the space occupied by both machines in the demonstration centre and a rest value of the machines are not taken into account, because they are unknown.

The actual value of a new mill is 5 million Sucres and the actual value of a new sifter 1.75 million Sucres. The mill is 3 years old and is expected to function 7 years more. The sifter is 2 years old and is expected to serve 6 years more. The value decrease of both machines is assumed linear.

The outcome of the calculation of the total depreciation costs is added to the other total fixed costs in table 8.3.

The fixed costs presented in table 8.3 are, except the depreciation costs, the costs made for producing whole cassava flour. The extra fixed costs (in administration, maintenance and interest) incurred in sifting the flour are not registered in the union's accounts. We will assume that the fixed costs presented in table 8.3 equal the fixed costs made for milling and sifting.

Now we will calculate the fixed costs per unit cassava flour. As shown in table 8.3, the whole cassava flour production during the processing period 1990-1991 was 473.39 ton. In order to get the administration, maintenance and interest costs per unit cassava flour, we will divide these items by this amount.

The depreciation costs per unit are calculated in the following way: the costs of the mill (500,000 Sucres) are divided by the cassava flour amount presented in table 8.3 (473.39 ton) and the costs of the sifter (218,750 Sucres) by the amount of sifted whole cassava flour sold to the plywood companies in the processing period 1990-1991 (174,028 kg; calculated from table 4.10 in § 4.5).

Table 8.4 The fixed costs per unit sifted whole cassava flour in the processing period 1990-1991

item	current Sucres / 50 kg cassava flour
administration	111.9
maintenance	63.0
interest	130.6
depreciation	115.6
total	421.1

Interest is the largest cost item in table 8.4, followed by the depreciation costs.

§ 8.2.2 Variable costs

The variable costs of sifted whole cassava flour consist of the items raw material, labour, energy, transport and others. We will discuss these items below.

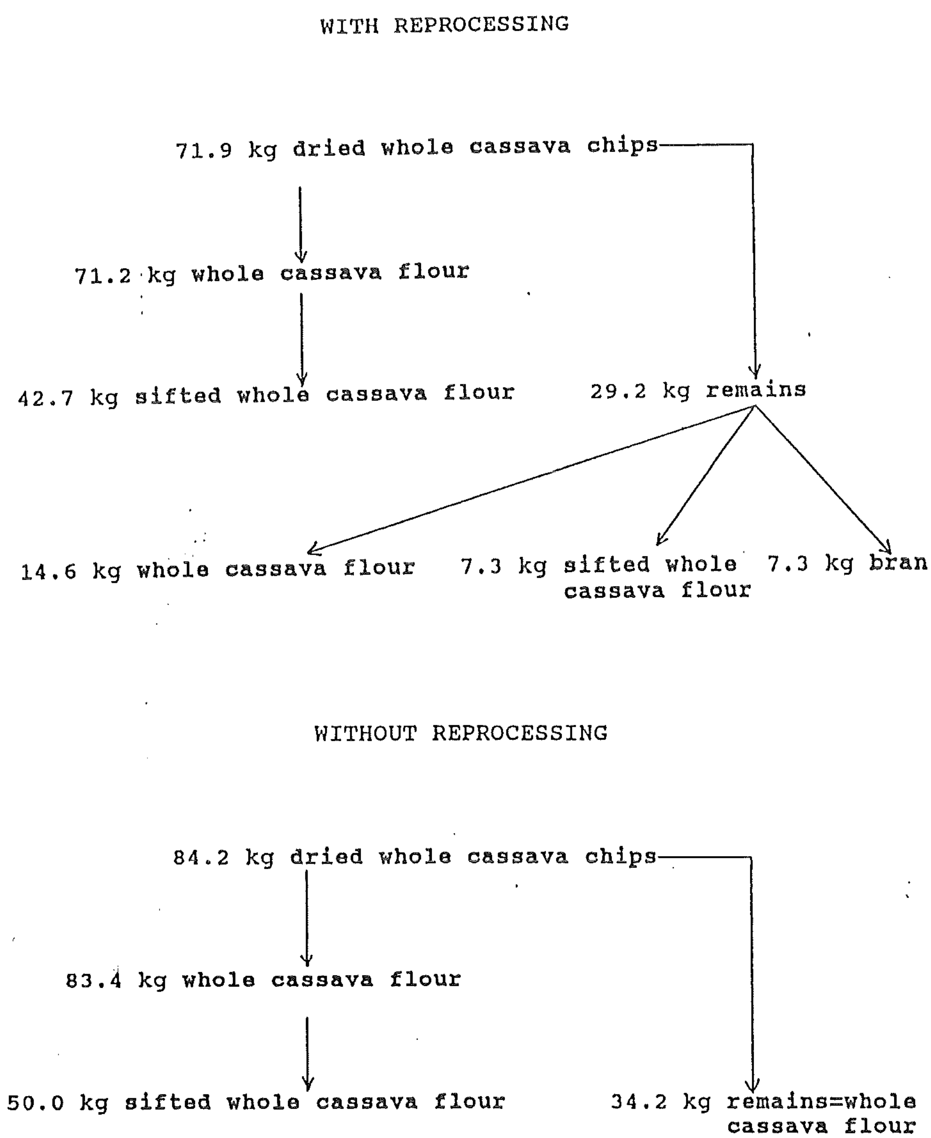
When the dried chips are processed into flour, 1 percent of the raw material is left over. When cassava flour is sifted, 40 percent of the flour is left over. These remains, which can be remilled and resifted, can be dealt with in 2 ways.

The first way is to remill and resift a certain amount of the remains and sell the rest directly as whole cassava flour to the shrimp and chicken feed industry.

Unknown is, however, how much exactly of the remains are remilled and resifted and how much is sold directly as whole flour. The remains left after reprocessing the first remains are sold as bran to the cattle feed industry (figure 8.1).

The second way is to sell the remains directly as whole cassava flour to the shrimp and chicken feed industry (figure 8.1).

Figure 8.1 The processing and reprocessing of dried whole cassava chips into 50 kg sifted whole cassava flour



We have made therefore 2 calculations of the variable processing costs. One in which a certain amount of the remains are reprocessed and the rest of these remains are sold directly to the shrimp and chicken feed industry and one in which all the remains are sold directly as whole cassava flour to the shrimp and chicken feed industry.

We will assume here that, in case we reprocess a part of the remains, 50 percent of these remains are reprocessed and the other 50 percent sold directly to the shrimp and chicken feed industry. We know furthermore that 50 percent of the reprocessed remains can be mixed with sifted whole cassava flour and be sold as such (V.Ruiz, UAPPY, 1991). This is all taken into account in figure 8.1, where we see what happens if we process dried whole cassava chips into sifted whole cassava flour.

The price paid by the union for 1 quintal dried whole cassava chips was 6,500 Sucres in December 1991. The price received in the shrimp and chicken feed industry for 1 quintal whole cassava flour was 8,000 Sucres in December 1991 and 3,000 Sucres in the same month in the cattle feed industry for 1 quintal of bran.

We will start now with the calculation of the variable costs of one unit sifted whole cassava flour in case 50 percent of the remains is reprocessed and the other 50 percent is sold directly to the shrimp and chicken feed industry, followed by the calculation of the variable costs in case all the remains are sold directly to the shrimp and chicken feed industry.

The raw material costs equal the price per unit dried whole cassava chips paid by the union times the amount of chips purchased. The raw material input necessary to produce 50 kg sifted whole cassava flour can be read from figure 8.1. This is 71.9 kg. Multiplied with the price the union pays for dried whole cassava chips (6,500 Sucres for 1 quintal or 143.3 Sucres per kg) results in the raw material costs presented in table 8.5.

The labour costs of milling 1 quintal flour are 80 Sucres and the labour costs of sifting 1 quintal flour 100 Sucres (V.Ruiz, UAPPY, 1991). There are 3 men working at the demonstration centre. Two persons are needed to tend the mill and one to tend the sifter. After milling 71.9 kg dried whole cassava chips, 71.2 kg whole cassava flour results (figure 8.1). After sifting this 71.2 kg flour, 42.7 kg sifted whole cassava flour results (figure 8.1).

The remains are 29.2 kg, of which 50 percent is remilled and resifted, resulting in another 7.3 kg sifted whole cassava flour.

How this is effected in the labour costs is shown in table 8.6. The total labour costs are presented also in table 8.5.

Table 8.5 The variable costs per unit sifted whole cassava flour in December 1991 in case 50% of the remains are reprocessed

item	current Sucres/50 kg	(%)
raw material	10,303.3	85.1
labour	340.7	2.8
energy	94.9	0.8
transport	1,322.8	10.9
others	48.5	0.4
subtotal	12,110.2	100.0
sale of by-product	3,057.9	
total variable costs	9,052.3	

Source: UAPPY, 1991

The estimated energy costs (electricity) of milling 1 quintal flour are 40 Sucres and the estimated energy costs (also electricity) of sifting 1 quintal flour 10 Sucres (V.Ruiz, UAPPY, 1991). The energy costs are calculated in the same way as the labour costs (table 8.7).

The sifted whole cassava flour is transported to 2 plywood companies in Quito by a transportation enterprise. The price presently (December 1991) paid for each quintal cassava flour transported to these companies is 1,200 Sucres, or 1,322.8 Sucres/50 kg (table 8.5).

The item others consists of handling, sacks and strings. Handling is the loading and unloading of the trucks that transport the cassava flour. The estimated handling, sack and string costs are 44 Sucres per quintal (V.Ruiz, UAPPY, 1991).

