The market for cocoa powder

Background paper for
'Modelling and forecasting the market for cocoa and chocolate'

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Executive summary:
Analysis of cocoa powder demand shows that price is not a major determinant of cocoa powder demand. In the countries where price systematically affects powder consumption, the elasticity is quite low: a ten per cent price increase for powder would result only in a 1 to 3.5 per cent decrease in consumption. Total demand for cocoa powder is found to be very sensitive to average income, indicating that cocoa powder is used in products which belong in the luxury-end of final product markets. Cocoa powder supply is closely tied to the supply of cocoa butter. Since butter is the cocoa product which fetches the highest price, capacity use in the cocoa products industry is geared towards the demand for butter. The industry has an innate tendency to produce an oversupply of cocoa powder, since powder demand follows a pattern different from that of butter. Powder prices cannot be trusted upon to bring equilibrium in the powder market, since price elasticity of demand is very low. Sales proceeds from powder are also too important for the profitability of the cocoa products industry to dispose of powder surpluses at dump prices. The solution is found in strategic stockholding, as powder is relatively easy to store. The complex market relations in the intermediate cocoa products industry are expressed formally in an integrated simulation model of the cocoa economy, focusing on the relation between chocolate demand and the market for intermediate cocoa products. It is shown on the basis of this model, that a fall in the demand for butter will improve the price for cocoa powder. Empirical testing of this relation yielded strong evidence that an inverse relation exists between the price of butter and that of powder in countries with a domestic cocoa-processing industry.

1 Introduction

The aim of this paper is to analyse the position of cocoa powder markets in the context of the international cocoa economy. Cocoa powder is an intermediate cocoa product jointly produced with cocoa butter. The demand and supply situation of cocoa butter affects the market for cocoa powder, and vice versa. Analysis of developments in an intermediate industry like the cocoa-processing industry has to consider the relations with the primary industry (the market for cocoa) and with final products markets (chocolate and non-chocolate food products). The report tries to clarify these sometimes complex relations.

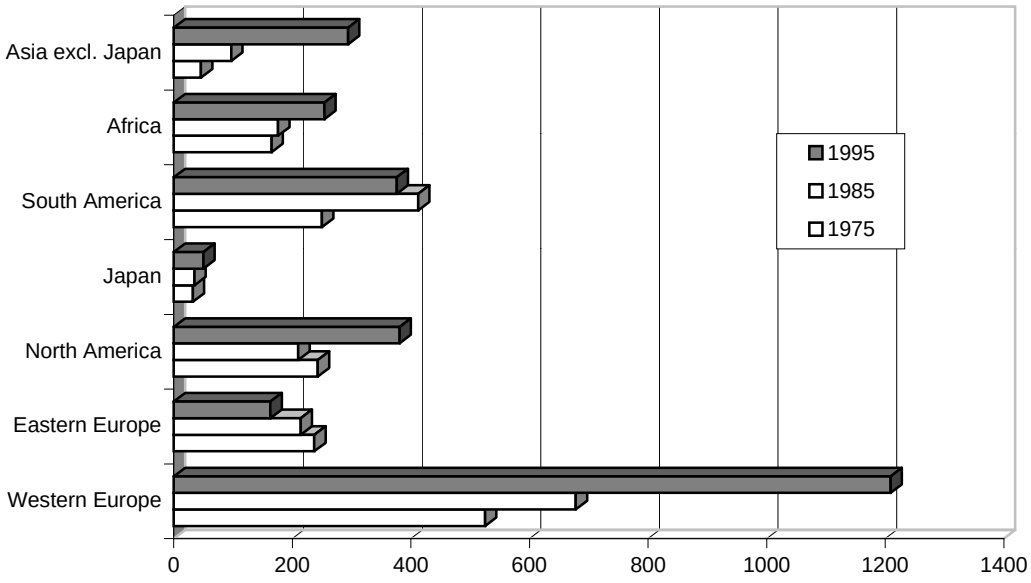
This study report forms a part of a wider research project which presents an analysis and a model of the world cocoa economy including the consumption of chocolate and other cocoa products for forecasting and policy evaluation. The model will make it possible to analyse the effects of the use of cocoa butter substitutes on the world cocoa economy, and the cocoa-exporting countries more in particular. The work continues on earlier work done by ESI researchers on the world cocoa economy. A draft of this report has been discussed with representatives of the Dutch and international cocoa products industry. Their comments have contributed to an improvement of the report. However, responsibility for any remaining errors or misinterpretations rests completely with the author.

Section 2 presents a brief overview of the market for cocoa powder and its links with other parts of the cocoa industry. Section 3 analyses the dynamics of cocoa powder supply. Section 4 concentrates on the demand for cocoa powder. Section 5 presents a synthetic theoretical model which positions the cocoa powder industry in the context of the overall cocoa economy. All main conclusions are brought together in Section 6.

2 The market for cocoa powder: an overview

After cocoa beans are pealed, cleaned and roasted, they are shelled. Subsequently they pass through huskers to separate the shells, husks and germs from the nibs (broken pieces of kernels). The next phase is that roasted nibs are ground, resulting in a cocoa liquor mass. After cooling the liquor mass solidifies into liquor blocks, which can easily be transported and traded. Cocoa liquor can be used directly as an input for chocolate production, or it can be further processed. By hydraulic pressing of the liquor blocks, most of the liquor's fat content can be freed in the form of cocoa butter, a light-yellow substance with a faint cocoa smell. Cocoa butter is the chocolate ingredient which is mainly responsible for the product's smelting characteristics. What remains of the liquor is a press cake which still contains some fat. After pulverising this cake, cocoa powder is obtained. It carries the typical colour, smell and taste of cocoa. It is mainly used outside the chocolate industry, in a large number of food industry products. It is important to note that cocoa powder is normally produced as a side-product of the more valuable cocoa butter. For the cocoa products industry in general, powder sales nevertheless form a substantial contribution to profitability. The Dutch cocoa products industry is a special case, since it has developed, through research, cocoa powder into a premium product.

Graph 1 World grindings of cocoa beans

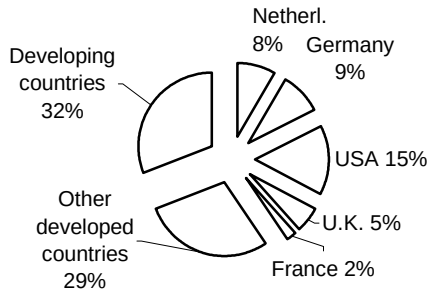


metric tons Source: ICCO Quarterly Bull. Of Statistics

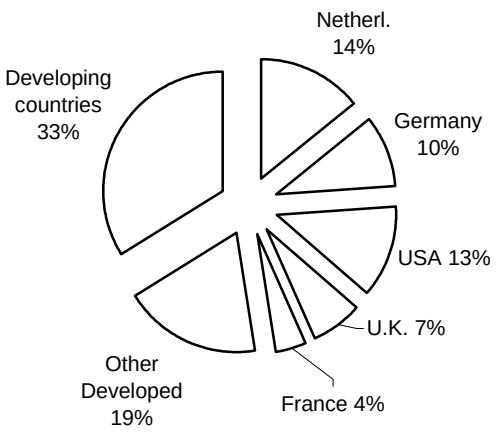
Most of the cocoa products industry is still situated in OECD countries as Graph 1 shows, with a dominant role for Western Europe. The share of African and Asian grindings has clearly increased since 1975, while grindings in South America suffered from a setback since the mid-1980s.

At a country level, the production of intermediate cocoa products has since 1975 become even more concentrated in a few countries. This holds both for the group of developing countries and for the OECD countries. While the collective 'market share' of developing countries remained virtually unchanged between 1975 and 1995, a group of four countries (Brazil, Ivory Coast, Malaysia and Indonesia) managed to increase the share of world grindings from 12 per cent to 20 per cent. A likewise spectacular concentration took place in Western Europe, where four countries (Netherlands, Germany, UK and France) had their share in world grindings increased from 24 in 1975 to 35 per cent in 1995.

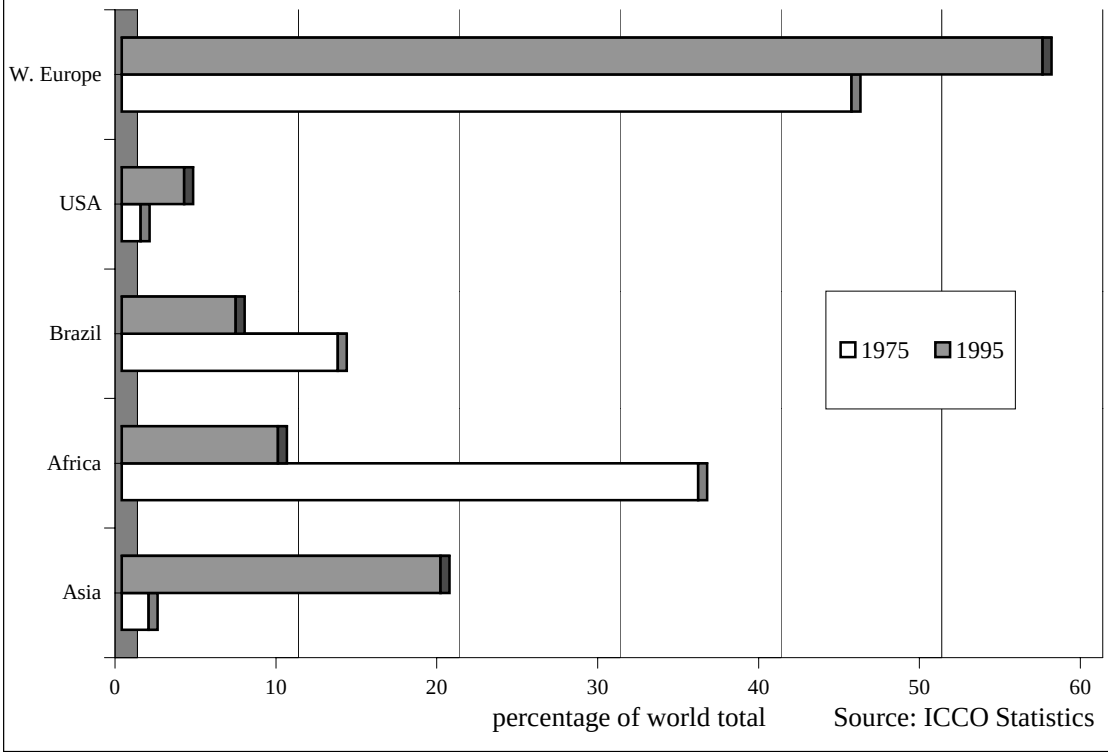
Graph 2 World grinding 1975



Graph 3 World grindings 1995



Graph 4 Region shares in world exports of cocoa powder and press cake



This location shift in world-wide grindings also had direct repercussions for the world cocoa powder industry. European and Asian cocoa product exports grew at the expense of the African share in the world market.[1] Particularly Ghana and Cameroon experienced a sharp drop in international market share. The Netherlands improved its leading market position and now supplies more than one third of world exports. Malaysia, Singapore and Indonesia quickly gained market share over the past two decades. After a strong growth of Brazilian powder exports up to 1985, this country fell back again in 1995, due to problems in domestic cocoa supply. The US is not a major player in world exports of cocoa powder. Further country details can be found in Table 1.

International import demand used to stem mainly from the US and Western Europe twenty years ago, but nowadays the market has become more geographically diversified. While world import volume more than doubled in this period, other market regions now account for approximately one-third of all cocoa powder imports. The regional shifts in international cocoa powder demand are pictured in Graph 5. US import demand grew much slower than overall demand. Within Europe, Germany, Spain and France became the major import markets. Notable growth markets are Latin America (especially Mexico) and Eastern Europe, each of which now accounts for about 7 per cent of world imports. Even stronger

[1] Cf. Burger and Smit (1998b: 221-232). Some industry commentators suggested that the 1995 African exports of powder and cake may be underestimated. It was their impression that the Ivorian customs authorities sometimes put the export of cakes into the cocoa liquor export category.

