**The joint products of the cocoa industry and the soaring powder prices**
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*Abstract*
We derive the case for a straight line connecting combinations of cocoa powder, paste and butter prices, we work out a mathematical model to explain this, and show it to apply empirically using graphs of recnt price changes. We tentatively try to explain the position on the line, but find no clear reasons for the recent surge in powder prices relative to butter prices.

**1. Introduction**

The cocoa industry processes beans into three products (liquor, cocoa butter and powder). Butter and powder are two products of the same liquor-pressing process and normally produced in a fixed proportion, not much different from 1:1. Such joint production of goods should have implications for the prices they fetch in the market. A positive supply response to a rise in price of one product always leads to more production of the other product too. To sell this second product in an otherwise unchanged market, its price should fall, compensating for the price rise of the former product.
We investigate if this phenomenon can be observed for the two cocoa products, powder and butter. If so, it may provide a useful vehicle to explore the recent dramatic changes in the prices of powder (which soared) and butter (which fell).
The economics of joint production is studied in many text books, and that fixed proportions in production lead to straight lines for the cost or revenue curves is well-known (e.g. Varian, 1984: 70). It has been applied in a number of studies in which production of one good implies production of another. A good example is the joint products of soybean meal and soybean oil (Piggot and Wohlgenant, 2002). Much of the analysis in the literature is on the implications of joint production for the price elasticity of the demand for the original products (e.g. soy beans). In our case, we use the revenues function, that is implied by the joint products of powder and butter, as a basis for analysis of price changes in the cocoa industry. The hypothesis is, that looking at changes of the position of both prices along this line, we better capture the implications of any shifts in demand or supply for beans, liquor, butter or powder. After a graphical analysis of the implications, and an algebraic derivation of the effects that these shifts should have on the prices of powder and butter, we check the realism of this model by looking at the changes in the world market and in the European industry's position in particular. Europe is the major processor of cocoa beans, it is the major exporter of cocoa powder, but is a substantial net importer of cocoa butter.

Some background on cocoa processing: upon processing the beans are roasted and ground, after which some part of the beans is used as paste (liquor), and another part is pressed to obtain cocoa butter and cake which is subsequently processed into cocoa powder. As the fat content of beans is fairly constant, the ratio of butter and powder that can obtained from pressing the beans is given for each type of bean. While most of the beans are used for the three purposes (paste, butter, powder), a considerable portion of beans is processed into paste and butter, with cake a mere residual.

Given the two uses of paste, immediate use or pressing, the returns to pressing should be approximately equal to the return to the alternative use after the grinding process, liquor. The returns to pressing can be derived from the prices of butter and powder and the pressing costs. The demands for the two products of pressing, butter and powder, follow however quite different patterns. As a result, butter prices and cocoa prices can differ widely, in spite of the roughly equal amounts at which they are supplied.

Here we look into the implications of this joint-product status of cocoa powder and butter and we do so in the light of the development in the past 15 years, which shows a particular pattern for the two prices. While for the most of the previous century, powder prices were quite below the prices of beans (the so-called powder ratio was below unity) and – therefore – the butter ratio was high, in the early years of this century powder prices soared. Between 2003 and 2009 they fell, but the powder ratio increased dramatically again in recent years, and had reached a level of 2.14 in December 2011 (based on Dutch export statistics). The butter ratio had dropped by then to a very low level of 1.53. Compared to the average ratios for the 1990s, namely a powder ratio of 0.72 and a butter ratio of 2.47, these changes are remarkable.

## 2. Graphical approach

Figure 1 presents a graphical analysis of how changes in demand for either powder or butter can affect the ratios of both.