Fifty percent of the remains are sold directly as whole flour to the shrimp and chicken feed industry and the remains of reprocessing the other 50 percent are sold as bran to the cattle feed industry. The amount of whole flour resulting from producing 50 kg sifted whole cassava flour is 14.6 kg and the amount of bran 7.3 kg (figure 8.1). Multiplying these amounts with the prices the union received respectively in the shrimp and chicken feed industry and the cattle feed industry gives the total revenues of the by-products (table 8.5).

Table 8.6 Calculation of the labour costs

PROCESSING	
1) milling	
71.9 kg • S/. 1.76/kg =	S/. 126.5
2) sifting	
71.2 kg • S/. 2.20/kg =	S/. 156.6
REPROCESSING	
1) milling	
14.6 kg • S/. 1.76/kg =	S/. 25.7
2) sifting	
14.5 kg • S/. 2.20/kg =	S/. 31.9 +
total	S/. 340.7

Note 1 labour costs (milling) = 80 Sucres/quintal = 1.76 Sucres/kg
labour costs (sifting) = 100 Sucres/quintal = 2.20 Sucres/kg

Note 2 a) reprocessed remains = 14.6 kg (see figure 8.1)
b) after remilling the remains, 14.5 kg flour results, which in its turn results, after sifting, in 7.3 kg sifted whole cassava flour

Table 8.7 Calculation of the energy costs

PROCESSING
1) milling

71.9 kg • S/. 0.90/kg = S/. 64.7

2) sifting

71.2 kg • S/. 0.20/kg = S/. 14.2

REPROCESSING
1) milling

14.6 kg • S/. 0.90/kg = S/. 13.1

2) sifting

14.5 kg • S/. 0.20/kg = S/. 2.9 +

total S/. 94.9

Note 1 energy costs (milling) = 40 Sucres/quintal = 0.90 Sucres/kg
energy costs (sifting) = 10 Sucres/quintal = 0.20 Sucres/kg
Note 2 a) reprocessed remains = 14.6 kg (see figure 8.1)
b) after remilling the remains, 14.5 kg flour results, which in its turn results, after sifting, in 7.3 kg sifted whole cassava flour

The other way of dealing with the remains is to sell it all directly as whole flour to the shrimp and chicken feed industry.

The raw material costs are higher, because more dried whole cassava chips are needed to produce 1 unit sifted whole cassava flour in case the remains are not reprocessed (figure 8.1). The variable costs per unit sifted whole cassava flour in case the remains are not reprocessed are presented in table 8.8.

Table 8.8 The variable costs per unit sifted whole cassava flour in December 1991 in case the remains are sold directly to the shrimp and chicken feed industry

item	current Sucres/50 kg	(%)
raw material	12,065.9	87.0
labour	331.7	2.4
energy	92.5	0.7
transport	1,322.8	9.5
others	48.5	0.3
subtotal	13,861.4	100.0
sale of by-product	6,032.9	
total variable costs	7,828.5	

Note: the variable cost items don't add up to 100 percent exactly, because of rounding off errors
Source: UAPPY, 1991

The labour and energy costs only consist of labour and energy costs incurred in processing 1 time dried chips into sifted whole cassava flour. The amounts of dried whole chips and whole flour to be milled and to be sifted are in this case respectively 84.2 and 83.4 kg (figure 8.1). These amounts multiplied with the labour and energy costs per unit (as was also done in table 8.6 and 8.7), results in the labour and energy costs presented in table 8.8. The items transport and others stay the same.

The revenues of the direct sale of the by-product (whole cassava flour) to the shrimp and chicken feed industry are now almost twice as much as in the case in which 50 percent of the remains are sold directly to these industries and 50 percent are reprocessed (table 8.8 and table 8.5).

In both cases the transportation costs to the industries involved (the shrimp and chicken feed industry and the cattle feed industry) are not subtracted from the sales of the by-products. Assuming that these transportation costs are the same in both cases and that the fixed costs per unit sifted whole cassava flour are also the same in both cases, we can conclude that the direct sale of all the remains to the shrimp and chicken feed industry is more lucrative than remilling and resifting 50 percent of them.

The price received in the plywood industry for 1 quintal of sifted whole cassava flour was 10.909,09 Sucres in December 1991 (table 4.13 in § 4.6), or 240.5 Sucres/kg. Taking the fixed and the variable costs per 50 kg sifted whole cassava flour together (table 8.4 and tables 8.5 and 8.8), the profit rate in case 50 percent of the remains are reprocessed and 50 percent are sold to the shrimp and chicken feed industry is 26.9 percent and in case all the remains are sold directly to the shrimp and chicken feed industry, 45.8 percent.

§ 8.3 Estimation of the processing costs of sifted whole cassava flour

In chapter 9, we will conduct a break-even analysis for the next 5 years (1992-1996). In order to be able to do this, we need estimations of the total fixed production costs of sifted whole cassava flour and the variable production costs per unit (§ 2.5). The total future fixed costs are dealt with in paragraph 8.3.1 and the future variable costs per unit in paragraph 8.3.2.

§ 8.3.1 Future fixed processing costs

The fixed cost items are assumed to evolve according to the projected inflation rate. For the item interest this means that the real interest rate stays constant*.

* assumption: change of the nominal interest rate = change of the inflation rate → change of the real interest rate = change of the nominal interest rate - change of the inflation rate = 0

The interest rate handled by the union refers to the interest rate charged by the National Development Bank for their loans for agricultural activities. This interest rate has always been lower than the average interest rate handled by private banks, but since October 1991 the National Development Bank increased its interest rate to a level comparable with that of private banks.

The development of the inflation rate in the past in the coast region in Ecuador is shown in table 8.9. The annual percent change of general consumer prices equals the monthly rate of inflation compared with the inflation rate in the same month one year ago. For example, the inflation rate in January 1990 was, according to table 8.9, 53.7 percent higher than the inflation rate in January 1989.

Table 8.9 Annual percent variation in general prices at consumer level in the coast area of Ecuador

year	month	inflation (annual % change)
1990	January	53.7
	February	53.6
	March	45.6
	April	48.3
	May	50.5
	June	49.0
	July	51.6
	August	48.8
	September	47.7
	October	49.4
	November	51.3
	December	50.8
1991	January	51.5
	February	50.3
	March	50.8
	April	49.0
	May	51.1
	June	50.0
	July	48.3
	August	50.3
	September	50.5
	October	50.1

Source: Banco Central del Ecuador, Division Tecnica, Gerencia de Estudios Economicos, "Indice de precios al consumidor. Area urbana", November 1991

The average annual percent change in the inflation rate in 1990 was 50.0 percent and from January to October 1991 50.2 percent. For the next 5 years we will therefore assume a constant annual inflation rate of 50 percent.

Table 8.10 The future total fixed costs in every processing period of the sifted whole cassava flour production

processing period	total fixed costs (Sucres)
1991-1992	3,611,513
1992-1993	5,417,270
1993-1994	8,125,905
1994-1995	12,188,858
1995-1996	18,283,286
1996-1997	27,424,929

How this asumption is elaborated in the total fixed costs for the next 5 years is shown above in table 8.10. The future total fixed costs are calculated by increasing the total fixed costs presented in table 8.3 every year with 50 percent.

§ 8.3.2 Future variable processing costs

The projections we will make in the following of the variable costs per unit sifted whole cassava flour are based on the following assumptions:

1) the union will sell in the future all the remains of processing dried whole cassava chips into sifted whole cassava flour directly to the shrimp and chicken feed industry. Demonstrated is that this is more lucrative than reprocessing 50 percent of the remains
(§ 8.2.2)

2) the amount of dried whole cassava chips needed to produce 1 unit sifted whole cassava flour is constant (figure 8.1)

3) based on past prices and the arbitrary way they were established by the union, we assume that the price the union pays for 1 quintal dried whole cassava chips increases every year with 10 percent

4) based on wages paid in the past by the union, we assume that the labour costs of 1 quintal milled and 1 quintal sifted whole cassava flour will increase every year with 20 percent

5) the energy costs will evolve according to the projected electricity prices (to be dealt with later on in this paragraph)

6) the items transport and others will evolve according to the projected inflation rate (§ 8.3.1)

7) the revenues of the sale of the by-product are a constant proportion of the variable costs per unit sifted whole cassava flour (43.5 percent as can be calculated from table 8.8).

The future prices paid by the union for 1 quintal dried whole cassava chips, the future raw material and the future labour costs per unit sifted whole cassava flour are elaborated in appendix 23.

The electricity prices in the province Manabí are presented in table 8.11. The average monthly percent change of the middle sales prices of electricity was 3.4 from January 1990 to June 1991. We will take this average as the future monthly rate of increase in electricity prices to calculate the future electricity costs per unit sifted whole cassava flour with. These electricity costs are also presented in appendix 23.

Table 8.11 Electricity prices in the province Manabí from January 1990 to June 1991

year	month	middle electricity sales price (S/. / KWH)
1990	January	18.72
	February	19.29
	March	19.94
	April	20.49
	May	20.95
	June	21.64
	July	22.14
	August	23.04
	September	23.08
	October	22.49
	November	23.99
	December	24.06
1991	January	27.77
	February	28.40
	March	29.90
	April	30.05
	May	30.94
	June	32.75

S/. / KWH = current Sucres per kilowatt hour

Source: INECEL, Dirección de Distribución y Comercialización, Dept.de Estadisticas, "Estadisticas electricas. Informe mensual", Quito, Ecuador

The future variable processing costs of sifted whole cassava flour are presented in table 8.12. These variable costs increase every year more than proportionately, while the total fixed costs presented in table 8.10 increase every year according to the annually constant assumed inflation rate.