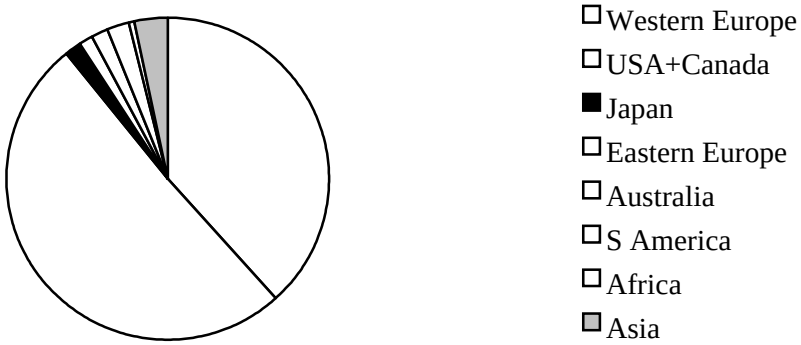
growth could be recorded in developing Asia which now demands one-tenth of world-wide imports.

Table 1: Exports of cocoa powder and cocoa cake

	1975	*1985*	*1995*	*1975*	*1985*	*1995*
	in metric tons			*% of world total*		
Western Europe	85420	118140	230200	46.6	47.4	57.2
Germany	18253	29390	36382	10.0	11.8	9.0
Netherlands	48590	72304	147047	26.5	29.0	36.6
UK	7231	6870	11740	3.9	2.8	2.9
France	6459	4978	16209	3.5	2.0	4.0
Others	4887	4598	18822	2.7	1.8	4.7
USA	2208	4155	15583	1.2	1.7	3.9
S America	31862	46300	37517	17.4	18.6	9.3
Brazil	26974	40583	28506	14.7	16.3	7.1
Japan	52	17	143	0.0	0.0	0.0
Africa	59580	61080	39040	32.5	24.5	9.7
Ivory Coast	14614	39987	32246	8.0	16.0	8.0
Ghana	25285	7425	2100	13.8	3.0	0.5
Cameroon	11782	5599	3906	6.4	2.2	1.0
Others	7899	8069	788	4.3	3.2	0.2
Asia	4340	23590	79690	2.4	9.5	19.8
Malaysia	230	7790	29571	0.1	3.1	7.4
Indonesia	0	4000	16128	0.0	1.6	4.0
Singapore	3933	14554	30053	2.1	5.8	7.5
World	183410	249360	402130	100.0	100.0	100.0

Source: ICCO, Quarterly Bulletin of Statistics, various editions.

Graph 5a Imports of cocoa powder and cake, 1975



Graph 5b Imports of cocoa powder and cake, 1995

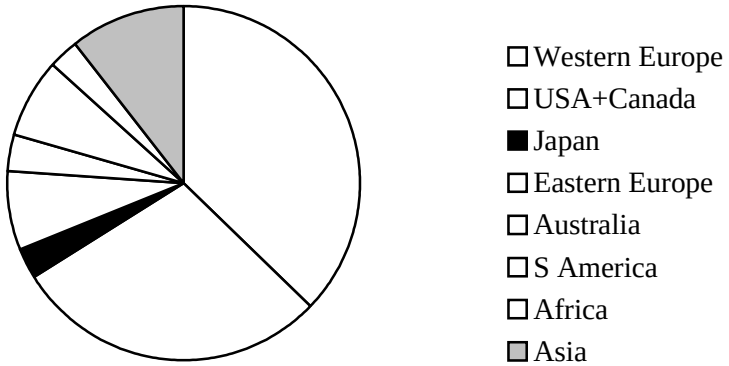


Table 2 illustrates the dominant position of Dutch cocoa powder exports in the world's major import markets, especially in the EU, but also in the large US market. The table does not consider local powder production.

Table 2: Dutch share in country imports of cocoa powder, 1995/96

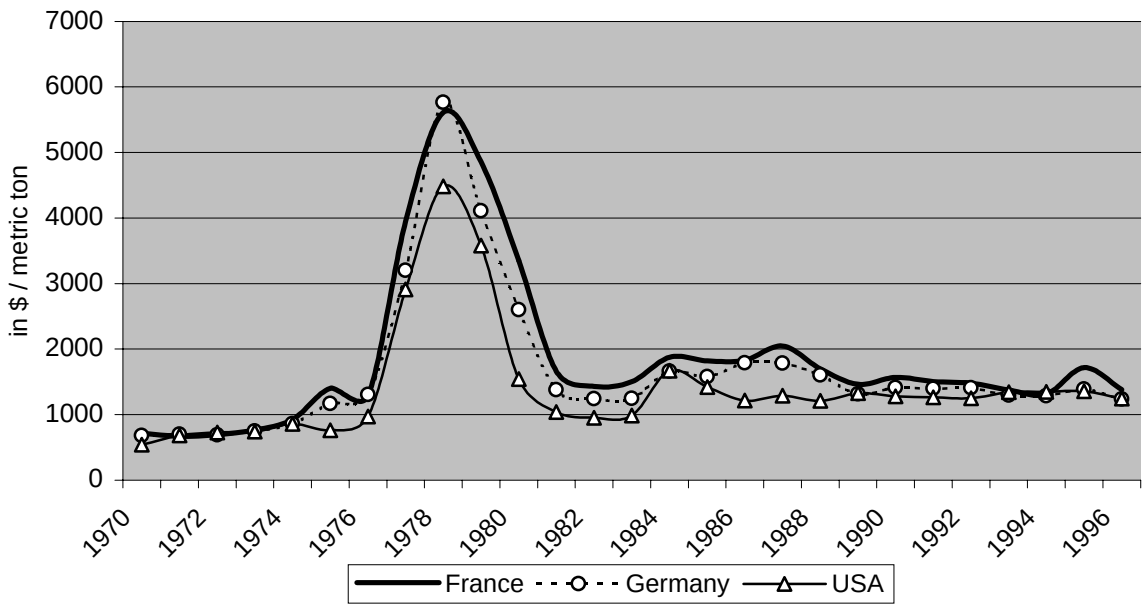
	Total imports	***Imports of Dutch origin***	***Dutch imp.share (%)***
USA	103471	43382	41,9
Germany	37122	29805	80,3
France	23561	13352	56,7
Italy	15378	8376	54,5
Japan	11971	6557	54,8
Belgium	7894	6087	77,1
UK	3160	2352	74,4
Switzerland	1976	1565	79,2
Subtotal	204533	111476	
Other markets	200557	35598	17,7
World	405090	147074	36,3

Source: ICCO statistics

Before concluding this overview of the cocoa powder market, Graph 6 shows how average import prices developed in some major import markets since 1970. Though countries differ in the types and source of their cocoa powder imports, prices show a similar overall pattern with US price typically below the European ones. The most remarkable event appears to have been the enormous price surge of 1977-1981. In 1977/78 prices soared as a consequence of a general rise in cocoa bean prices. The most important factor, however, was strategic stockbuilding by cocoa powder users fearing future shortages of cocoa powder. Their short-term purchasing activity drove up market prices for powder. Since 1988, powder prices experienced a slightly decreasing tendency, which can be explained by a persistent

oversupply. Development of powder prices will be dealt with at greater length later in this report.

Graph 6 Cocoa powder: average import prices, selected markets



3 Dynamics of cocoa powder supply

This section will focus first on technological aspects of cocoa powder supply as a part of the cocoa products industry. It is illustrated how technology choice can affect the supply of cocoa powder. Afterwards, more economic factors of cocoa powder supply will be analysed.

Technological trajectories

Cocoa beans can be processed mainly by two technological trajectories. The choice of trajectory has implications for the relative quantities in which powder and other intermediary cocoa products come available. Investment in cocoa-processing capacity determines the technological trajectory for the medium and long term, thereby introducing supply inflexibility. At present, two basic technological trajectories are available to the cocoa products industry: the grinding method and the expeller method.

Grinding method

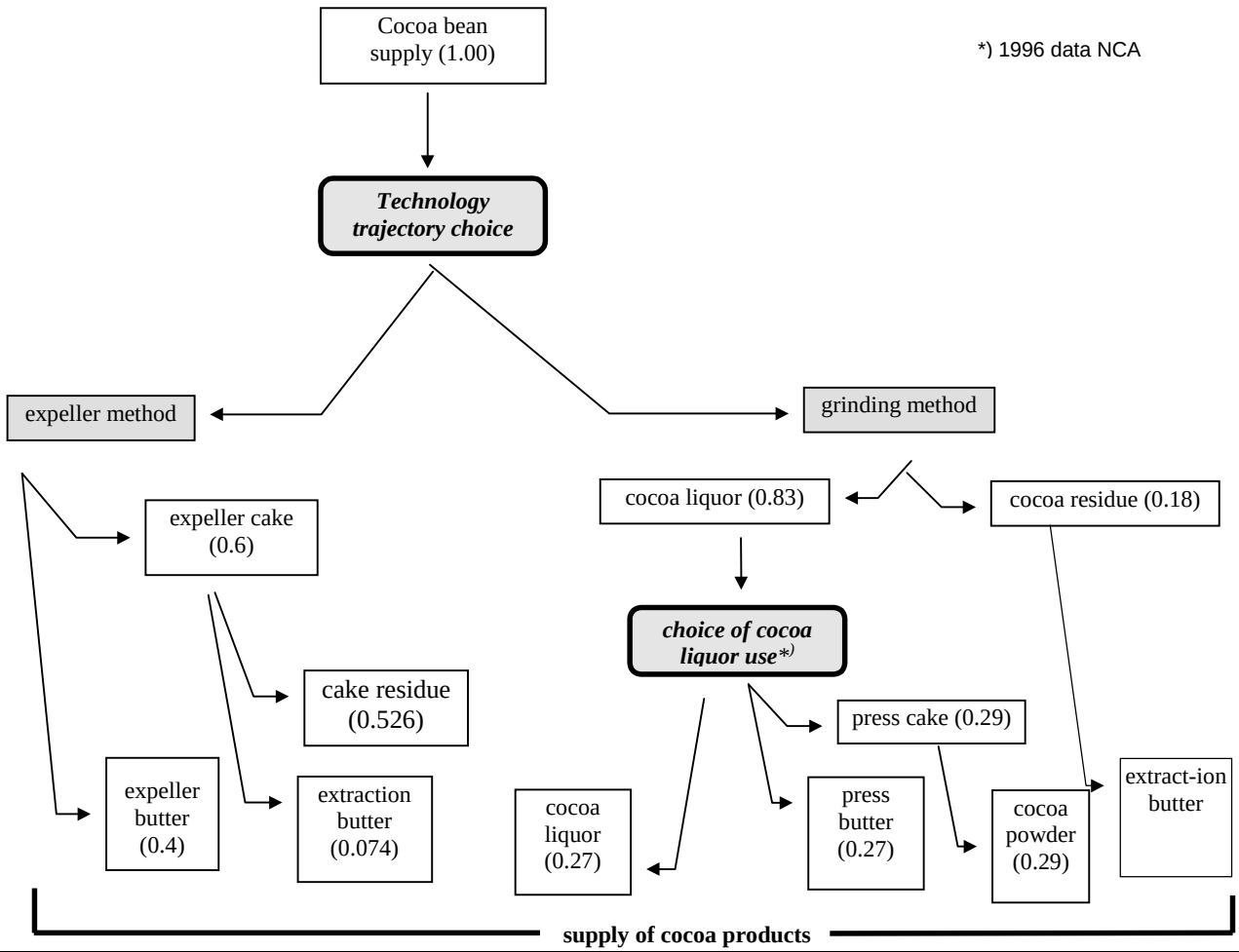
The grinding technology is the oldest and most widely applied production trajectory, both in cocoa-producing countries and elsewhere. The essential step in this process is that bean kernels are finely ground after removing the husks from the beans and after roasting. Grinding yields cocoa liquor, sometimes also referred to as cocoa mass or cocoa paste. It is a thick fluid mass with a fat content of approximately 55 per cent. After cooling, the liquor

mass is mostly solidified into liquor blocks.[2] In a technical sense, grinding 100 kg cocoa beans yields approximately 83 kg cocoa liquor and 17 kg cocoa residue (husks, shells, skins).[3] The cocoa residue represents a relatively small value. Through an extraction process still some cocoa butter can be produced from it. The main use of the cocoa residue is its use as cattle feed component.