Table 8.12 The future variable costs per unit sifted whole cassava flour

year	month	variable costs (Sucres/50 kg)
1991	December	7,828.5
1992	December	8,959.9
1993	December	10,374.2
1994	December	12,178.5
1995	December	14,542.2
1996	December	17,706.9

In the next chapter, we will calculate the future break-even amounts of sifted whole cassava flour with the estimated fixed and variable costs calculated in this chapter and the estimated sifted whole cassava flour prices in chapter 6.

The total fixed costs we estimated in this chapter are the total costs for the next 5 **processing periods**, as opposed to the variable processing costs per unit sifted whole cassava flour and the sifted whole cassava flour prices in chapter 6, which have been estimated for the next 5 **years**.

In order to be able to calculate the break-even amounts of sifted whole cassava flour for the next 5 **years** and compare them with the estimated cassava flour demand from the plywood industry for the next 5 **years** in chapter 7, we will assume that the total fixed production costs in every processing period equal the fixed production costs at the end of every year.

CHAPTER 9 BREAK-EVEN ANALYSIS

In this chapter we will calculate the future break-even amounts of sifted whole cassava flour and compare them with the estimated sifted whole cassava flour demand from the plywood industry. Only if the future cassava flour demand larger is than the future break-even amounts, the union will be stimulated to continue the production of sifted whole cassava flour for this specific industry.

§ 9.1 The break-even amounts

In chapter 2 (§ 2.5) we already discussed the set-up of a break-even analysis. The formula with which we will calculate the future break-even amounts is:

$$Q = \frac{TFC}{p - vc}$$

in which Q = the break-even amount, or the amount that has to be sold in order to cover all costs incurred in producing and providing the product involved to the market involved

TFC = the total fixed costs of the product involved

p = the price per product unit

vc = the variable unit costs of the product involved.

All the variables needed to calculate the break-even amounts have been dealt with in earlier chapters (table 6.2 in chapter 6 and tables 8.10 and 8.12 in chapter 8). Below, in table 9.1, we will present the calculated future break-even amounts.

Table 9.1 Future break-even amounts of sifted whole cassava flour

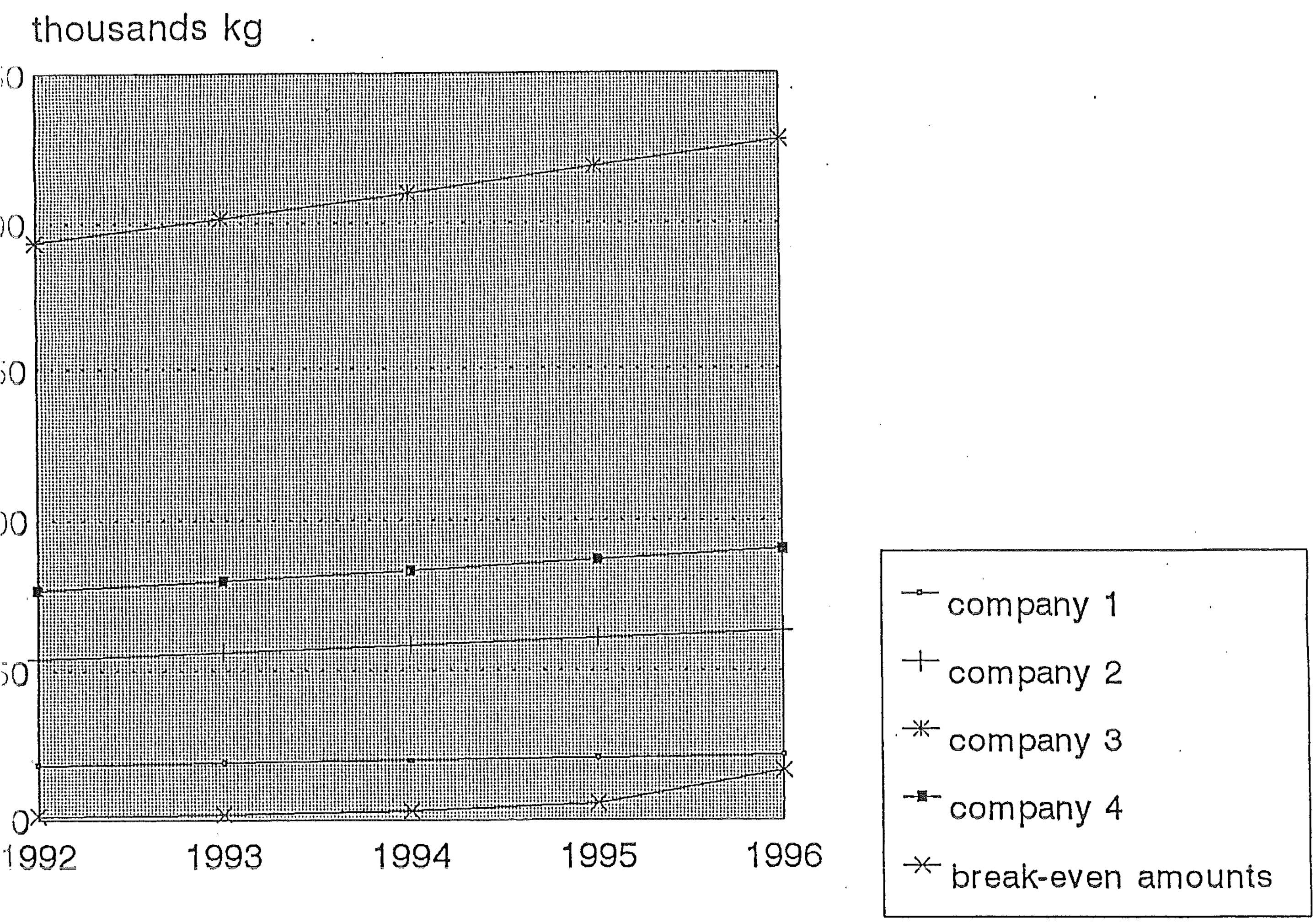
year	break-even amount (kg)
1992	1,276
1993	1,857
1994	2,961
1995	5,541
1996	16,321

The break-even amounts increase more than proportionately from almost 1,300 kg in 1992 to more than 16,000 kg in 1996.

§ 9.2 Comparison of the break-even amounts with the demanded amounts

The estimated cassava flour demand from 1992 to 1996 from the plywood companies was presented in chapter 7 in table 7.9. The estimated demand from company 3, who purchases all its cassava flour from the union, is already larger than the calculated break-even amounts in table 9.1. This is demonstrated more clearly in figure 9.1.

Figure 9.1 The demanded amounts of cassava flour by the plywood industry and the break-even amounts of cassava flour in the next 5 years



From the tables 7.9 and 9.1 and figure 9.1 we can conclude that the demand for sifted whole cassava flour from the plywood companies, who already purchase cassava flour from the union (company 3 and 4), is much larger than the amounts the union needs to sell in order to cover all costs incurred in providing them the product.

CHAPTER 10 CONCLUSIONS, RECOMMENDATIONS AND DISCUSSION

In this final chapter, we will draw some conclusions, make recommendations and discuss the shortcomings of this study.

§ 10.1 Conclusions

The main objective of this study, the estimation of the sifted whole cassava flour demand from the plywood industry, was completed in chapter 7. Another objective was to determine whether this demand is economically sustainable. This was done in chapter 9. The conclusions we can draw are the following:

- The national and foreign plywood demand were estimated by means of multiple regression. The commonly shared opinion in the plywood industry that there exist sales growth possibilities abroad could not be confirmed for the next 5 years, even though we used a functional form based on exponential growth.

- In the regression analysis, the national plywood demand was best explained by the urbanization degree and the foreign plywood demand by the world prices of plywood, particleboard and medium density fibreboard.

- The substitution potential of cassava flour in the particleboard industry is neglectable.

- The total plywood production in Ecuador is estimated to increase each year for the next 5 years with a little more than 2,000 cubic metres. This increase is in our estimation largely caused by the increase in domestic demand.

- The substitution potential of cassava flour in the plywood industry depends on 4 factors: its price, its quality, its availability and knowledge about the first 3 factors just mentioned.

- The derived cassava flour demand has been estimated by using 3 different scenarios in which cassava flour substitutes wheat flour to a certain extent. The estimated total amount of cassava flour to be used in the plywood industry in the next 5 years is about 1.9 thousands of tons.

- The largest cassava flour user in the plywood industry in the next 5 years will be, like in the past, company 3. This company alone will account for a little more than 56% of the total amount of cassava flour to be used in the next 5 years in the plywood industry.

- The substitution potential of cassava flour is, as said, limited by the inferior product characteristics of cassava flour compared to wheat flour. The price of cassava flour is and will therefore be always lower than the wheat flour price. In our price analysis, the cassava flour price appeared to be on average less than 70 percent of the wheat flour price.

- Of all the cassava flour purchased by the plywood industry, about 70 percent originates from the union (UAPPY).

- The processing of sifted whole cassava flour is more profitable when all the remains are sold directly to the shrimp and chicken feed industry, instead of reprocessing 50 percent of them.

- The amounts of sifted whole cassava flour the union has to sell in the future to cover all costs incurred in providing this product to the plywood industry are much smaller than the estimated demanded amounts, meaning that the production of sifted whole cassava flour will be more than profitable for the next 5 years.

§ 10.2 Recommendations

The recommendations we make to the union (UAPPY) are the following:

- In order to be able to compete with wheat flour mills and other cassava flour suppliers, quality control should receive priority during and after processing.

- In order to be able to make more accurate production costs estimations and consequently know more about the profitability of the different cassava flour types (portfolio analysis), not only should there be made a distinction in the accounts between white and whole flour, but also between sifted and non-sifted cassava flour.

- Prices handled by wheat flour mills and other cassava flour suppliers should be monitored and price strategies should be worked out based on these registered prices and the more accurately administered production costs.

- A more thorough production costs analysis should reveal possible economies of scale, just prices to pay to the associations and the profitability of transporting cassava flour self to the plywood companies instead of contracting this out.

- More official promotion activities should be considered towards plywood companies (but also towards other possible customers), like advertising (brochures) with information about product types and product characteristics.

- All the remains after processing cassava chips into flour should be sold directly to the shrimp and chicken feed industry instead of reprocessing part of it.

- The profit to be made by not reprocessing part of the remains should be investigated more thoroughly, however. Here we assumed alternatively that 50% of the remains are reprocessed. More carefully should be looked at the impact on profitability of reprocessing different shares of the remains.

§ 10.3 Discussion

In this final paragraph, we will discuss some shortcomings of this study.

Because it was hard to get information from the plywood companies, we had to do with the plywood production and exports figures published by the Food and Agriculture Organization of the United Nations.
As we demonstrated in this study, however, these figures showed from 1987 to 1989 a different course than the scarce figures provided by the plywood industry self. We consider therefore the estimated plywood demand, based on the FAO-figures, assailable, even though we corrected the estimated plywood demand for the mentioned difference.

We consider furthermore the lack of a more thorough investigation of other cassava flour suppliers, beside establishing their location and their share in the total cassava flour supply to the plywood industry, as a shortcoming of this study.

Finally, we want to remark that we made an estimation in this study of the cassava flour demand for the next 5 years. If we want to look further than these 5 years, longer run impacts like technology changes and/or (in)direct policy changes should be taken into consideration.

A technology change may be the more efficient production of sifted whole cassava flour, resulting in lower production costs. Or more favourable product characteristics of cassava (flour) by means of bio-genetic technology changes, making cassava flour perhaps a 100 percent substitute of wheat flour.
Indirect government policy impacts may be ecological policies (reforestation), import policies, which make wheat imports cheaper and therefore wheat flour, export policies (for example within the Andean group), which may have a considerable impact on the exportation of Ecuadoran plywood or monetary policies, which influence among others the exchange rate, which in its turn may have a positive or negative impact on the demand for Ecuadoran plywood abroad.

Appendix 1

The Andean integration*

Ecuador, Colombia, Venezuela, Peru and Bolivia are called the Andean group, not only because of their geographical position, but also because of their cooperation, especially on economic matters.

These countries signed the "Acuerdo de Cartagena", an agreement on economic and social integration.

On May 26th 1969 this agreement was signed by Bolivia, Colombia, Chile, Ecuador and Peru to look for a solution for the existing disequilibrium between the contracting countries of the "Asociación Latino Americana de Libre Comercio" (A.L.A.L.C.). On February 13th 1973 Venezuela joined, while on October 30th 1976 Chile withdrew from it.

The objectives of the agreement are, among others,

1) to promote the balanced and harmonic development of member countries

2) to accelerate their growth through economic integration

3) to establish suitable conditions for the conversion of the ALALC into a common market.

The objectives were established to procure a persistent improvement in the level of living of all inhabitants of the subregion constituted by the 5 Andean countries.

To achieve the objectives, the following mechanisms are, among others, used:

1) the harmonizing of economic and social policies and the approximation of the national legislations in pertinent matters

2) the joint programming and intensification of the subregional industrialization process by the execution of "Programas Sectoriales de Desarrollo Industrial"

3) a more accelerated "Programa de Liberación" of the trade than adopted in general in the framework of ALALC

* this appendix is largely based on information obtained from "Sistema Andino de Integración 1969-1984", Junta del Acuerdo de Cartagena, January 1985

4) a common external tariff, which is preceded by a minimum common external tariff, "Arancel Externo Mínimo Común"

5) programmes to accelerate the development of the agricultural sector

6) the canalization of resources in and outside the subregion to finance the necessary investments in the integration process

7) preferential treatments in favour of Bolivia and Ecuador.

The organizational structure of the agreement exists of:

1) La Comisión

The Commission is the highest organ of the agreement and is constituted of a plenipotentiary representative of every member government. The Commission is the political and decisive organ, which means principally, that the Commission formulates the general policy of the agreement, adopts the necessary measurements to achieve the objectives and looks after the harmonic execution of the obligations resulting from the agreement

2) La Junta

The Junta is the technical community organ of the agreement and is composed of 3 members, who remain (and can be reelected) in post for three years. The task of the Junta is:

- to look after the application of the agreement and the execution of the Commission's decisions
- to present proposals to the Commission that facilitate or accelerate the execution of the established objectives in the agreement
- to carry out studies and propose necessary measurements to applicate the special treatment in favour of Bolivia and Ecuador
- to pay special attention to the execution of the equitable distribution of the benefits of the integration and to recommend the necessary corrective measurements to the Commission.

The Junta is seated in Lima. The Commission normally assembles three times a year at the headquarters of the Junta.

Auxiliary organs are:

- the Comité Consultivo advises and collaborates with the Junta to realize the Junta's tasks whenever required

- the Comité Asesor Económico y Social (C.A.E.S.) is initially put up with the analysis of the participation of the social groups in the integration process

- the Consejo Consultivo Empresarial Andino and the Consejo Consultivo Laboral Andino express their opinion, on request of the principal organs of the agreement, on the different aspects related to the definition of the Andean integration policies and promote all those actions between the national organizations, of which the two organs are made up, that tend to secure the effective participation of both sectors in the execution of the common programs

- with the intention to obtain a more agile and efficient execution of the integration tasks, the Commission has furthermore created the following councils:
  - Consejo de Planificación
  - Consejo Monetario y Cambiario,
  - Consejo Financiamiento
  - Consejo Política Fiscal
  - Consejo Comercio Exterior
  - Consejo Turismo
  - Consejo Asuntos Sociales
  - Consejo Salud
  - Consejo Integración Física
  - Consejo Agropecuario
  - Consejo Estadísticas
  - Consejo Asuntos Aduaneros
  - Consejo Política Industrial
  - Consejo Ciencia y Tecnología.

In December 1989 the 5 Andean countries decided to establish a Customs Union in 1995 in the subregion, which means the non-existence of tariffs on intrasubregional trade and a common tariff on importations from abroad. Now a minimum common external tariff is in force (Diario "Hoy", September 19th 1991).

At the beginning of December 1991, the heads of state of the 5 Andean countries met in Cartagena in Colombia, where they decided to accelerate the economic integration process by proclaiming the Customs Union already the first of January of 1992.

Because of discord between the 5 countries on the common external tariff, however, a free trade zone will come into force only between Colombia, Venezuela and Bolivia. Ecuador and Peru will join this free trade zone in July 1992. The Customs Union can come into force, when there will be agreement on the fixation of the common external tariff (Diario "Hoy", December 29th 1991).

Appendix 2

Calculation of the constant national plywood price from 1984 to 1989:

year	current price (Sucres/cubic metre)	manufacturing value added deflator (1987=100)	constant price (Sucres/cubic metre)
1980		15.8	
1981		16.9	
1982		20.5	
1983		29.1	
1984	20,098	48.1	41,783.8
1985	24,020	60.1	39,966.7
1986	25,399	79.6	31,908.3
1987	41,613	100.0	41,613.0
1988	80,541	181.6	44,350.8
1989	129,861	349.2	37,188.1

Sources: - current plywood prices: plywood industry, Ecuador, 1991
- manufacturing value added deflator: World Bank, World Tables 1990, 1991

Calculation of the constant national particleboard price from 1980 to 1989:

year	current price (Sucres/cubic metre)	manufacturing value added deflator (1987=100)	constant price (Sucres/cubic metre)
1980	6,650.0	15.8	42,088.6
1981	7,520.8	16.9	44,501.8
1982	9,295.1	20.5	45,341.8
1983	13,442.9	29.1	46,195.6
1984	18,059.5	48.1	37,545.7
1985	23,545.7	60.1	39,177.5
1986	30,263.2	79.6	38,019.1
1987	36,247.4	100.0	36,247.4
1988	63,387.0	181.6	34,904.7
1989	100,049.1	349.2	28,650.9

Sources: - current plywood prices: plywood industry, Ecuador, 1991
- manufacturing value added deflator: World Bank, World Tables 1990, 1991

Appendix 3

The total Ecuadorean population and gross national income per capita from 1980 to 1989:

year	total population (thousands)	gross national income/capita (1987 US dollars)
1980	8,123	1,330
1981	8,354	1,310
1982	8,589	1,240
1983	8,828	1,180
1984	9,071	1,170
1985	9,317	1,180
1986	9,566	1,070
1987	9,819	1,000
1988	10,073	1,060
1989	10,329	1,050

Source: World Bank, World Tables 1990, 1991

Appendix 4

Countries importing regularly Ecuadorean plywood:

Developed countries	Developing countries
U.S.A.	El Salvador
Canada	Panama
Spain	Colombia
United Kingdom	Venezuela
Germany	Peru
Sweden	Chile
France	Mexico
Japan	China
South-Korea	

Source: Banco Central del Ecuador, 1991

Appendix 5

****** MULTIPLE REGRESSION ******

Listwise Deletion of Missing Data

Equation Number 1   Dependent Variable..   X1   CASSAVA FLOUR PRICE

Block Number 1. Method: Enter   X2

Variable(s) Entered on Step Number 1..   X2   WHEAT FLOUR PRICE

Multiple R	.82054	Analysis of Variance			
R Square	.67328		DF	Sum of Squares	Mean Square
Adjusted R Square	.65695	Regression	1	25260968.09699	25260968.09699
Standard Error	782.88373	Residual	20	12258138.75574	612906.93779

F =   41.21501   Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X2	.705181	.109843	.820538	6.420	.0000
(Constant)	-837.179519	1734.831230		-.483	.6346

End Block Number 1 All requested variables entered.