Cocoa liquor can be used directly as an input for the chocolate manufacturing industry, or it can be further processed. By hydraulic pressing, the largest part of its fat content is freed in the form of cocoa press butter. What remains is cocoa press cake, which still holds a 10-22 per cent fat content. Pulverising this cake yields cocoa powder. Production of high-quality cocoa powder from the cake is the technologically most challenging part of this

Chart 1 Technology choice and the supply of cocoa products

(in parentheses: weight-based technical conversion factors, partly based on 1996 figures)
Bold cadres with rounded edges represent major decision steps in the supply of cocoa products.



[2] In the Netherlands it is transported in liquid form.

[3] NCV (1996: 38); Schuurs (1980: 3).

technological trajectory. In 1996, approximately 67 per cent of all cocoa liquor was processed into powder and butter (NCV 1996: 38). If we use the prior figure that grinding 100 kg beans yields 83 kg of liquor, this implies that 56 kg of the 83 kg cocoa liquor was further processed. This mostly results in slightly more cocoa powder (29 kg) than cocoa butter (27 kg).

Expeller method

The second, and newer technological trajectory in cocoa processing is the expeller method. It entails that the fat content is directly wrung out of the beans, without grinding, thereby producing cocoa butter (expeller butter) with cocoa cake (expeller cake) as a residual product. In quantity terms, 100 kg of beans yields 40 kg of butter and 60 kg cake. Through an extraction process, another 7.4 kg of cocoa butter (extraction butter) can still be generated from the cake, leaving 52.6 kg cake residue. The extraction is often done by separate companies or production units. Expeller cake has little remaining value; it is mainly used as cattle feed and for the production of theobromine, a raw material for the pharmaceutical industry.

The two technological trajectories described thus far, can be pictured as a flow diagram (Chart 1). Typical for the expeller production trajectory is that no cocoa powder is produced.[4] The expeller method forms a good alternative for producers which are only interested in producing butter. The production method is simpler, requiring less capital investment. The quality and prices of expeller butter and press butter are not identical. The expeller process changes the molecule structure of cocoa butter in the sense that it becomes softer ('steamed flat'), more odourless and more perishable. For these reasons, expeller butter is not suitable for several chocolate types. Its price is generally lower compared to press butter. The residue from the expeller process, cocoa cake, is much less valuable than press cake, the residue of the grinding process. The latter can be used to produce cocoa powder while expeller cake can only be used to produce extraction butter. The latter has a much lower quality and fetches a much lower price than press butter or expeller butter.

Choice between both technological trajectories

The choice of technology trajectory can be framed in a decision model for the case that a single company would have to decide between both processes. Basic assumption is that the choice is determined by relative profitability of both processes. Gross margins of each process can be expressed per unit of cocoa beans used in that process. Profitability of the expeller method is entirely dependent on the price of cocoa butter. Because the expeller method can also be used for damaged cocoa beans, the relative profitability of this process is also affected by price discounts for low bean quality. Disregarding residual products, the gross profit margin of the expeller process (h_{exp}) amounts to:

[4] Some producers (like Testa in Italy) are using the expeller cake to produce theobromine, but others expell the nibs and mix the expeller cake with press cake.

$$h_{exp} = 0.4\left(p_b - c_{\exp}\right) + 0.074\left(p_{eb} - c_{eb}\right) - (1-\delta)\ p_{cocoa} \quad (1)$$

in which:

p_b: price of cocoa butter (press butter or expeller butter);
p_{eb}: price of extraction butter;
c_{exp}: unit production costs of the expeller process, excl. cocoa bean costs
c_{eb}: unit production costs of the extraction process, excl. cocoa bean costs
δ: price discount for low bean quality
p_{cocoa}: cocoa bean price.

For the grinding process, again abstracting from residual products, the gross margin (h_g) amounts to:

$$h_g = q\left(p_{liq}\right) + (1-q)\left\{0.48\left(p_b - c_{pb}\right) + 0.52\left(p_{pow} - c_{pow}\right)\right\} - c_{liq} - p_{cocoa} \quad (2)$$

in which:

q: fraction of cocoa liquor production directly used for chocolate production;
p_{pow}: price of cocoa powder
p_{liq}: price of cocoa liquor
c_{liq}: cost price of liquor production, excluding cocoa bean costs
c_{pow}: cost price of the cocoa powder production, excluding liquor costs
c_{pb}: cost price of press butter production, excluding liquor costs

Assuming rational producer behaviour, a technology shift towards grinding occurs if $h_g > h_{exp}$. Inspection of equations (1) and (2) indicates that many factors may cause profitability differences. To make the comparison easier, some simplifying assumptions may help. It is first assumed that all cocoa liquor is processed into butter and powder (i.e. $q=0$). A second assumption is that all unit cost prices remain constant over time.[5] With these assumptions the grinding process will always be preferred if:

$$[0.08\ p_b + 0.52\ p_{pow}] > [0.074\ p_{eb} + \delta\ p_{cocoa}] + A \quad (3)$$

For a given level of production costs (A), relative prices of cocoa and cocoa products determine technology choice. The grinding process yields only slightly higher butter proceeds ($0.08\ p_b$), while also the proceeds from extraction butter ($0.074\ p_{eb}$) are small. So, the technology decision in fact hinges on the relation of powder proceeds and bean price

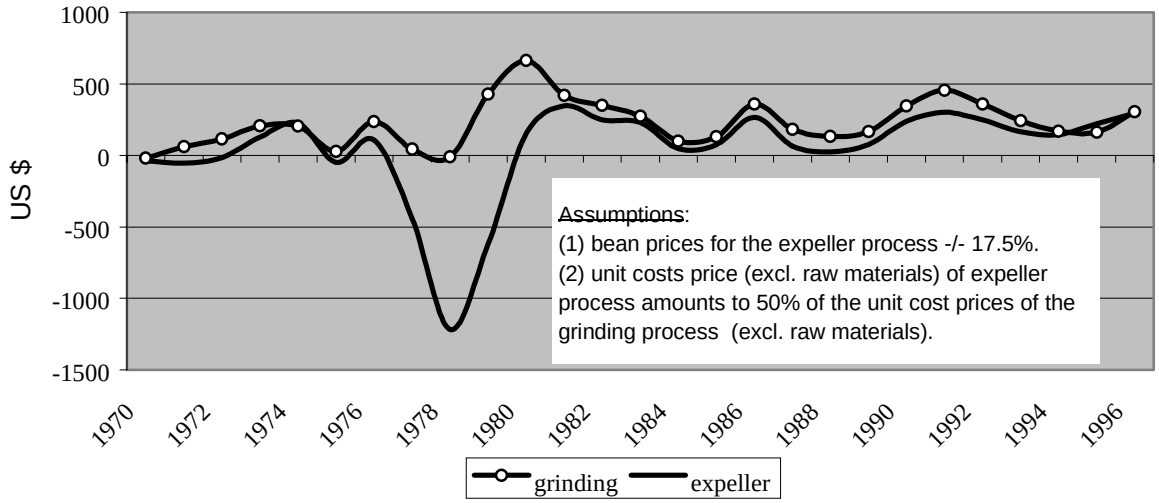
[5] This makes it possible to lump all cost price elements of the profitability comparison in one constant term:

$A = [\ 0.48\ c_{pb} + 0.52\ c_{pow} + c_{liq} - 0.4\ c_{exp} - 0.074\ c_{eb}]$.

The term A reflects the initial relation of overall costs prices of both processes. Because it is held constant over time, A does not play a dynamic role in technology switch decisions.

discount. The expeller process only outperforms profitability of the grinding process when gains from bean price discounts (δ) are higher than half the powder proceeds (*0.52* p_{pow}). The expeller method will be preferred only when beans with a high price discount can be used, or when powder prices are very low. Simulations with actual import prices were done for Spain. All cost prices of the expeller/extraction process (c_{exp}, c_{eb}) were, for simplifying reasons, put at half the cost prices in the grinding/pressing process (c_{liq}, c_{pow} ,c_p) and kept constant over time. The results, shown in Graph 7, are that even with a 17.5 per cent bean price discount, the expeller process would have been preferred in only two of the past 26 years.[6] No factual value can be attributed to these simulation results. However, they can be used to show that with a zero discount the grinding/pressing method is *always* preferred above the expeller/extraction method. This explains why the expeller process is in fact only used for low-grade and damaged beans. The expeller/extraction trajectory is only profitable when its raw material fetches low prices in the market. Most OECD countries only apply the expeller process for damaged beans and other beans which cannot profitably be processed by the grinding process. This holds for the processing industries in cocoa-producing countries and elsewhere. Finally, according to industry sources, expeller capacity is sometimes maintained for strategic reasons in order to keep the butter ratio under pressure.

Graph 7 Simulated gross margin of expeller method and grinding method, Spain



The expeller method is used in several countries. European producers include the Netherlands (Schoemaker BV), Italy and Spain. It is applied furthermore in the USA and Malaysia. In the European Union, processing by the expeller process only accounts for a few per cents of total bean processing. In some cocoa-exporting countries with unpromising

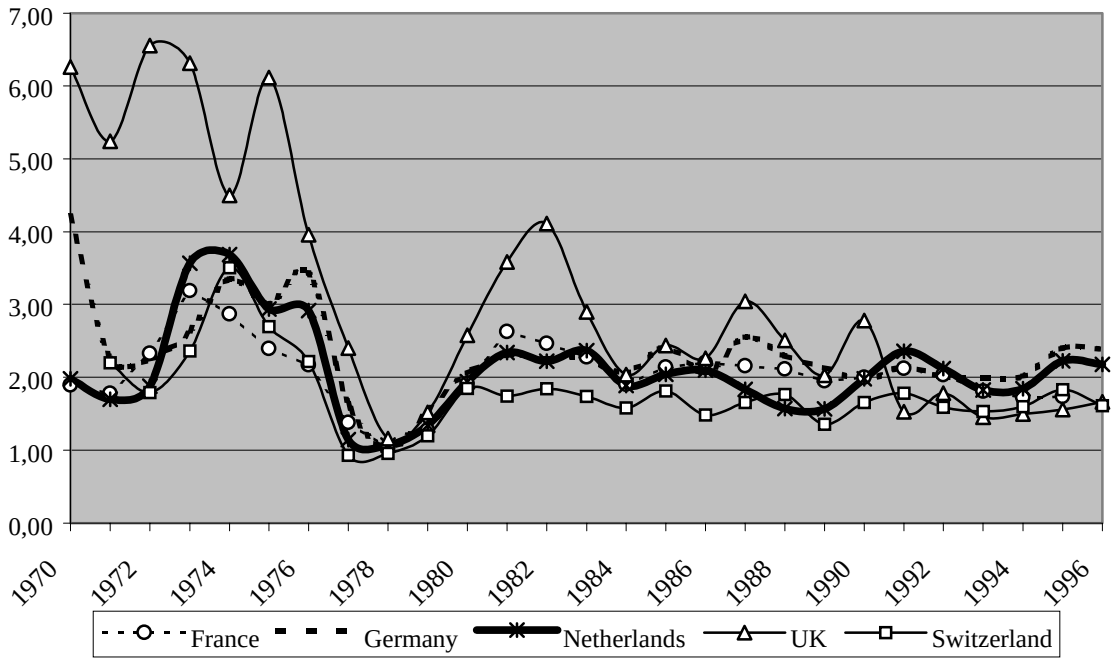
[6] The upward tendency in gross margins probably results from disregarding cost prices increases over the period (cost prices are held constant), while actual cocoa product prices do reflect these cost increases.

domestic and export outlets for cocoa powder, processing industries might well prefer the expeller technology.[7]

Liquor prices and the supply of cocoa powder

The technical supply of cocoa butter and cocoa powder depends on cocoa grinding and further processing of cocoa liquor. When more liquor is directly used for chocolate manufacturing, less will be available for butter and powder production. Hence, the fraction of liquor that is directly used as input for chocolate production (q in equation 2), forms a determinant of butter and powder production. Direct liquor use for chocolate production depends on food-chemical parameters, consumer taste (type of chocolate), quality requirements of the chocolate industry, and on prices of cocoa butter and powder compared to that of cocoa liquor. The chocolate industry tends to purchase its intermediate cocoa inputs rather than doing the grinding itself.