****** MULTIPLE REGRESSION ******

Equation Number 1   Dependent Variable..   X1   CASSAVA FLOUR PRICE

Residuals Statistics:

	Min	Max	Mean	Std Dev	N
*PRED	9423.2002	12843.3262	10248.5818	1096.7695	22
*RESID	-1406.4999	1438.2520	.0000	764.0163	22
*ZPRED	-.7526	2.3658	.0000	1.0000	22
*ZRESID	-1.7966	1.8371	.0000	.9759	22

Total Cases =   22

Durbin-Watson Test =   .78979

Appendix 6

**** MULTIPLE REGRESSION ****

Listwise Deletion of Missing Data

Equation Number 1   Dependent Variable..   X1   WHEAT FLOUR PRICE

Block Number 1. Method: Enter   X2

Variable(s) Entered on Step Number 1..   X2   TREND

Multiple R	.84864
R Square	.72019
Adjusted R Square	.70748
Standard Error	823.41870

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	1	38393491.84783	38393491.84783
Residual	22	14916403.98551	678018.36298

F = 56.62604   Signif F = .0000

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X2	182.717391	24.281293	.848643	7.525	.0000
(Constant)	13338.949275	346.947871		38.447	.0000

**** MULTIPLE REGRESSION ****

Equation Number 1   Dependent Variable..   X1   WHEAT FLOUR PRICE

Residuals Statistics:

	Min	Max	Mean	Std Dev	N
*PRED	13521.6670	17724.1660	15622.9167	1292.0071	24
*RESID	-1346.9928	1858.5508	.0000	805.3194	24
*ZPRED	-1.6263	1.6263	.0000	1.0000	24
*ZRESID	-1.6359	2.2571	.0000	.9780	24

Total Cases = 25

Durbin-Watson Test = .51507

Appendix 7

**** MULTIPLE REGRESSION ****

Listwise Deletion of Missing Data

Equation Number 1 , Dependent Variable.. X1 PLYWOOD CONSUMPTION

Block Number 1. Method: Enter X2 X3 X4 X5

Variable(s) Entered on Step Number	1..	X5	URBANIZATION
	2..	X2	PLYWOOD PRICE
	3..	X4	NATIONAL INCOME
	4..	X3	PARTICLEBOARD PRICE

Multiple R	.88665	Analysis of Variance			
R Square	.78616		DF	Sum of Squares	Mean Square
Adjusted R Square	-.06922	Regression	4	356.39031	89.09758
Standard Error	9.84596	Residual	1	96.94302	96.94302

F = .91907 Signif F = .6442

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X5	-4.059079	6.261041	-.565536	-.648	.6338
X2	9.743410E-05	.001014	.044931	.096	.9390
X4	.006495	.011401	.294956	.570	.6704
X3	-.002830	.002242	-1.123651	-1.262	.4265
(Constant)	294.148484	462.422371		.636	.6393

**** MULTIPLE REGRESSION ****

Equation Number 1 Dependent Variable.. X1 PLYWOOD CONSUMPTION

Residuals Statistics:

	Min	Max	Mean	Std Dev	N
*PRED	41.8343	64.6956	49.6667	8.4426	6
*RESID	-5.5119	4.9589	.0000	4.4032	6
*ZPRED	-.9277	1.7801	.0000	1.0000	6
*ZRESID	-.5598	.5036	.0000	.4472	6

Total Cases = 10

Durbin-Watson Test = 3.47922

Appendix 8

**** MULTIPLE REGRESSION ****

Listwise Deletion of Missing Data

Equation Number 1. Dependent Variable.. X1 PLYWOOD CONSUMPTION

Block Number 1. Method: Enter X3 X4 X5

Variable(s) Entered on Step Number 1.. X5 URBANIZATION
2.. X4 NATIONAL INCOME
3.. X3 PARTICLEBOARD PRICE

Multiple R	.79109
R Square	.62583
Adjusted R Square	.43874
Standard Error	11.60852

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	3	1352.35358	450.78453
Residual	6	808.54642	134.75774

F = 3.34515 Signif F = .0971

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X5	7.818864	2.909754	1.381536	2.687	.0362
X4	.015699	.012458	.363696	1.260	.2544
X3	.001999	.001384	.700726	1.444	.1990
(Constant)	-601.423177	286.000395		-2.103	.0802

**** MULTIPLE REGRESSION ****

Equation Number 1 Dependent Variable.. X1 PLYWOOD CONSUMPTION

Residuals Statistics:

	Min	Max	Mean	Std Dev	N
*PRED	18.2268	59.7354	44.1000	12.2581	10
*RESID	-14.0498	14.6659	.0000	9.4783	10
*ZPRED	-2.1107	1.2755	.0000	1.0000	10
*ZRESID	-1.2103	1.2634	.0000	.8165	10

Total Cases = 10

Durbin-Watson Test = 2.04383

Appendix 9

**** MULTIPLE REGRESSION ****

Listwise Deletion of Missing Data

Equation Number 1 . Dependent Variable.. X1 PLYWOOD CONSUMPTION

Block Number 1. Method: Enter X3 X5

Variable(s) Entered on Step Number 1.. X5 URBANIZATION
2.. X3 PARTICLEBOARD PRICE

Multiple R	.72581	Analysis of Variance			
R Square	.52680		DF	Sum of Squares	Mean Square
Adjusted R Square	.39161	Regression	2	1138.37269	569.18634
Standard Error	12.08616	Residual	7	1022.52731	146.07533

F = 3.89653 Signif F = .0729

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X5	5.994076	2.627660	1.059110	2.281	.0565
X3	.001309	.001324	.459087	.989	.3557
(Constant)	-314.451298	180.131044		-1.746	.1244

**** MULTIPLE REGRESSION ****

Equation Number 1 Dependent Variable.. X1 PLYWOOD CONSUMPTION

Residuals Statistics:

	Min	Max	Mean	Std Dev	N
*PRED	21.1804	56.1303	44.1000	11.2466	10
*RESID	-15.6925	13.7946	.0000	10.6590	10
*ZPRED	-2.0379	1.0697	.0000	1.0000	10
*ZRESID	-1.2984	1.1414	.0000	.8819	10

Total Cases = 10

Durbin-Watson Test = 1.53994

Appendix 10

**** MULTIPLE REGRESSION ****

Listwise Deletion of Missing Data

Equation Number 1 . Dependent Variable.. X1 PLYWOOD CONSUMPTION

Block Number 1. Method: Enter X5

Variable(s) Entered on Step Number 1.. X5 URBANIZATION

Multiple R	.67876	Analysis of Variance			
R Square	.46071		DF	Sum of Squares	Mean Square
Adjusted R Square	.39330	Regression	1	995.55178	995.55178
Standard Error	12.06932	Residual	8	1165.34822	145.66853

F = 6.83436 Signif F = .0309

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X5	3.841456	1.469423	.678757	2.614	.0309
(Constant)	-152.736215	75.389904		-2.026	.0773

**** MULTIPLE REGRESSION ****

Equation Number 1 Dependent Variable.. X1 PLYWOOD CONSUMPTION

Residuals Statistics:

	Min	Max	Mean	Std Dev	N
*PRED	27.0439	57.7756	44.1000	10.5175	10
*RESID	-19.0439	16.8951	.0000	11.3791	10
*ZPRED	-1.6217	1.3003	.0000	1.0000	10
*ZRESID	-1.5779	1.3998	.0000	.9428	10

Total Cases = 10

Durbin-Watson Test = 1.37210

Appendix 11

Estimation of the urbanization degree by means of regression on its trend variable

Dependent variable.. urbanization degree

Variable(s) entered on step number 1.. trend

Multiple R	.99190
R square	.98387
Adjusted R square	.98185
Standard error	.36882

Analysis of variance

	DF	Sum of squares	Mean square
Regression	1	66.37576	66.37576
Residual	8	1.08824	.13603

F = 487.94832 Signif F = .0000

------------- Variables in the equation --------------

Variable	B	SE B	Beta	T	Sig T
Trend	.896970	.040606	.991902	22.090	.0000
(Constant)	46.306667	.251954		183.790	.0000

Durbin-Watson test = .50492

number of cases: 10

Source: SPSS/PC 4.01

Appendix 12

The estimated urbanization degree from 1990 to 1996

year	urbanization degree (%)
1990	56.2
1991	57.1
1992	58.0
1993	58.9
1994	59.8
1995	60.7
1996	61.6

Appendix 13

**** MULTIPLE REGRESSION ****

Listwise Deletion of Missing Data

Equation Number 1 . Dependent Variable.. X1 EXPORTS

Block Number 1. Method: Enter X2 X3 X4 X5 X6

Variable(s) Entered on Step Number	1..	X6	AGGREGATED INCOME
	2..	X2	EXPORT PRICE
	3..	X3	WORLD PRICE
	4..	X4	PARTICLEBOARD PRICE
	5..	X5	MDF PRICE

Multiple R	.93772
R Square	.87931
Adjusted R Square	.72845
Standard Error	.31509

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	5	2.89347	.57869
Residual	4	.39714	.09928

F = 5.82864 Signif F = .0562

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X6	3.922896E-05	2.99521E-04	.108295	.131	.9021
X2	.002245	.006524	.074898	.344	.7480
X3	.056515	.042621	.886525	1.326	.2555
X4	.062378	.025557	1.240434	2.441	.0712
X5	-.075555	.060960	-1.511471	-1.239	.2829
(Constant)	-1.356526	2.055179		-.660	.5453

**** MULTIPLE REGRESSION ****

Equation Number 1 Dependent Variable.. X1 EXPORTS

Residuals Statistics:

	Min	Max	Mean	Std Dev	N
*PRED	2.0658	3.8573	2.8930	.5670	10
*RESID	-.5013	.2289	.0000	.2101	10
*ZPRED	-1.4588	1.7006	.0000	1.0000	10
*ZRESID	-1.5909	.7265	.0000	.6667	10

Total Cases = 10

Durbin-Watson Test = 3.07464

Appendix 14

**** MULTIPLE REGRESSION ****

Listwise Deletion of Missing Data

Equation Number 1 Dependent Variable.. X1 EXPORTS

Block Number 1. Method: Enter X2 X3 X4 X5

Variable(s) Entered on Step Number 1.. X5 MDF PRICE
2.. X2 EXPORT PRICE
3.. X3 WORLD PRICE
4.. X4 PARTICLEBOARD PRICE

Multiple R	.93744
R Square	.87879
Adjusted R Square	.78183
Standard Error	.28243

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	4	2.89177	.72294
Residual	5	.39884	.07977

F = 9.06303 Signif F = .0164

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X5	-.068238	.021875	-1.365107	-3.119	.0263
X2	.002069	.005722	.069024	.362	.7324
X3	.051351	.014503	.805516	3.541	.0166
X4	.062055	.022801	1.234014	2.722	.0417
(Constant)	-1.129307	.987608		-1.143	.3046

**** MULTIPLE REGRESSION ****

Equation Number 1 Dependent Variable.. X1 EXPORTS

Residuals Statistics:

	Min	Max	Mean	Std Dev	N
*PRED	2.0708	3.8622	2.8930	.5668	10
*RESID	-.5069	.2181	.0000	.2105	10
*ZPRED	-1.4505	1.7099	.0000	1.0000	10
*ZRESID	-1.7949	.7722	.0000	.7454	10

Total Cases = 10

Durbin-Watson Test = 3.00068

Appendix 1

****** MULTIPLE REGRESSION ******

Listwise Deletion of Missing Data

Equation Number 1 . Dependent Variable.. X1 EXPORTS

Block Number 1. Method: Enter X3 X4 X5

Variable(s) Entered on Step Number 1.. X5 MDF PRICE
2.. X3 WORLD PRICE
3.. X4 PARTICLEBOARD PRICE

Multiple R	.93575
R Square	.87562
Adjusted R Square	.81344
Standard Error	.26118

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	3	2.88134	.96045
Residual	6	.40927	.06821

F = 14.08019 Signif F = .0040

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X5	-.070574	.019327	-1.411834	-3.652	.0107
X3	.053121	.012625	.833285	4.208	.0056
X4	.064839	.019847	1.289378	3.267	.0171
(Constant)	-1.164758	.908766		-1.282	.2472

****** MULTIPLE REGRESSION ******

Equation Number 1 Dependent Variable.. X1 EXPORTS

Residuals Statistics:

	Min	Max	Mean	Std Dev	N
*PRED	2.0866	3.9229	2.8930	.5658	10
*RESID	-.5018	.2777	.0000	.2132	10
*ZPRED	-1.4252	1.8203	.0000	1.0000	10
*ZRESID	-1.9214	1.0633	.0000	.8165	10

Total Cases = 10

Durbin-Watson Test = 3.04687

Appendix 16

Correlations:

variables	X1	X2
world price of plywood (X1)	1.0000 (10) P= .	0.2390 (10) P=.253
world price particleboard/ world price medium density fibreboard (X2)	0.2390 (10) P=.253	1.0000 (10) P= .

(coefficient / (cases) / 1-tailed significance)
" . " is printed if a coefficient cannot be computed

Source: SPSS/PC 4.01

Appendix 17

**** M U L T I P L E   R E G R E S S I O N ****

Listwise Deletion of Missing Data

Equation Number 1   Dependent Variable..   X1   EXPORTS

Block Number 1. Method: Enter   X2   X3

Variable(s) Entered on Step Number 1..   X3   PART/MDF
2..   X2   WORLD PRICE PLYWOOD

Multiple R	.91661
R Square	.84018
Adjusted R Square	.79451
Standard Error	.27410

Analysis of Variance

	DF	Sum of Squares	Mean Square
Regression	2	2.76469	1.38235
Residual	7	.52592	.07513

F = 18.39921   Signif F = .0016

------------------ Variables in the Equation ------------------

Variable	B	SE B	Beta	T	Sig T
X3	.064166	.019717	.506415	3.254	.0140
X2	.041597	.009920	.652511	4.193	.0041
(Constant)	-6.975396	1.828006		-3.816	.0066

**** M U L T I P L E   R E G R E S S I O N ****

Equation Number 1   Dependent Variable..   X1   EXPORTS

Residuals Statistics:

	Min	Max	Mean	Std Dev	N
*PRED	2.0246	3.7774	2.8930	.5542	10
*RESID	-.4268	.3237	.0000	.2417	10
*ZPRED	-1.5669	1.5956	.0000	1.0000	10
*ZRESID	-1.5572	1.1810	.0000	.8819	10

Total Cases = 10

Durbin-Watson Test = 2.35582

Appendix 18

Estimation of the world plywood price by means of regression on its trend variable and a lag

Dependent variable.. world price of plywood

Variable(s) entered on step number 1.. trend
2.. lagged world price of plywood

Multiple R	.76308
R square	.58229
Adjusted R square	.44305
Standard error	6.15484

Analysis of variance

	DF	Sum of squares	Mean square
Regression	2	316.84293	158.42146
Residual	6	227.29263	37.88210

F = 4.18196 Signif F = .0729

------------- Variables in the equation ----------------

Variable	B	SE B	Beta	T	Sig T
trend	1.236129	.834262	.410474	1.482	.1889
lag	.647104	.229712	.780397	2.817	.0305
(Constant)	26.391463	23.723076		1.112	.3085

number of cases: 9

Source: SPSS/PC 4.01

Appendix 19

Estimation of the world particleboard price by means of regression on its trend variable and a lag

Dependent variable.. world price of particleboard

Variable(s) entered on step number 1.. trend
2.. lagged world price of particle board

Multiple R	.81507
R square	.66435
Adjusted R square	.55246
Standard error	8.44189

Analysis of variance

	DF	Sum of squares	Mean square
Regression	2	846.31535	423.15767
Residual	6	427.59354	71.26559

F = 5.93776 Signif F = .0378

------------- Variables in the equation -----------------

Variable	B	SE B	Beta	T	Sig T
trend	2.286677	1.169218	.496262	1.956	.0983
lag	.624357	.322425	.491368	1.936	.1009
(Constant)	20.599009	26.014914		.792	.4586

number of cases: 9

Source: SPSS/PC 4.01

Appendix 20

Estimation of the world price of medium density fibreboard by means of regression on its trend variable and a lag

Dependent variable.. world price of medium density fibreboard (m.d.f.)

Variable(s) entered on step number 1.. trend
2.. lagged world price of m.d.f.

Multiple R	.94344
R square	.89009
Adjusted R square	.85345
Standard error	4.90636

Analysis of variance

	DF	Sum of squares	Mean square
Regression	2	1169.62162	584.81081
Residual	6	144.43394	24.07232

F = 24.29391 Signif F = .0013

------------- Variables in the equation ----------------

Variable	B	SE B	Beta	T	Sig T
trend	2.092918	.685956	.447220	3.051	.0225
lag	.852923	.184776	.676596	4.616	.0036
(Constant)	5.128883	15.968711		.321	.7590

Source: SPSS/PC 4.01

Appendix 21

The estimated world prices of plywood, particleboard and medium density fibreboard from 1990 to 1996

year	plywood (index)	particleboard (index)	medium density fibreboard (index)
1990	103.7	107.2	123.9
1991	107.1	112.6	133.8
1992	110.5	118.3	144.4
1993	114.0	124.1	155.5
1994	117.5	130.0	167.1
1995	121.0	136.0	179.0
1996	124.5	142.0	191.3

Appendix 22

Table B-5 Durbin-Watson statistic (Savin-White tables) Durbin-Watson statistic: 1 percent significance points of *dL* and *dU*[a]