Graph 8 Price ratio of cocoa butter to cocoa liquor, selected countries (import prices)



The issue of relative prices is taken up here for further analysis. Relative prices of liquor, powder and butter can be assumed to have an influence on input choice of the chocolate industry. When liquor becomes relatively cheap vis-à-vis butter and powder, probably more liquor will be used, provided this is possible within the boundaries set by national food regulations. At present, butter is the main cocoa product since its price mostly is about 2 to 3 times the powder price. Graph 8 shows, for selected markets, the development over time of

[7] The reasons for lacking export opportunities mostly are that the local powder product has a low or inconsistent quality, an unreliable supply, or that it is not blended/mixed with other (non-local) powder types.

the price ratio of butter to liquor. Prices are average import prices for each of the countries. They differ between countries, *inter alia* because of different types and qualities of imported cocoa products. The general picture which emerges is that the price of butter relative to the liquor price has fallen between 1970 and the early 1980s. In the UK the decline went on longer, but for most countries the price ratio stabilised after 1980. Compared to the 1970s, using butter instead of liquor has become slightly cheaper for chocolate producers.

Joint production of cocoa powder and cocoa butter

An important technical characteristic of the grinding process is that powder and butter are produced as joint products, in approximately equal quantities. Since demand for these cocoa products follows distinct patterns, stocks would normally build up for one of both products. Because of its much higher price, butter normally is the main product with powder being the side-product. In cocoa-producing countries the butter is exported but no margin is expected from the powder which is sold at low-priced by-product on the local market. Capacity use in the cocoa products industry will therefore be geared predominantly towards the butter market. This also holds in most OECD countries.[8] Hence, powder stocks and powder prices must have an accommodating role. The powder market only clears when the powder price fluctuates inversely with stock levels. However, since profitability of grinding operations depends on the prices of powder and butter, companies will not treat one of both cocoa products as a purely residual side-product which can be disposed of at dump prices.

As will be shown later in Table 4 demand for cocoa powder in important OECD markets has a low price elasticity of demand (-0.1 to -0.5) whereas in some other markets no sensitiveness to the powder price could be established. The upshot of this is that a lower powder price does not lead to a proportionally higher powder demand. Stock-holding is practised for powder in order to limit excessive price fluctuations and give-away prices for powder. Of course, such stockholding is not a solution for permanent overproduction of cocoa powder. Powder can be stored for two years at maximum, but stocks can be recycled and refreshed.[9] Due to these factors, oversupply of cocoa powder is an inherent trait of the cocoa products industry in most OECD countries.[10]

Taking the joint-products analysis a bit further, it can be expected that when the main product (butter) is strong in demand, it will fetch a higher price in the market. More butter will be produced, resulting in approximately equal amounts of additional powder. But because powder demand does not peak simultaneously, powder stocks build up and powder

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[8] The Netherlands forms a somewhat atypical case, because its cocoa pressing industry is dedicated to the production of up-market powders from which it may expect a higher margin.

[9] The so-called 'nearby powder' that becomes too old and can no longer be stored, is sometimes sold at discount prices ($0.25-0.30, according to industry sources) in market segments that do not too much affect the core powder business. No public data are available on the size of company powder stocks and their development over time.

[10] This is different in Southeast Asia because there is a large demand in this region for cheap chocolate-like products (compound chocolate) which is made from cocoa butter substitutes with cocoa powder. According to Sunarcia (1995) Indonesian cocoa products industry has no problems with disposing of its cocoa powder.

prices deteriorate. This results in an inverse relation between the price of butter and the price of powder.

It is interesting, in this context, to analyse how an increased use of cocoa butter alternatives would affect the powder price. 'Cocoa butter alternatives' is an umbrella name for several products with different functions (Elshof 1994). At least three types of cocoa-butter alternatives have to be distinguished in order to derive the possible impact of their use on the powder price:

- **cocoa-butter equivalents** (CBE)
  These substances have the same technical and physical characteristics as cocoa butter (tempering fat). They can be mixed with cocoa butter in any proportion and even be used as a 100 per cent replacement. It is possible to make chocolate on the basis of only cocoa liquor plus CBEs, without changes in the chocolate production process. The use of CBEs has no direct effect on cocoa powder demand. However, if it leads to lower butter production, it will also imply lower powder production (lowering stocks) and hence an improvement of the powder/butter price ratio.
- **cocoa-butter replacers** (CBRs)
  These are non-tempering fats based on oils rich in C16/C18 which makes them easy to mix with cocoa butter. The main application of CBRs is in coatings for cookies, ice cream, countlines or candy bars. In these applications they can replace cocoa butter up to 100 per cent. They can be mixed with high-fat cocoa powder or with cocoa liquor; powder thus competes with liquor. The boundaries for such substitution are set by national food quality regulations. If application of CBRs makes final products cheaper, this may create additional demand for cocoa powder, having a positive effect on the powder price. Whether the powder/butter price ratio changes, depends on the net impact of CBRs on cocoa butter demand. If the latter impact is negative, the price ratio improves.
- **cocoa-butter substitutes** (CBSs)
  CBSs are non-tempering lauric fats having a high lauric acid content (C12) and produced on the basis of fractionated and hydrogenated commodity oils (e.g. palm kernel and coconut oil). CBSs are very difficult to mix with cocoa butter. Even mixture with high-fat cocoa powder (>20% fat content) is difficult. In practice, CBSs are mostly used in combination with low-fat cocoa powder (8-10% fat content). The main application of CBSs is in coatings for cookies, ice cream, countlines or candy bars where chocolate taste does not play a crucial role. In Asia 'compound chocolate' recipes are made using only 6-16% cocoa powder, combined with 25-35% CBSs, 0-14% milk powder and 40-55% sugar (Sunarcia 1995:7). Increased CBS use will lead to additional demand for low-fat cocoa powders, probably more in developing country markets than in quality-sensitive OECD-markets. Since competition from local suppliers is strongest in this powder market segment, it is unlikely that CBSs will lead to higher powder prices.

Overall, an increased use of cocoa butter alternatives will improve the price of cocoa powder vis-à-vis cocoa butter. Cocoa powder stocks will probably be lowered. In the extreme case, these stocks might run out and cocoa butter, despite a lacking butter demand, would have to

be produced in order to step up powder production. This would lead to a collapse of the butter price, and a complete reversal of the relation between butter and powder.[11] This is of course an extreme situation. More in general, if the use of cocoa butter alternatives leads to less use of cocoa butter, the latter product will probably remain the main intermediate cocoa product, but its price ratio with cocoa powder can be expected to deteriorate.

World market supply by LDC powder exporters

In order to get a good picture of the dynamics of cocoa powder supply it is worthwhile to look at possible geographical shifts in supply, and particularly, possible tendencies for production to shift towards developing countries. Most cocoa-producing countries aim for a higher share in the value-added chain of cocoa processing. Their policies favour domestic cocoa-processing industries, producing cocoa paste, butter and powder mainly for domestic markets and exports. As shown in Table 1, a number of developing countries have become large powder exporters over the past two decades. Brazil, Côte d' Ivoire, Malaysia and Singapore together supplied one third of 1995 world powder exports. Indonesia is an upcoming world market supplier. The question is whether this development is getting further momentum.

With Brazil as a notable exception, LDC domestic markets for powder are small, and most cocoa products are destined for exports.[12] Up to now, several factors limit OECD market penetration by cocoa powder produced in cocoa-producing countries:

- **Freight rates**
  A new tendency is that cocoa beans are being shipped increasingly as a bulk cargo. So far this only holds for bean exports from Côte d'Ivoire, but it might become more general in the future. Bulk shipping leads to substantial lowering of bean transport and handling costs. This change in transport mode makes bean transport relatively cheap compared to transport of intermediate cocoa products, thus enhancing the competitiveness of cocoa processing in OECD countries vis-à-vis processing and exports by LDC powder producers.
- **Quality problems**
  Like cocoa liquor, cocoa powder determines the taste, colour and odour of the end products in which it is applied. Therefore, final producers have strong demand for a high and constant quality of cocoa powder. Technical problems and climatic factors make it difficult for producers in LDCs to produce cocoa cake and cocoa powder of good quality. At tropical temperatures, bacteriological infestation easily leads to deterioration of aromatic and other quality aspects. Ideally, plants should be sealed off from open air, with air-conditioning providing for a constant temperature and humidity level. Such air-conditioning and humidity controls means higher capital outlay and requires dependable supplies of electrical energy; equipment mostly has to be imported from abroad. These

[11] This happened in 1978 when fear arose among cocoa powder users that powder stocks might run out, evoking a bidding-up of the powder price to extreme altitudes (e.g. Bensdorp 1995). Improved market information nowadays probably limits the chance of such market panics.

[12] Brazil ranks among the seven largest cocoa-consuming countries and has important cocoa-processing and chocolate industries (cf. Monteiro de Carvalho & De Souza Menezes 1995).

incremental cost elements for the production of quality cocoa powder offset the competitive advantages of lower wages. Due to these technical problems, press cake remaining after producing cocoa butter is often exported without further processing. Cocoa cake from LDCs tends to fetch a lower price than cake exported by OECD countries. The problems associated with guaranteeing a stable and high quality of cocoa powder will in the foreseeable future remain a limiting factor for LDC powder exports to OECD countries. Countries like Indonesia and Malaysia export most of their powder to other developing countries and to countries in the former Soviet bloc.

- **Problems with domestic cocoa supply**
  Production growth in Brazil and Malaysia probably will at best be very limited, as a consequence of lower domestic cocoa supply. In Malaysia, labour shortages and a development orientation towards industrialisation led to lower production of cocoa beans, despite efforts to increase cocoa farm productivity (Musa 1995a, 1995b). Pest and disease problems lowered domestic cocoa bean supply. The latter problems (particularly the witches' broom disease) have also been a very import factor in reducing the Brazilian production of cocoa, leading to a sharply lowered export supply of cocoa powder compared to a decade before.

The factors described so far limit the perspectives for fast growth of LDC cocoa powder exports to OECD markets. There are, however, also some factors which improve the outlook for growth of LDC powder exports to the OECD markets:

International investment in LDC cocoa processing

Since Côte d' Ivoire liberalised its cocoa sector, several foreign firms invested in the Ivorian cocoa sector. Recent foreign investments in the Ivorian cocoa sector are oriented at securing a stable and high-quality export supply of cocoa beans. However, other foreign investments may invigorate the Ivorian cocoa-processing sector, improve its technological standards and international market access.[13] Such foreign investments in processing will first lead to replacement of bean exports by liquor exports, but may well lead also to increased powder exports in the future. Liberalisation of cocoa purchasing and exports in Cameroon and Ghana may eventually give rise to similar developments in these export countries.