n	k'=1		k'=2		k'=3		k'=4		k'=5		k'=6		k'=7		k'=8		k'=9		k'=10	
	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U
6	0.390	1.142	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	0.435	1.036	0.294	1.676	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	0.497	1.003	0.345	1.489	0.229	2.102	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	0.554	0.998	0.408	1.389	0.279	1.875	0.183	2.433	—	—	—	—	—	—	—	—	—	—	—	—
10	0.604	1.001	0.466	1.333	0.340	1.733	0.230	2.193	0.150	2.690	—	—	—	—	—	—	—	—	—	—
11	0.653	1.010	0.519	1.297	0.396	1.640	0.286	2.030	0.193	2.453	0.124	2.892	—	—	—	—	—	—	—	—
12	0.697	1.023	0.569	1.274	0.449	1.575	0.339	1.913	0.244	2.280	0.164	2.665	0.105	3.053	—	—	—	—	—	—
13	0.738	1.038	0.616	1.261	0.499	1.526	0.391	1.826	0.294	2.150	0.211	2.490	0.140	2.838	0.090	3.182	—	—	—	—
14	0.776	1.054	0.660	1.254	0.547	1.490	0.441	1.757	0.343	2.049	0.257	2.354	0.183	2.667	0.122	2.981	0.078	3.287	—	—
15	0.811	1.070	0.700	1.252	0.591	1.464	0.488	1.704	0.391	1.967	0.303	2.244	0.226	2.530	0.161	2.817	0.107	3.101	0.068	3.374
16	0.844	1.086	0.737	1.252	0.633	1.446	0.532	1.663	0.437	1.900	0.349	2.153	0.269	2.416	0.200	2.681	0.142	2.944	0.094	3.201
17	0.874	1.102	0.772	1.255	0.672	1.432	0.574	1.630	0.480	1.847	0.393	2.078	0.313	2.319	0.241	2.566	0.179	2.811	0.127	3.053
18	0.902	1.118	0.805	1.259	0.708	1.422	0.613	1.604	0.522	1.803	0.435	2.015	0.355	2.238	0.282	2.467	0.216	2.697	0.160	2.925
19	0.928	1.132	0.835	1.265	0.742	1.415	0.650	1.584	0.561	1.767	0.476	1.963	0.396	2.169	0.322	2.381	0.255	2.597	0.196	2.813
20	0.952	1.147	0.863	1.271	0.773	1.411	0.685	1.567	0.598	1.737	0.515	1.918	0.436	2.110	0.362	2.308	0.294	2.510	0.232	2.714
21	0.975	1.161	0.890	1.277	0.803	1.408	0.718	1.554	0.633	1.712	0.552	1.881	0.474	2.059	0.400	2.244	0.331	2.434	0.268	2.625
22	0.997	1.174	0.914	1.284	0.831	1.407	0.748	1.543	0.667	1.691	0.587	1.849	0.510	2.015	0.437	2.188	0.368	2.367	0.304	2.548
23	1.018	1.187	0.938	1.291	0.858	1.407	0.777	1.534	0.698	1.673	0.620	1.821	0.545	1.977	0.473	2.140	0.404	2.308	0.340	2.479
24	1.037	1.199	0.960	1.298	0.882	1.407	0.805	1.528	0.728	1.658	0.652	1.797	0.578	1.944	0.507	2.097	0.439	2.255	0.375	2.417
25	1.055	1.211	0.981	1.305	0.906	1.409	0.831	1.523	0.756	1.645	0.682	1.766	0.610	1.915	0.540	2.059	0.473	2.209	0.409	2.362
26	1.072	1.222	1.001	1.312	0.928	1.411	0.855	1.518	0.783	1.635	0.711	1.759	0.640	1.889	0.572	2.026	0.505	2.168	0.441	2.313
27	1.089	1.233	1.019	1.319	0.949	1.413	0.878	1.515	0.808	1.626	0.738	1.743	0.669	1.867	0.602	1.997	0.536	2.131	0.473	2.269
28	1.104	1.244	1.037	1.325	0.969	1.415	0.900	1.513	0.832	1.618	0.764	1.729	0.696	1.847	0.630	1.970	0.566	2.098	0.504	2.229
29	1.119	1.254	1.054	1.332	0.988	1.418	0.921	1.512	0.855	1.611	0.788	1.718	0.723	1.830	0.658	1.947	0.595	2.068	0.533	2.193
30	1.133	1.263	1.070	1.339	1.006	1.421	0.941	1.511	0.877	1.606	0.812	1.707	0.748	1.814	0.684	1.925	0.622	2.041	0.562	2.160
31	1.147	1.273	1.085	1.345	1.023	1.425	0.960	1.510	0.897	1.601	0.834	1.698	0.772	1.800	0.710	1.906	0.649	2.017	0.589	2.131
32	1.160	1.282	1.100	1.352	1.040	1.428	0.979	1.510	0.917	1.597	0.856	1.690	0.794	1.788	0.734	1.889	0.674	1.995	0.615	2.104
33	1.172	1.291	1.114	1.358	1.055	1.432	0.996	1.510	0.936	1.594	0.876	1.683	0.816	1.776	0.757	1.874	0.698	1.975	0.641	2.080
34	1.184	1.299	1.128	1.364	1.070	1.435	1.012	1.511	0.954	1.591	0.896	1.677	0.837	1.766	0.779	1.860	0.722	1.957	0.665	2.057
35	1.195	1.307	1.140	1.370	1.085	1.439	1.028	1.512	0.971	1.589	0.914	1.671	0.857	1.757	0.800	1.847	0.744	1.940	0.689	2.037
36	1.206	1.315	1.153	1.376	1.098	1.442	1.043	1.513	0.988	1.588	0.932	1.666	0.877	1.749	0.821	1.836	0.766	1.925	0.711	2.018
37	1.217	1.323	1.165	1.382	1.112	1.446	1.058	1.514	1.004	1.586	0.950	1.662	0.895	1.742	0.841	1.825	0.787	1.911	0.733	2.001
38	1.227	1.330	1.176	1.388	1.124	1.449	1.072	1.515	1.019	1.585	0.966	1.658	0.913	1.735	0.860	1.816	0.807	1.899	0.754	1.985
39	1.237	1.337	1.187	1.393	1.137	1.453	1.085	1.517	1.034	1.584	0.982	1.655	0.930	1.729	0.878	1.807	0.826	1.887	0.774	1.970
40	1.246	1.344	1.198	1.398	1.148	1.457	1.098	1.518	1.048	1.584	0.997	1.652	0.946	1.724	0.895	1.799	0.844	1.876	0.789	1.956
45	1.288	1.376	1.245	1.423	1.201	1.474	1.156	1.528	1.111	1.584	1.065	1.643	1.019	1.704	0.974	1.768	0.927	1.834	0.881	1.902
50	1.324	1.403	1.285	1.446	1.245	1.491	1.205	1.538	1.164	1.587	1.123	1.639	1.081	1.692	1.039	1.748	0.997	1.805	0.955	1.864
55	1.356	1.427	1.320	1.466	1.284	1.506	1.247	1.548	1.209	1.592	1.172	1.638	1.134	1.685	1.095	1.734	1.057	1.785	1.018	1.837
60	1.383	1.449	1.350	1.484	1.317	1.520	1.283	1.558	1.249	1.598	1.214	1.639	1.179	1.682	1.144	1.726	1.108	1.771	1.072	1.817
65	1.407	1.468	1.377	1.500	1.346	1.534	1.315	1.568	1.283	1.604	1.251	1.642	1.218	1.680	1.186	1.720	1.153	1.761	1.120	1.802
70	1.429	1.485	1.400	1.515	1.372	1.546	1.343	1.578	1.313	1.611	1.283	1.645	1.253	1.680	1.223	1.716	1.192	1.754	1.162	1.792
75	1.448	1.501	1.422	1.529	1.395	1.557	1.368	1.587	1.340	1.617	1.313	1.646	1.284	1.682	1.256	1.716	1.227	1.746	1.199	1.785
80	1.466	1.515	1.441	1.541	1.416	1.568	1.390	1.595	1.364	1.624	1.338	1.653	1.312	1.683	1.285	1.714	1.259	1.745	1.232	1.777
85	1.482	1.528	1.458	1.553	1.435	1.578	1.411	1.603	1.386	1.630	1.362	1.657	1.337	1.685	1.312	1.714	1.287	1.743	1.262	1.773
90	1.496	1.540	1.474	1.563	1.452	1.587	1.429	1.611	1.406	1.636	1.383	1.661	1.360	1.687	1.336	1.714	1.312	1.741	1.288	1.769
95	1.510	1.552	1.489	1.573	1.468	1.596	1.446	1.618	1.425	1.642	1.403	1.666	1.381	1.690	1.358	1.715	1.336	1.741	1.313	1.767
100	1.522	1.562	1.503	1.583	1.482	1.604	1.462	1.625	1.441	1.647	1.421	1.670	1.400	1.693	1.378	1.717	1.357	1.741	1.335	1.765
150	1.611	1.637	1.598	1.651	1.584	1.665	1.571	1.679	1.557	1.693	1.543	1.708	1.530	1.722	1.515	1.737	1.501	1.752	1.486	1.767
200	1.664	1.684	1.653	1.693	1.643	1.704	1.633	1.715	1.623	1.725	1.613	1.735	1.603	1.746	1.592	1.757	1.582	1.768	1.571	1.779

Table B-5 (*Continued*) Durbin-Watson statistic: 5 percent significance points of dL and dU