Reduction of import tariffs

Import tariffs still play a considerable role in international cocoa trade. The full European MFN tariff for powder amounted to 16% before the Uruguay Round, thus creating an effective import barrier. Developing countries received a preferential treatment under the GSP scheme and under the Lomé Agreement. Countries participating in the Lomé Convention, among which all African cocoa exporters, enjoyed a zero tariff. LDCs exporting under the GSP scheme were confronted with a 9% import tariff which still is an effective market entry barrier. The GSP rate for cocoa powder applies to countries like Indonesia, Brazil and Malaysia. The GSP concession of the EU was limited with a volume ceiling. The Uruguay Round of trade negotiations led to considerable lowering of tariff protection for

[13] E.g. the joint venture between Cargill and the locally-owned company GIP (Fin. Times October 30th 1997).

cocoa products. Table 3 gives EEC tariffs on cocoa products before and after the Uruguay Round. The general MFN tariff on powder and the GSP tariff will be lowered stepwise to 8% in 2001, thus improving possibilities for market access. The preferential market access position for African Lomé countries vis-à-vis other countries will diminish due to the tariff reduction. However, cocoa product manufacturers in non-ACP developing countries still complain about unfair market access treatment by the EU (e.g. Sunarcia 1995).

Table 3: MFN Tariffs on cocoa and cocoa products, European Union

Tariff items	***Pre-Uruguay Round (up to 1994)***	***Post-Uruguay Round***	***Tariff reduction, 1995-2001***	***% reduction***
Cocoa beans	3	0	3	100
Cocoa paste	15	9.6	5.4	36
Cocoa powder, unsweetened	**16[b)]**	**8[c)]**	**8**	**50**
Cocoa butter, fat and oil	12	7.7	4.3	35.8
Chocolate	16,8%+sd a)	12% + sd a)	4.8%+sd	28.6

Note: a) sd = special duties. b) Countries participating in the Lomé Treaty enjoy a *0* % tariff, while other developing countries are subject to a *9* % tariff under the EU's General System of Preferences. c) The MFN tariff is lowered in annual steps to 8 % in the year 2001, while differences between the GSP and MFN tariffs are to disappear. Source: UNCTAD TD/B/CN.1/30/Add.1 (1995).

The USA applies no tariffs on cocoa products, but has effective non-tariff barriers in the form of phytosanitary regulations that hamper LDC market access.

Summarising the aforementioned factors, it is fair to expect no spectacular changes in LDC powder exports to OECD countries. Quality problems, logistic developments and production problems are not likely to be surmounted in the short to medium term. On the other hand, lower import tariffs and increased foreign direct investment in LDC cocoa processing will improve their possibilities to access OECD powder markets. Because LDC powder exports enter at the low-price, low-quality end of the international powder market, they are most likely to benefit strongly from future growth in LDC markets, especially in Asia and Latin America. This process will, however, only materialise in the long run.

Conclusions

This section has shown that cocoa powder supply is closely tied to the supply of cocoa butter. When butter is high in demand, press capacity is adjusted to butter demand. The industry has an innate tendency to produce an oversupply of cocoa powder, since powder demand follows a pattern different from that of butter. Powder prices cannot be trusted upon to bring equilibrium in the powder market, since price elasticity of demand is very low. Moreover, sales proceeds from powder are too important for the profitability of the cocoa products industry to dispose of powder surpluses at dump prices. A temporary solution for this dilemma is found in strategic stockholding, as powder is relatively easy to store. The result of the joint production process and the different demand structures is that the prices of

cocoa butter and its 'joint product' cocoa powder are inversely related. If the commercial position of cocoa butter would decline as a consequence of increased use of cocoa butter alternatives this is likely to result in an improved commercial position (less overproduction, higher price) for cocoa powder. Beyond the medium term, LDC powder exports to the large OECD countries might become more important. OECD powder producers will face increasing competition from LDC powder producers in developing country markets, especially in the low-priced end of the market.

4 Demand for cocoa powder

Market structure

Market outlets for cocoa powder are distinctly different from those of other intermediary cocoa products. While cocoa butter and cocoa liquor are mainly destined for chocolate industry, most cocoa powder is used in the *non*-chocolate food industry. Five market segments and their share in total cocoa powder use can be distinguished:[14]

- bakery and biscuit industry (25%),
- instant drinks production (25%),
- compound confectionery (25%),
- dairy and ice-cream production (20%),
- other, speciality uses (5 %).

Cocoa powder is typically used for adding chocolate-like flavour and/or odour to other food products. Cocoa powder is also used as a natural colorant for food products. Several food industries apply cocoa powder in chocolate-like dressings, coatings or couvertures (e.g. in cakes, biscuits and ice cream).

Because of its specific characteristics, cocoa powder mostly is an important ingredient in the recipe in which it is used. Only relatively small quantities are needed to achieve the required impact on flavour, colour or odour of the final food product in which powder is applied. Understandably, food industries demand a consistent powder quality (taste, colour, odour) because of this input's strong impact on their final product. Bensdorp (1995:88) estimates that cocoa powder represents on average only 4 to 5 per cent of the weight of food recipes in which powder is used, and always less than 20 per cent of weight. Most food industries apply cocoa powder only in small quantities. Average order size for the powder industry is much smaller than for the cocoa butter industry. Market concentration in the powder-using food industries is generally lower than in the international chocolate industry which is dominated by a handful large, global players.

The diversity of the powder-using food industry also has its implication for product diversity. Powder is supplied with different product specifications (often between 60 and 100

[14] Estimates by Bensdorp (1995 and direct communication). The shares of each end use are broad averages, since the distribution differs by country. Use of cocoa powder for instant drinks, for instance, is lower in the UK, but higher in France and Spain. Use of powder in compound confectionary is much higher in developing countries, but lower in OECD countries. Use of cocoa powder in dairy and ice cream manufacturing is relatively higher in the Netherlands and Europe.

types) and also pricing structure differs by powder-using industry. Product specifications may vary as to fat content (0 - 37%, though mostly below 22%), degree of alkalinisation, fineness and colour. Powder types, like 'black' powder and non-fat powders sometimes fetch a price premium in the market. Price premiums for speciality powders differ between regional markets.

Non-cocoa substitutes of cocoa powder do not play an important role. US chemical companies have been active in developing cocoa-powder substitutes. Cocoa-powder substitutes are prepared on the basis of, for example, carob powder and beer yeast. Demand for cocoa-powder substitutes in the USA mainly stems from low-quality applications in the non-chocolate food industry, like mixes, drinks and pudding powders. So far, the flavour of cocoa powder could not be reproduced synthetically. Low prices of cocoa powder have also prevented demand growth for powder substitutes. These substitutes would only become an important market factor when cocoa powder prices would rise again to levels like in the late 1970s.

Factors affecting demand size

Cocoa powder is an intermediary product. Normally, when one tries to assess the relative size of factors determining demand quantity, one focuses on demand for the main final product(s) in which the intermediate product is used. Demand for cocoa butter can to a large extent be derived from demand for chocolate products. However, this procedure cannot be used for cocoa powder due to the dispersed nature of its market outlets. Each of the powder-using industries supplies a range of products, which fit in differently in the consumer budget, comprising both the low-end of the market (basic staple foods) and the high-end of the market (luxury food items). Moreover, demand patterns for the powder-using industries may differ sharply between countries. Due to these problems a different procedure is used here.

Rather than looking at final product demand, country demand for cocoa powder will be derived directly from the country's average income level and the price of cocoa powder. Per capita cocoa powder demand in a country can then be represented by the following demand function:

$$D = e^{\alpha}\, Y^{\beta}\, p^{\gamma} \qquad (4)$$

in which: D is domestic demand per capita for cocoa powder, e^{α} is a constant which represents country-specific general demand characteristics, Y is average income, measured as GDP per capita in the country under consideration, p represents the cocoa powder price, β is the income elasticity of powder demand, and γ is the price elasticity of powder demand. Note that price of cocoa powder substitutes are not taken into account in this demand equation.

Three straightforward hypotheses are investigated:

A) demand for cocoa powder reacts negatively to a higher price (negative price elasticity); and
B) cocoa powder demand reacts positively to an increase in average income (positive income elasticity);

C) cocoa powder is mainly applied for luxury food products. For this to be true, cocoa powder demand should not only react positively to an increase in average income, but demand should rise even faster (at higher incomes the consumer can afford the purchase of more food products in which cocoa powder is applied).[15]

When (in order to facilitate interpretation) the demand function is expressed in a log-linear way, the aforementioned hypotheses lead to expected parameter signs as indicated below the equation:

$$\ln(D) = \underset{(+/-)}{\alpha} + \underset{(+)}{\beta \ln(Y)} + \underset{(-)}{\gamma \ln(p)} \qquad (5)$$

Hypothesis C translates into the requirement for β to be greater than 1.

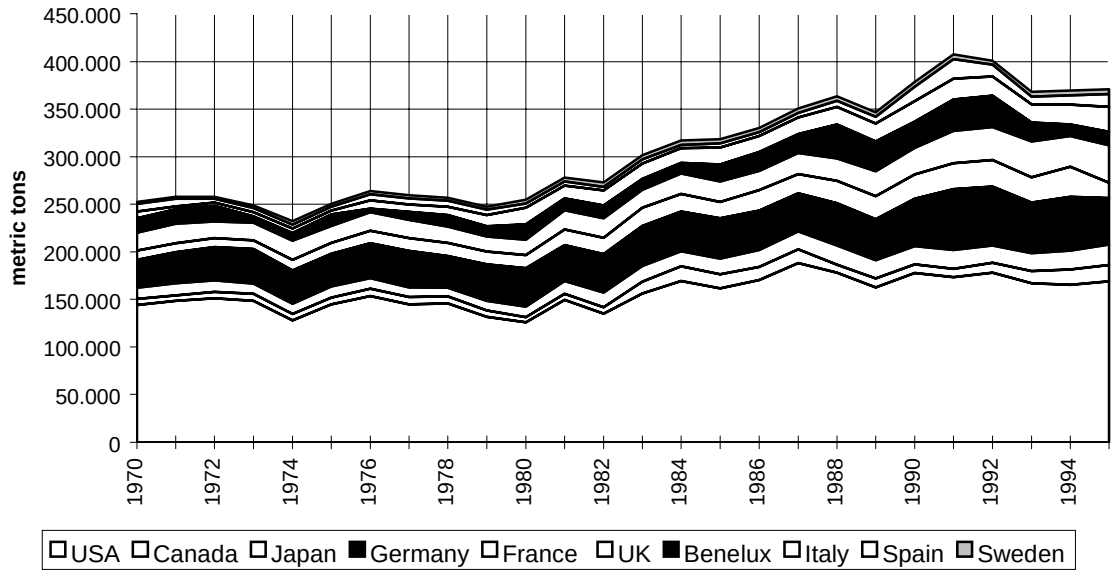
Empirical data for testing the aforementioned hypotheses was not readily available. An important part of the work consisted of producing a consistent and reliable data set. Cocoa powder demand per country is calculated as apparent consumption, i.e. domestic production plus imports minus exports. UN Industrial Statistics Yearbooks formed the source for production data. These data are based on national reports to the UN Statistical Office, but secrecy reasons often led to considerable underreporting and data gaps. Because of this, production figures sometimes had to be estimated on the basis of cocoa grindings or net bean imports using plausible and conservative bean conversion data. Trade data have been derived mainly from UNCTAD's COMTRADE database. Data gaps were repaired with the help of additional data sources and estimates.

Graph 9 shows the time profile of apparent cocoa powder consumption in the world's major markets. European markets show a consumption peak in 1991/92 with a slight fall in consumption afterwards. Part of this consumption fall after 1992 can be attributed to statistical deficiencies.[16] The main drawback of using apparent consumption is that changes in stock levels are disregarded. In fact, it assumes that positive and negative changes in stock levels cancel out over time.

[15] For luxury products an income elasticity would be found above unity, whereas in the case of staple foods, an income elasticity below unity ($\beta<1$) can be expected.

[16] There are indications that due to increased cocoa butter production since 1992, there was an oversupply of powder for which no immediate consumption outlets existed. However, statistical data on trade and production always give conservative estimates of recent production, imports and exports. Often, such data are revised upward after one or two years. The dip in apparent powder consumption since 1992 might for this statistical reason turn out to be somewhat smaller than reported in Graph 9.

Graph 9 Apparent consumption of cocoa powder, selected markets



A lack of price data for cocoa powder was surmounted by using average import prices per country, derived from UNCTAD's COMTRADE database. Tests have been performed to assess whether there are significant disparities between import prices of different countries, but most import prices moved over time in a very similar and consistent way (cf. Graph 6), indicating an effective price arbitrage between countries. This fact also seems to ease off the possible drawback that imported cocoa powders form a specific market segment in each country, with prices different from more 'average' domestic powder prices.[17] Prices are converted into national currency on the basis of nominal exchange rates. The time series cover the period 1975-1996, and in some cases 1975-1995. Regressions performed with the ordinary least squares (OLS) method and the error correction method produced comparable results. The econometric results obtained with the OLS method are presented in Table 4.

With reference to the three initial hypotheses, the following conclusions can be inferred from the estimation results.

Re. hypothesis A (price sensitivity)

The null hypothesis (prices have no effect on demand) could be firmly rejected in the case of ten countries: France, United Kingdom, Spain, Belgium, USA, Japan, Canada, Austria, Denmark and Italy. In absolute terms, all price elasticities are lying within a plausible range, between 0.11 and 0.51. Ten per cent price increase thus results in a 1 to 5 per cent change in consumption. Except for Italy, the price elasticity parameter also had the predicted negative sign, i.e. powder consumption is negatively correlated with price of powder. The result for Italy (+0.28) is rather odd and counter-intuitive. It would imply that cocoa powder is considered as a so-called *Giffen good*, of which consumption diminishes as its price falls, e.g. because a lower price causes consumer suspicion about the product's quality. In

[17] According to industry sources, a market segmentation exists in the USA, where imported powders generally have a higher quality and higher prices compared to domestically produced powders.

economic theory, Giffen goods are curiosities, however. According to industry sources, the result for Italy may well be due both to unreliable data and to the presence of an expeller

Table 4: Factors affecting cocoa powder demand in major consumption countries

Country	***income elasticity*** [a]	***price elasticity*** [a]		R^2 ***adj.***
France [b]	0.53	**- 0.20**		0.98
Germany [c]	0.28	- 0.03	e)	0.80
United Kingdom [b]	0.44	**-0.27**		0.82
Italy [b]	0.44	**+0.28**	d)	0.90
Spain [b]	0.41	**- 0.51**		0.47
Austria	0.49	**- 0.14**		0.81
Sweden	0.23	- 0.05	e)	0.70
Belgium [b]	0.80	**- 0.12**		0.98
Netherlands	1.87 [d]	+0.32	e)	0.24
Denmark	0.21	**- 0.11**		0.82
Finland	0.41	+0.02	e)	0.64
Ireland	0.32	- 0.10	e)	0.50
Switzerland	0.72	+0.04	e)	0.86
USA [f]	0.42	**- 0.30**		0.60
Japan	0.37	**- 0.22**		0.82
Canada [b]	0.46	**- 0.43**		0.38

Notes: a) If not specified, all found elasticities were significant at the 5 per cent level (two-tailed) or better. b) The regression equation included a dummy for the years 1977 an 1978 when panic about future supply shortages led to sharp bidding-up of prices. c) The regression equation included a dummy for unification (0 before 1989; 1 afterwards) which was significant at the 5% level. d) See remark in main text. e) Significant at less than 5% per cent (two-tailed). f) Includes a price dummy for the years 1977-'79.

operation (Tesca) which is using the powder for extracting theobromine rather than for food consumption uses.

The null hypothesis could not be rejected in the case of six countries: Germany, Netherlands,[18] Sweden, Finland, Ireland and Switzerland. Although the price elasticity parameter had the expected negative sign in three of these countries, low *t*-values made the result unreliable. It means that demand in six countries shows no systematic sensitivity for powder prices. If the powder consumption data are correct, it means that in these countries cocoa powder tends to be used irrespective of its price.[19]

[18] The regression for the Netherlands has also been done with export prices and with the average of export and import prices, but this did not yield results in a more plausible range of outcomes.

[19] Powder stock variations make apparent consumption data unreliable. Industry sources suggest that this effect applies in the case of the Netherlands and Germany.

The conclusion with respect to hypothesis *A* is that price is a systematic determinant of cocoa powder use in almost two-thirds of the countries. Possible explanations for the apparent lack of price sensitivity in the other countries are that:

- costs of cocoa powder represent just a small share of total production costs of the recipes in which it is applied, and/or
- cocoa powder is too important for taste, flavour or colour of the final product so that it cannot be replaced.

Re. hypothesis B (sensitivity to average income)

The null hypothesis (no effect of income on demand) could be strongly rejected. Strong evidence was found in all countries that the demand for cocoa powder grows as average income levels increase. In most countries a one per cent increase in average income leads to a 0.4 per cent increase in per capita use of cocoa powder. Hence, economic growth clearly matters for cocoa powder demand.

Re: hypothesis C (cocoa powder applied in luxury food products)

The third hypothesis had to be rejected. The level of the income elasticity parameter indicates whether cocoa powder is used in luxury food products or in the staple-food end of the final products market. Table 4 reveals that in all but one case income elasticities were in the bandwidth between 0.21 and 0.80. It means that, holding prices constant, the share of income devoted to goods in which cocoa powder is applied, declines as income grows. It may thus be concluded that cocoa powder is predominantly applied in non-luxury food products. In the largest OECD markets, demand for cocoa powder only grows by some four per cent when income grows by ten per cent. In Scandinavia and in Germany[20] the increase is only half of that. In Belgium and Switzerland, both countries with an important chocolate industry, the income elasticity is two times the average. A clear statistical outlier is the Netherlands with income elasticity having an implausibly high value. Considering the low correlation coefficient for the Dutch demand equation, this statistical result must be distrusted. The most likely explanation in the Dutch case is that apparent consumption data (production minus exports plus imports) yield a biased image of Dutch powder demand, because changes in domestic powder stocks generate large, unsystematic biases in apparent consumption figures.

The results so far only referred to OECD markets. If we extrapolate the results to developing countries, the implication is that the most dynamic markets are to be found in developing countries, particularly in Asia. Graph 5 showed that over the past two decades the Asian share in world imports grew faster than that of any other region. Table 5 specifies import volumes for a number of emerging import regions. Imports in India and China are still very low, partly due to culturally determined food consumption patterns. However, when their enormous populations grow out of poverty, so that they can afford more luxury-like food items, this will lead to a complete overturn of current international demand patterns

[20] Even after including a dummy for the unification with the former German Democratic Republic.

for cocoa powder.[21] Economic recovery and growth in Latin America also offers perspectives for strong demand growth. Finally, a strong backlog demand for more luxury food items can be expected from the countries of the former Soviet Union bloc; demand already has picked up strongly in Eastern European countries. In the pre-reform era, chocolate products were permanently kept in short supply and product quality was poor, but nowadays chocolate and chocolate-like products are sold in all tastes and price brackets. Per capita consumption of chocolate and chocolate-like sweets in the Soviet Union still stands at only one third of that in the UK and Switzerland, so that considerable demand growth can be expected as income growth is restored (cf. Thornhill 1998).

Table 5: Emerging import regions for cocoa powder (metric tons)

	1974/75	*1985/86*	*1996/97*
Eastern Europe plus ex-Soviet Union	3300	7000	31400
Egypt	..	150	4420
Turkey	0	767	7720
Mexico	..	..	12917
Argentina	..	267	7810
Chile	400	1597	4625
South Korea	307	2256	4717
India	68	50	160
China	..	1859[a)]	290
Singapore	..	..	6660
Philippines	..	..	5789
Indonesia	146	180	682
Thailand	200	748	3142
Total	4439	14874	90342

Note: a) Koo (1995:66. Source: ICCO Quarterly bulletin of statistics

5 The cocoa powder industry in an integrated simulation model of the cocoa economy

Findings so far can be combined to situate the powder market in an integrated model of the cocoa economy. A theoretical model is useful when complex market relations between a range of interrelated variables makes intuitive interpretations and prognostications error-prone. The model may guide applied econometric research on specific aspects of the cocoa economy. At the end of this section, one important prediction of the model will be subjected to empirical testing.

[21] Chocolate consumption in Asia at present is less than 0.1 kg per capita per year compared to more than 5 kg in the developed countries. For the case of China, Koo (1995) made plausible that no short-term surge in Chinese powder demand can be expected; in the medium to long term a fast demand growth can be expected.

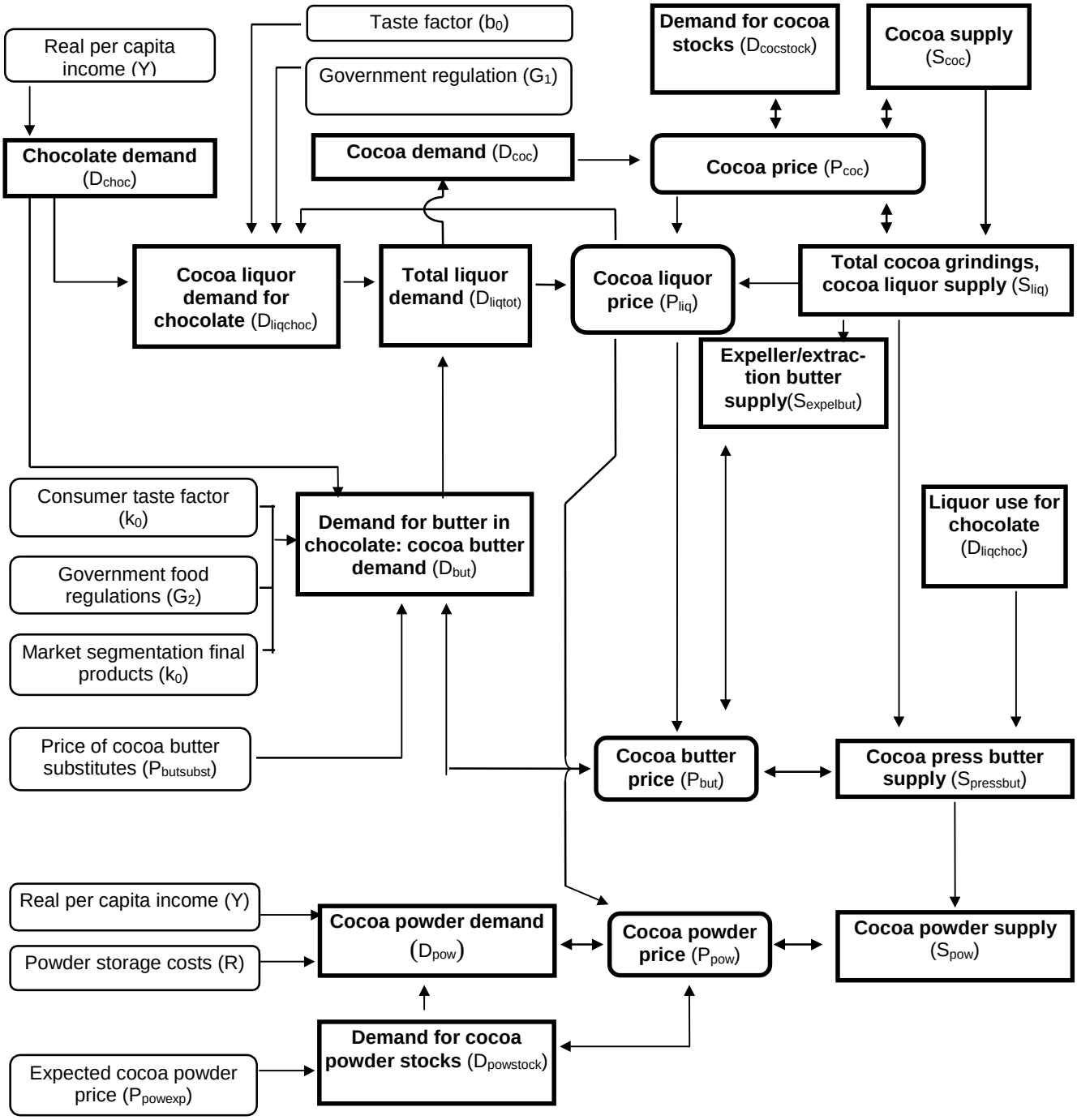
The model of this section focuses on the market for *intermediate* cocoa products, while modelling of other aspects of the cocoa economy - like final chocolate demand and primary cocoa supply - is held fairly simple. The latter issues are covered more comprehensively in companion reports. Functioning of the primary cocoa market is treated at greater length in companion reports (e.g. Burger & Smit 1999, 1998b; Burger 1996), while the market for chocolate is covered in-depth in Burger and Smit (1998a).