n	k'=1		k'=2		k'=3		k'=4		k'=5		k'=6		k'=7		k'=8		k'=9		k'=10	
	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U	d_L	d_U
6	0.610	1.400	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
7	0.700	1.356	0.467	1.896	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
8	0.763	1.332	0.559	1.777	0.368	2.287	—	—	—	—	—	—	—	—	—	—	—	—	—	—
9	0.824	1.320	0.629	1.699	0.455	2.128	0.296	2.588	—	—	—	—	—	—	—	—	—	—	—	—
10	0.879	1.320	0.697	1.641	0.525	2.016	0.376	2.414	0.243	2.822	—	—	—	—	—	—	—	—	—	—
11	0.927	1.324	0.758	1.604	0.595	1.928	0.444	2.283	0.316	2.645	0.203	3.005	—	—	—	—	—	—	—	—
12	0.971	1.331	0.812	1.579	0.658	1.864	0.512	2.177	0.379	2.506	0.268	2.832	0.171	3.149	—	—	—	—	—	—
13	1.010	1.340	0.861	1.562	0.715	1.816	0.574	2.094	0.445	2.390	0.328	2.692	0.230	2.985	0.147	3.266	—	—	—	—
14	1.045	1.350	0.905	1.551	0.767	1.779	0.632	2.030	0.505	2.296	0.389	2.572	0.286	2.848	0.200	3.111	0.127	3.360	—	—
15	1.077	1.361	0.946	1.543	0.814	1.750	0.685	1.977	0.562	2.220	0.447	2.472	0.343	2.727	0.251	2.979	0.175	3.216	0.111	3.438
16	1.106	1.371	0.982	1.539	0.857	1.728	0.734	1.935	0.615	2.157	0.502	2.388	0.398	2.624	0.304	2.860	0.222	3.090	0.155	3.304
17	1.133	1.381	1.015	1.536	0.897	1.710	0.779	1.900	0.664	2.104	0.554	2.318	0.451	2.537	0.356	2.757	0.272	2.975	0.198	3.184
18	1.158	1.391	1.046	1.535	0.933	1.696	0.820	1.872	0.710	2.060	0.603	2.257	0.502	2.461	0.407	2.667	0.321	2.873	0.244	3.073
19	1.180	1.401	1.074	1.536	0.967	1.685	0.859	1.848	0.752	2.023	0.649	2.206	0.459	2.396	0.456	2.589	0.369	2.783	0.290	2.974
20	1.201	1.411	1.100	1.537	0.998	1.676	0.894	1.828	0.792	1.991	0.692	2.162	0.595	2.339	0.502	2.521	0.416	2.704	0.336	2.885
21	1.221	1.420	1.125	1.538	1.026	1.669	0.927	1.812	0.829	1.964	0.732	2.124	0.637	2.290	0.547	2.460	0.461	2.633	0.380	2.806
22	1.239	1.429	1.147	1.541	1.053	1.664	0.958	1.797	0.863	1.940	0.769	2.090	0.677	2.246	0.588	2.407	0.504	2.571	0.424	2.734
23	1.257	1.437	1.168	1.543	1.078	1.660	0.986	1.785	0.895	1.920	0.804	2.061	0.715	2.208	0.628	2.360	0.545	2.514	0.465	2.670
24	1.273	1.446	1.188	1.546	1.101	1.656	1.013	1.775	0.925	1.902	0.837	2.035	0.751	2.174	0.666	2.318	0.584	2.464	0.506	2.613
25	1.288	1.454	1.206	1.550	1.123	1.654	1.038	1.767	0.953	1.886	0.868	2.012	0.784	2.144	0.702	2.280	0.621	2.419	0.544	2.560
26	1.302	1.461	1.224	1.553	1.143	1.652	1.062	1.759	0.979	1.873	0.897	1.992	0.816	2.117	0.735	2.246	0.657	2.379	0.581	2.513
27	1.316	1.469	1.240	1.556	1.162	1.651	1.084	1.753	1.004	1.861	0.925	1.974	0.845	2.093	0.767	2.216	0.691	2.342	0.616	2.470
28	1.328	1.476	1.255	1.560	1.181	1.650	1.104	1.747	1.028	1.850	0.951	1.958	0.874	2.071	0.798	2.188	0.723	2.309	0.650	2.431
29	1.341	1.483	1.270	1.563	1.198	1.650	1.124	1.743	1.050	1.841	0.975	1.944	0.900	2.052	0.826	2.164	0.753	2.278	0.682	2.396
30	1.352	1.489	1.284	1.567	1.214	1.650	1.143	1.739	1.071	1.833	0.998	1.931	0.926	2.034	0.854	2.141	0.782	2.251	0.712	2.363
31	1.363	1.496	1.297	1.570	1.229	1.650	1.160	1.735	1.090	1.825	1.020	1.920	0.950	2.018	0.879	2.120	0.810	2.226	0.741	2.333
32	1.373	1.502	1.309	1.574	1.244	1.650	1.177	1.732	1.109	1.819	1.041	1.909	0.972	2.004	0.904	2.102	0.836	2.203	0.769	2.306
33	1.383	1.508	1.321	1.577	1.258	1.651	1.193	1.730	1.127	1.813	1.061	1.900	0.994	1.991	0.927	2.085	0.861	2.181	0.795	2.281
34	1.393	1.514	1.333	1.580	1.271	1.652	1.208	1.728	1.144	1.808	1.080	1.891	1.015	1.979	0.950	2.069	0.885	2.162	0.821	2.257
35	1.402	1.519	1.343	1.584	1.283	1.653	1.222	1.726	1.160	1.803	1.097	1.884	1.034	1.967	0.971	2.054	0.908	2.144	0.845	2.236
36	1.411	1.525	1.354	1.587	1.295	1.654	1.236	1.724	1.175	1.799	1.114	1.877	1.053	1.957	0.991	2.041	0.930	2.127	0.868	2.216
37	1.419	1.530	1.364	1.590	1.307	1.655	1.249	1.723	1.190	1.795	1.131	1.870	1.071	1.948	1.011	2.029	0.951	2.112	0.891	2.198
38	1.427	1.535	1.373	1.594	1.318	1.656	1.261	1.722	1.204	1.792	1.146	1.864	1.088	1.939	1.029	2.017	0.970	2.098	0.912	2.180
39	1.435	1.540	1.382	1.597	1.328	1.658	1.273	1.722	1.218	1.789	1.161	1.859	1.104	1.932	1.047	2.007	0.990	2.085	0.932	2.164
40	1.442	1.544	1.391	1.600	1.338	1.659	1.285	1.721	1.230	1.786	1.175	1.854	1.120	1.924	1.064	1.997	1.008	2.072	0.945	2.149
45	1.475	1.566	1.430	1.615	1.383	1.666	1.336	1.720	1.287	1.776	1.238	1.835	1.189	1.895	1.139	1.958	1.089	2.002	1.038	2.088
50	1.503	1.585	1.462	1.628	1.421	1.674	1.378	1.721	1.335	1.771	1.291	1.822	1.246	1.875	1.201	1.930	1.156	1.986	1.110	2.044
55	1.528	1.601	1.490	1.641	1.452	1.681	1.414	1.724	1.374	1.768	1.334	1.814	1.294	1.861	1.253	1.909	1.212	1.959	1.170	2.010
60	1.549	1.616	1.514	1.652	1.480	1.689	1.444	1.727	1.408	1.767	1.372	1.808	1.335	1.850	1.298	1.894	1.260	1.939	1.222	1.984
65	1.567	1.629	1.536	1.662	1.503	1.696	1.471	1.731	1.438	1.767	1.404	1.805	1.370	1.843	1.336	1.882	1.301	1.923	1.266	1.964
70	1.583	1.641	1.554	1.672	1.525	1.703	1.494	1.735	1.464	1.768	1.433	1.802	1.401	1.837	1.369	1.873	1.337	1.910	1.305	1.948
75	1.598	1.652	1.571	1.680	1.543	1.709	1.515	1.739	1.487	1.770	1.458	1.801	1.428	1.834	1.399	1.867	1.369	1.901	1.339	1.935
80	1.611	1.662	1.586	1.688	1.560	1.715	1.534	1.743	1.507	1.772	1.480	1.801	1.453	1.831	1.425	1.861	1.397	1.893	1.369	1.925
85	1.624	1.671	1.600	1.696	1.575	1.721	1.550	1.747	1.525	1.774	1.500	1.801	1.474	1.829	1.448	1.857	1.422	1.886	1.396	1.916
90	1.635	1.679	1.612	1.703	1.589	1.726	1.566	1.751	1.542	1.776	1.518	1.801	1.494	1.827	1.469	1.854	1.445	1.881	1.420	1.909
95	1.645	1.687	1.623	1.709	1.602	1.732	1.579	1.755	1.557	1.778	1.535	1.802	1.512	1.827	1.489	1.852	1.465	1.877	1.442	1.903
100	1.654	1.694	1.634	1.715	1.613	1.736	1.592	1.758	1.571	1.780	1.550	1.803	1.528	1.826	1.506	1.850	1.484	1.874	1.462	1.898
150	1.720	1.746	1.706	1.760	1.693	1.774	1.679	1.788	1.665	1.802	1.651	1.817	1.637	1.832	1.622	1.847	1.608	1.862	1.594	1.877
200	1.758	1.778	1.748	1.789	1.738	1.799	1.728	1.810	1.718	1.820	1.707	1.831	1.697	1.841	1.686	1.852	1.675	1.863	1.665	1.874

Source: Johnston, J., "Econometric methods", 3rd edition, McGraw-Hill International Editions, 1984

Appendix 23

Calculation of the future raw material, labour and electricity costs per unit sifted whole cassava flour

The price paid by the union in December 1991 for 1 quintal dried whole cassava chips to the associations was 6,500 Sucres. Assumed is that this price increases every year with 10 percent. The future prices per unit dried whole cassava chips are presented together with the future raw material costs per unit sifted whole cassava flour in the table below.

year	dried whole cassava chips price (Sucres/quintal)	raw material costs (Sucres/50 kg)
1991	6,500	12,065.9
1992	7,150	13,269.9
1993	7,865	14,600.3
1994	8,652	16,056.9
1995	9,517	17,665.2
1996	10,469	19,433.4

The labour costs for milling and sifting are assumed to increase every year with 20 percent. In December 1991 they were 80 and 100 Sucres respectively for 1 quintal. The future labour costs for milling and sifting dried whole cassava chips into 50 kg sifted whole cassava flour are presented in the table below.

year	labour costs (Sucres/50 kg)
1991	331.7
1992	393.6
1993	469.0
1994	561.2
1995	670.1
1996	804.1

The energy costs of milling and sifting 1 quintal dried whole chips and 1 quintal whole flour were estimated 40 and 10 Sucres respectively in December 1991. These costs are assumed to increase with 3.4 percent every month. The future energy costs per unit sifted whole cassava flour are presented in the table below.

year	energy costs (Sucres/50 kg)
1991	92.5
1992	137.8
1993	206.7
1994	308.5
1995	460.6
1996	688.4

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