Model assumptions

The underlying assumptions for the model are:

- Strategic demand for stocks plays a role for cocoa beans and cocoa powder, but not for liquor and butter. Strategic demand for stocks depends on the trade-off between storage costs and expected future price gains (speculation purpose). Note that this strategic demand for stocks can be negative.
- Government regulations have an impact on the share of cocoa liquor in chocolate and on the share of cocoa butter in chocolate.
- Supply of expeller butter is modelled as a fixed fraction of total cocoa grindings, corresponding to a fixed percentage of damaged and inferior beans.
- To keep the final demand section of the model as simple as possible, it is assumed that chocolate demand is solely a function of average income. Factors like demographic structure, population growth and the consumer price of chocolate are disregarded. Later in this section, an alternative treatment of final demand will be discussed.
- Equations (nos. 4 and 6) are based on technically fixed average bean conversion rates in the grinding process.
- Normal cocoa supply is treated as exogenous here. In the complete model to be published in companion reports, it will be endogenised.
- Cocoa butter demand for chocolate manufacture partly depends on the price of cocoa butter alternatives.
- International trade aspects are left out of the model, but can be easily included at the level of each sub-market.
- Equation (no. 17) expresses the joint-product character of cocoa powder and press butter.

Chart 2 Schematic representation of an integrated model of the cocoa economy



The structure of the model sections for the cocoa bean, cocoa liquor and cocoa butter markets have an independent solution. Conversely, the cocoa powder market depends through two causal lines on the other sections of the industry (liquor price, press butter supply).

Formal model

All behavioural equations are expressed in a log-linear form. Accounting equations (nos. 5, 9, 13 and 20) and technical transformation relations (nos. 4, 6 and 8) are in a linear form. A list of variables is given below. Exogenous variables are indicated with an asterisk.

Market module for cocoa liquor and cocoa butter

(1) $S_{coc} = c_o + c_1 S^*_{cocnorm} + c_2 P_{coc}$

(2) $D_{choc} = a_o + a_1 Y^*$

(3) $D_{liqchoc} = b_o + b_1 D_{choc} - b_2 P_{liq} + b_3 G_1^*$

(4) $D_{liqbut} = y D_{but}$

(5) $D_{liqtot} \equiv D_{liqchoc} + D_{liqbut}$

(6) $S_{liq} = w S_{coc}$

(7) $P_{liq} = d_o + d_1 P_{coc} - d_2 (S_{liq} - D_{liqtot})$

(8) $D_{coc} = z D_{liqtot} + (D_{cocstock} - D_{cocstock,\ t-1})$

(9) $X_{coc} = X_{coc,\ t-1} + S_{coc} - D_{coc}$

(10) $D_{cocstock} = h_o + h_1 (P^*_{cocexp} - P_{coc}) - h_2 R^*$

(11) $P_{coc} = e_o - e_1 X_{coc} + e_2 P_{coc,\ t-1}$

(12) $D_{but} = k_o + k_1 D_{choc} - k_2 P_{but} + k_3 G_2^* + k_4 P^*_{butsubst}$

(13) $S_{but} \equiv S_{expelbut} + S_{press\ but}$

(14) $S_{pressbut} = g_o + g_1 (S_{liq} - D_{liqchoc}) + g_2 P_{but}$

(15) $S_{expelbut} = f_o + f_1 S_{liq} + f_2 P_{but}$

(16) $P_{but} = n_o + n_1 P_{liq} - n_2 (S_{but} - D_{but})$

Powder market module

(17) $S_{pow} = q_o + q_1 S_{pressbut} + q_2 P_{pow}$

(18) $D_{pow} = r_o + r_1 Y^* - r_2 P_{pow} + r_3 (D_{powstock} - D_{powstock,\ t-1})$

(19) $D_{powstock} = v_o + v_1 (P^*_{powexp} - P_{pow}) - v_2 R^*$

(20) $X_{pow} \equiv X_{pow,\ t-1} + S_{pow} - D_{pow}$

(21) $P_{pow} = s_o + s_1 P_{liq} - s_2 X_{pow}$

List of endogenous variables

D_{choc} , D_{liqtot} $D_{coc,}$ D_{but} , D_{pow}: demand volume for, respectively, chocolate, cocoa liquor, cocoa beans, cocoa butter, and cocoa powder

S_{choc} , S_{liq} , S_{coc} , S_{but} , S_{pow}: supply volume for, respectively, chocolate, cocoa liquor, cocoa beans, cocoa butter, and cocoa powder

P_{choc} , P_{liq} , P_{coc} , P_{but} , P_{pow}: market price for, respectively, chocolate, cocoa liquor, cocoa beans, cocoa butter, and cocoa powder

X_{coc} , X_{pow}: actual end-of year stocks for, respectively, cocoa beans and cocoa powder

$D_{cocstock}$, $D_{powstock}$: strategic demand for stocks of, respectively, cocoa beans and cocoa powder

$S_{expelbut}$: supply of expeller / extraction butter

$S_{pressbut}$: supply of press butter (grinding trajectory)

$D_{liqchoc}$: demand for cocoa liquor to be applied directly in chocolate manufacturing

D_{liqbut} : demand for cocoa liquor for processing into cocoa butter

List of exogenous variables

Y: real income per capita in consuming country

$S^*_{cocnorm}$: normal cocoa bean production (per country) or production capacity, based on area size and vintage structure of plantings

P^*_{cocexp} : expected price of cocoa beans

P^*_{powexp}: expected price of cocoa powder

R*: real interest costs and other costs of storage

G_1*: government regulation determining minimal cocoa liquor content and cocoa butter content of chocolate

G_2*: government regulation factors determining allowed use of cocoa butter alternatives in chocolate instead of cocoa butter (proposed EU CBA directive and similar measures)

$P^*_{butsubst}$: price of cocoa butter alternatives

Model solution

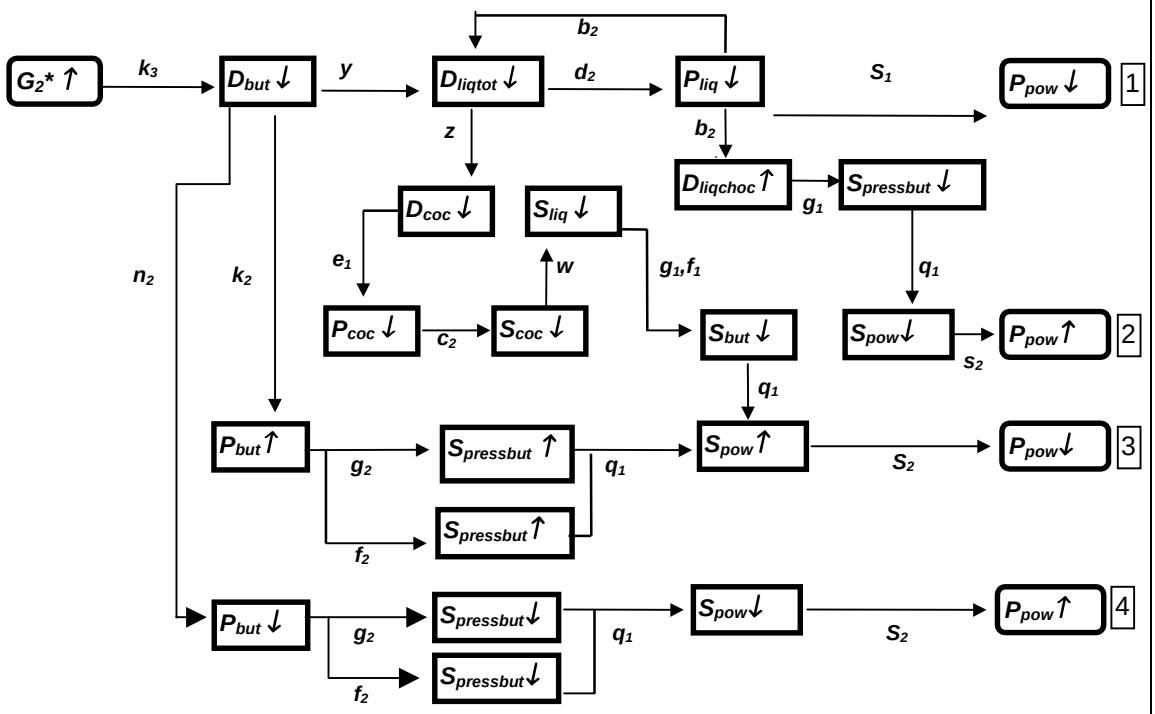
The market module for cocoa liquor and cocoa butter is self-contained. It has 16 endogenous variables and 16 equations which can be solved simultaneously. Subsequently, these results can be used for recursively deriving the five remaining endogenous variables of the powder market module.

Scenario analysis with the model

The model allows to investigate theoretical scenarios relating to actual policy questions. One scenario related to the central question of this research project will be briefly analysed, namely the question how the price of cocoa powder will be affected by implementation of the proposed EU directive on cocoa butter alternatives.

In the model, this directive will increase the variable $\boldsymbol{G_2^*}$. The main impacts of a policy impulse that increases $\boldsymbol{G_2^*}$ can be traced through the model by a diagrammatic presentation as in Chart 3. The policy impulse evokes a series of reactions, of which some work out positively on the powder price, and some in a negative way. It can be assumed that the numerical value of reaction parameter $\boldsymbol{k_3}$ is strictly negative, so that the initial effect is a lower butter demand. Grinding volumes fall and so will the price of liquor, leading to a lower price of cocoa powder. This line of events is the most direct one and pictured as reaction chain 1 in Chart 3.

Chart 3 Initial impact of more CBA use on the price of cocoa powder



The situation may change in the medium term when powder stocks get depleted (reaction chain 2). Effects on the price of cocoa butter will cause compensatory effects (chains 3 and 4). The overall outcome depends on the numerical values of all reaction parameters. However, the most direct effects (reaction chain 1) are probably stronger than indirect effects reflected in reaction chains 2 and 3. Chart 3 only presents the main initial effects of the policy impulse; further secondary effects are left out. The full impact of the measure on the cocoa powder price cannot any more be understood intuitively because of the many interactions. It can be arrived at mathematically after solving the set of simultaneous model equations. The full impact of the policy impulse ($d P_{pow} / d G_2^*$) can be shown to depend in a complex way on 20 different model parameters after all secondary and higher-order effects have been accounted for.[22]

In the model, a lower chocolate cost price as a consequence of the proposed CBA directive of the EU does not enlarge overall chocolate demand through the price channel. The European chocolate industry has argued that an increased use of CBAs would strengthen product flexibility for chocolate manufacturers compared to the use of only cocoa butter. CBAs can be added in chocolate to raise its melting point, thus preventing 'whitening' of chocolate at high temperatures; it would improve marketing possibilities of chocolate in warm countries. In the present model such a demand shift could only be reflected in a higher

[22] The full solution is available upon request from the author of this working paper.

a_0 parameter (fixed country-wise demand effect). An alternative modelling approach is to add the average consumer price of chocolate as variable in the demand equation for chocolate (no. 2). It is necessary then to add an extra equation explaining this price from e.g. the lagged price of cocoa liquor price and the exogenously determined price of non-cocoa chocolate ingredients.

Partial estimation of model relations

In Section 4 of this report it was argued that the price of powder does not only depend positively on the price of its main raw material (liquor), but also that there is a negative relation with the price of cocoa butter. The model allows a more precise statement of this relation.

Even without resorting to the full (but complex) simultaneous solution of the model we already get a good insight in the relevant relations by a partial approach. By combining equations (nos. 3, 14 and 17-21) we get:

$$P_{pow} = \frac{s_1 - s_2 q_1 g_1 b_2}{1 + s_2 (q_2 + r_2 - r_3 v_1)} P_{liq} - \frac{s_2 q_1 g_2}{1 + s_2 (q_2 + r_2 - r_3 v_1)} P_{but} + \textit{fixed effects} + \textit{second. effects} \quad (6)$$

The *fixed effects* term consists of all fixed-level effects, i.e. the constants plus the effects of lagged and exogenous variables. The *secondary effects* run through two remaining endogenous, non-lagged variables, namely chocolate demand (D_{choc}) and total liquor supply (S_{liq}). We might hypothesise that the secondary effects are relatively small, because they are intermediated by a further range of reaction parameters. By ignoring the secondary effects and simplifying the remaining terms of equation *(6)* to single symbols, we get the following equation:

$$\underset{+/-}{p_{pow}} = \lambda_o + \underset{+}{\lambda_1 p_{liq}} + \underset{-}{\lambda_2 p_{but}} \quad (7)$$

While partial estimation can never validate an entire model, it may serve to test two hypotheses which are reflected in the expected signs of λ_1 and λ_2, as indicated below equation *(7)*:

A) The price of cocoa powder is inversely related to the price of cocoa butter;
B) The price of cocoa powder is positively related to the price of cocoa liquor.

Price data for testing this equation are unit prices calculated from international trade statistics. They all stem from UNCTAD's COMTRADE database. Import price were used for countries without substantial own export of intermediate cocoa products. In some cases averages of import and export prices were used. In the case of the Netherlands export prices were used because exports clearly dominate imports of similar products. All prices were inflation-corrected using national GDP deflators with 1987 as base year.

Methodologically a measurement problem arises, because prices of all intermediate cocoa products are formed more or less simultaneously in strongly related markets, so that the explanatory variables may be endogenous. Estimation was therefore done using an error-

correction approach: for each country, first the long-run price equation is estimated, leading to an error-correction term e_{t-1} that can be used for analysis of short-term price relations.[23] The regression equation is formulated in relative changes (first differences of natural logarithms). Regression results are presented in Table 6.

Re: hypothesis A (powder prices negatively related to butter price)

The parameter for the price of butter (λ_2) had the expected negative sign in 15 out of the 17 country cases. However, the λ_2 parameter was found to be significantly different from zero in only eight countries, including most OECD countries with a significant cocoa-processing industry. These results confirm the hypothesis of an inverse relation between the price of cocoa butter and the price of cocoa powder. Apparently, the relation does not hold in most countries which only import cocoa butter and cocoa powder. This result might be explained by strategic pricing (regional price differentiation) applied by the cocoa products industry.

Re: hypothesis B (powder price positively related to liquor price)

The null hypothesis could be rejected firmly. Parameters found for λ_1 were significantly different from zero in all but two countries and had the expected sign. This supports the assumption that the price of cocoa liquor co-determines the price of cocoa powder. Table 6 also indicates that in countries with a domestic cocoa-processing industry λ_1 in most cases was higher than in other countries.[24]

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[23] Regression with the error-correction mechanism is based on the idea that a stable, long-term equilibrium price underlies short-term fluctuations. Hence, 'below the surface' of the actual P_{pow} lies the long-term equilibrium value P^*_{pow}, so that:

$$P_{pow} = \alpha\,[other,\ short\ term\ impacts] + \beta\,[P^*_{pow}] \quad \text{and:}$$

$$\Delta P_{pow} = \alpha\,\Delta[other,\ short\ term\ impacts] + \beta\,[P_{pow,\,t-1} - P^*_{pow}].$$

Parameter β represents the adaption to the long-term equilibrium. Now, supposing that equation *(7)* is also the form of the long-term equilibrium P^*_{pow}, we may state the regression equation with the error-correction mechanism as follows:

$$\Delta P_{pow} = \alpha\,[\lambda_1\,\Delta P_{liq} + \lambda_2\,\Delta P_{but}] + \beta\,[P_{pow,\,t-1} - \lambda_o + \lambda_1 P_{liq,\,t-1} + \lambda_2\,P_{but,\,t-1}] + e_t\ ,$$

with the term e_t representing the (unexplained) regression residues. The term preceded by β is in fact the unexplained part in the preceding period, or: e_{t-1}. Hence, with a small simplification, we get the regression equation:

$$\Delta P_{pow} = \lambda'_1 \Delta P_{liq} + \lambda'_2 \Delta P_{but} + \beta\, e_{t-1} + e_t\,.$$

[24] A possible explanation for this difference is that in the other countries more use is made of strategic pricing (oligopolistic price margin), while in the countries with an own cocoa-processing industry import prices for competitive reasons have to be more in line with real costs. Quality differences (e.g. prevailing of cheap low-fat powder imports) could constitute a further explanatory factor.

Table 6: Price formation for cocoa powder: regression results (equation 7), selected countries 1975-1995 (t-values for parameters in parenthesis)

Country	*(impact P_{liq})* λ_1	*(impact P_{but})* λ_2	*(impact error term)* β	R^2 *adj.*
Countries with large intermediate cocoa-processing industry				
France	0.75 (4.44)	***-0.15*** (-1.74)	0.58 (2.96)	0.84
Germany	0.91 (6.40)	***-0.21*** (-2.69)	0.91 (4.54)	0.85
Netherlands	1.02 (7.59)	***-0.31*** (4.06)	0.76 (4.14)	0.86
USA	0.64 (2.71)	***-0.31*** (-1.87)	0.21 (1.59)	0.66
Belgium	0.75 (4.19)	***-0.21*** (-2.37)	0.50 (3.33)	0.80
United Kingdom[a)]	0.43 (3.93)	+0.03 (0.43)[b)]	0.56 (4.23)	0.77
Countries without large intermediate cocoa-processing industry				
Norway	0.85 (4.53)	***-0.49*** (-2.18)	0.81 (28.1)	0.93
Japan	0.88 (6.39)	***-0.20*** (-2.81)	0.55 (5.31)	0.89
Italy[a)]	0.46 (2.40)	-0.01 (-0.06)[b)]	0.19 (1.22)[b)]	0.57
Switzerland	0.32 (3.87)	+0.06 (0.97)[b)]	0.67 (8.74)	0.88
Ireland	0.16 (2.88)	-0.00 (-0.04)[b)]	0.28 (1.81)	0.42
Spain	0.37 (2.29)	0.00 (0.03)[b)]	0.76 (3.53)	0.33
Denmark	0.34 (1.94)	-0.03 (-0.23)[b)]	0.89 (4.69)	0.68
Austria[a)]	0.19 (1.13)[b)]	-0.05 (-0.43)[b)]	0.55 (3.73)	0.71
Sweden	0.55 (3.50)	-0.12 (-1.21)[b)]	0.67 (3.34)	0.50
Finland	-0.15 (-1.22)[b)]	***+0.39*** (3.66)	0.49 (3.85)	0.69
Canada	0.45 (3.59)	+0.01 (0.14)[b)]	0.24 (1.48)[b)]	0.69

Notes: a) Average of import and export prices have been used. b) Parameter not significant (significance less than 10% level, two-tailed). c) Export prices have been used. Data sources: all unit prices have been calculated from UNCTAD's COMTRADE database, and were corrected for inflation with GDP deflators for each of the countries.

6 Conclusions

Most of the cocoa products industry is still situated in OECD countries, with a dominant role for Western Europe. The share of African and Asian grindings has clearly increased since 1975, while grindings in South America suffered from a setback since the mid-1980s. The location shift in world-wide grindings had direct repercussions for the cocoa powder industry. European and Asian powder exports grew at the expense of the African share in the world market. Particularly Ghana and Cameroon experienced a sharp drop in international market share. The Netherlands improved its leading market position and now supplies more than one third of world exports. Malaysia, Singapore and Indonesia quickly gained market share over the past two decades. After a strong growth of Brazilian powder exports up to 1985, this country fell back again in 1995, due to problems in domestic cocoa supply. The US is not a major player in world exports of cocoa powder.

Twenty years ago, import demand for cocoa powder used to stem mainly from the US and Western Europe, but the market has become more geographically diversified. While world import volume doubled the last twenty years, US import demand stagnated, while

Western Europe maintained its position as an import market for cocoa powder. Other market regions now account for approximately one-third of all cocoa powder imports. Within Europe, Germany, Spain and France became the major import markets.

Supply of cocoa powder is closely tied to the supply of cocoa butter. When butter is high in demand, press capacity is adjusted to this demand. The industry has an innate tendency to produce an oversupply of cocoa powder, since powder demand follows a pattern different from that of butter. Powder prices cannot be trusted upon to bring equilibrium in the powder market, since price elasticity of demand is very low. Moreover, sales proceeds from powder are too important for the profitability of the cocoa products industry to dispose of powder surpluses at dump prices. The solution is found in strategic stockholding, as powder is relatively easy to store. The result of the joint production process and the different demand structures is that the prices of cocoa butter and its 'joint product' cocoa powder are inversely related. If the commercial position of cocoa butter would decline as a consequence of increased use of cocoa butter alternatives this is likely to result in an improved commercial position (less overproduction, higher price) for cocoa powder.

Powder exports from developing countries to the OECD will in the foreseeable future be hampered by quality problems, logistic developments and production problems which are unlikely to be surmounted in the short to medium term. On the other hand, lower import tariffs and increased foreign direct investment in LDC cocoa processing will improve their possibilities to access OECD powder markets. Because LDC powder exports enter at the low-price, low-quality end of the international powder market, they are most likely to benefit strongly from future growth in LDC markets, especially in Asia and Latin America. This process will, however, only materialise in the long run.

Analysis of the factors that determine overall demand for cocoa powder (cf Section 4) showed that the powder price has a significant impact on powder demand in two-thirds of the OECD countries that were investigated. In the remaining countries, including a large market such as Germany, no systematic correlation between prices and apparent powder consumption could be established. Strong evidence was found in all countries that demand for cocoa powder grows as average income levels increase. In OECD markets cocoa powder appears to be predominantly applied in non-luxury food products. In the largest OECD markets, demand for cocoa powder only grows by some four per cent when income grows by ten per cent. In Scandinavia and in Germany (even after accounting for the German unification) the increase is only half of that. This reaction pattern implies that, holding prices constant, the share of income devoted to goods in which cocoa powder is applied, declines as income grows. In developing countries and Eastern Europe a different demand pattern exists. The food products in which cocoa powder is applied are luxury goods, for which demand grows at a faster pace than income. The strongest growth has already been recorded in developing Asia and can also be expected for the future when the recent monetary problems are overcome. Other new growth markets are Latin America (especially Mexico) and the former Soviet bloc where a backlog demand for chocolate and chocolate-like products exists. In absolute terms these markets are still relatively small, however. Expectations that China will become a giant market for cocoa powder seem ill-founded, at least for the medium term.

All the main demand and supply characteristics of cocoa powder and their interactions with other parts of the cocoa economy have been integrated in a synthetic theoretical model.

It may be used for scenario analysis. As an example, the model was used to assess how a higher use of cocoa butter alternatives could affect the price of cocoa powder.

Two model predictions were tested empirically: (a) that the price of cocoa powder is inversely related to the price of cocoa butter; and (b) that the price of cocoa powder is positively related to the price of cocoa liquor. The first hypothesis was strongly confirmed for all countries with a major domestic cocoa-processing industry. In most other countries, this result could not be established, which might be explained by strategic pricing behaviour (regional price differentiation) of the cocoa products industry. The second hypothesis was confirmed by the empirical findings. The price of cocoa liquor was found to be strongly correlated to the price of cocoa powder.

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