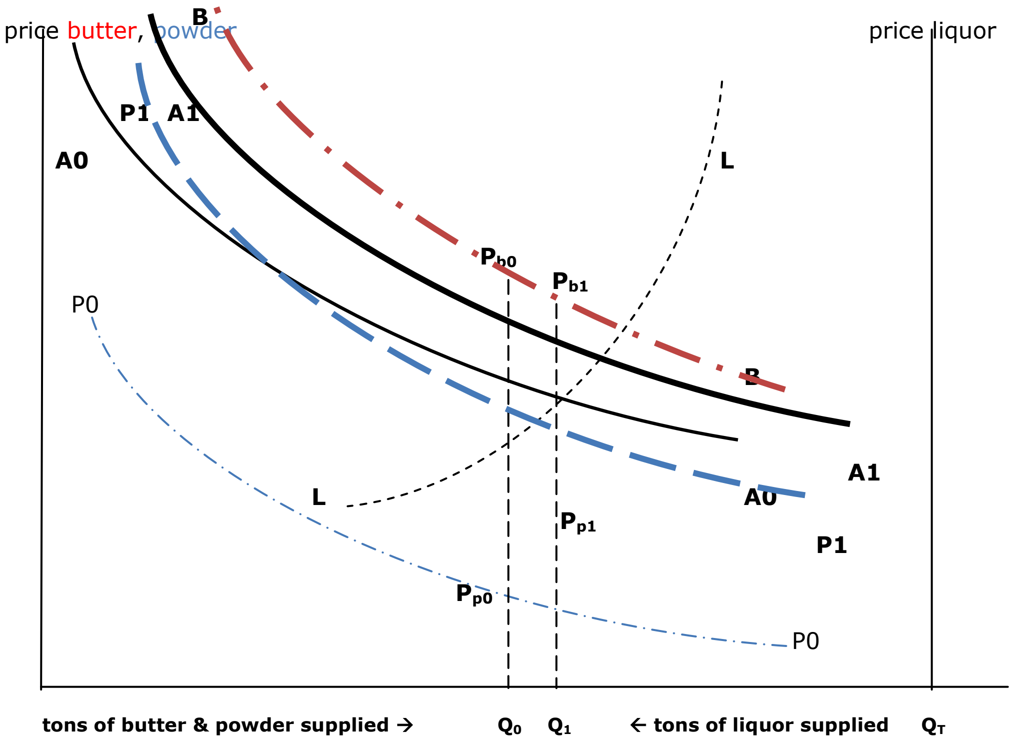



**Figure 1 Equilibrium between powder, butter, liquor, before and after a shift of powder demand from P0-P0 to P1-P1, with average powder-butter demand curve moving from A0-A0 to A1-A1**

For a total quantity of $Q_T$ that is ground, a part of $Q_0$ is pressed, leaving $Q_T - Q_o$ as supply of cocoa liquor. Demand curve for liquor, measured from right to left, is indicated by the line L-L. As both processes should yield the same return (as the same material is used for both), the intersection of the *average* price of butter and powder should be equal to the price of liquor. That is, after allowing for the costs of pressing, which we abstract from here.

Demand curve for cocoa powder (P0-P0) is positioned below that of butter (B-B), as was normally the case. Now suppose the demand for powder increases and the (light dotted) demand curve P0-P0 shifts up to the new level, indicated by the (bold blue) dotted line P1-P1, with the corresponding new average line A1-A1.

This shifts the supply of both cocoa powder and butter up to $Q_1$, with a corresponding increase in the price of cocoa liquor, a fall in the price of cocoa butter (from $P_{b0}$ to $P_{b1}$) and a strong rise in that of powder from $P_{p0}$ to $P_{p1}$. As drawn, the ratio of butter to liquor falls and that of powder to liquor rises.

An even further shift of the demand curve for powder could take the powder demand curve even above that of butter, generating powder ratios that are higher than butter ratios.

The figure also shows that a decrease in total supply of cocoa for grinding, which amounts to a shift leftward of the demand curve for liquor, leads normally to higher prices for butter and powder, and for liquor.

Similarly, a fall in demand for butter would lead to a shift downward of the (red striped/dotted) demand curve, possibly leading to powder ratios that are higher than butter ratios. Shifting the curve downward leads to lower liquor prices, lower butter prices, but higher powder prices.

In a diagram with butter prices on the X-axis and powder prices on the Y-axis, we would therefore expect to see a movement to the North-West (lower butter, but higher powder prices) in this case. Similarly, increasing demand for butter (at a given supply of beans) leads to a movement in this diagram to the South-East.
Increasing demand for powder also leads to similar changes (movement to the NW). An increase in total supply (or a decrease in demand for liquor) typically leads to lower powder and butter prices: a movement to the SW.
Demand for liquor typically depends on chocolate demand, but so (to a large extent) does the demand for butter. Hence *ceteris paribus* an increase in chocolate production entails a shift in the red demand curve for butter plus a shift in the same direction of the demand for liquor. This leads to higher prices for liquor and butter, *and* higher prices for powder, as shown by the intersection of the demand curves at the new equilibrium volumes $Q_1$ in Figure 2.

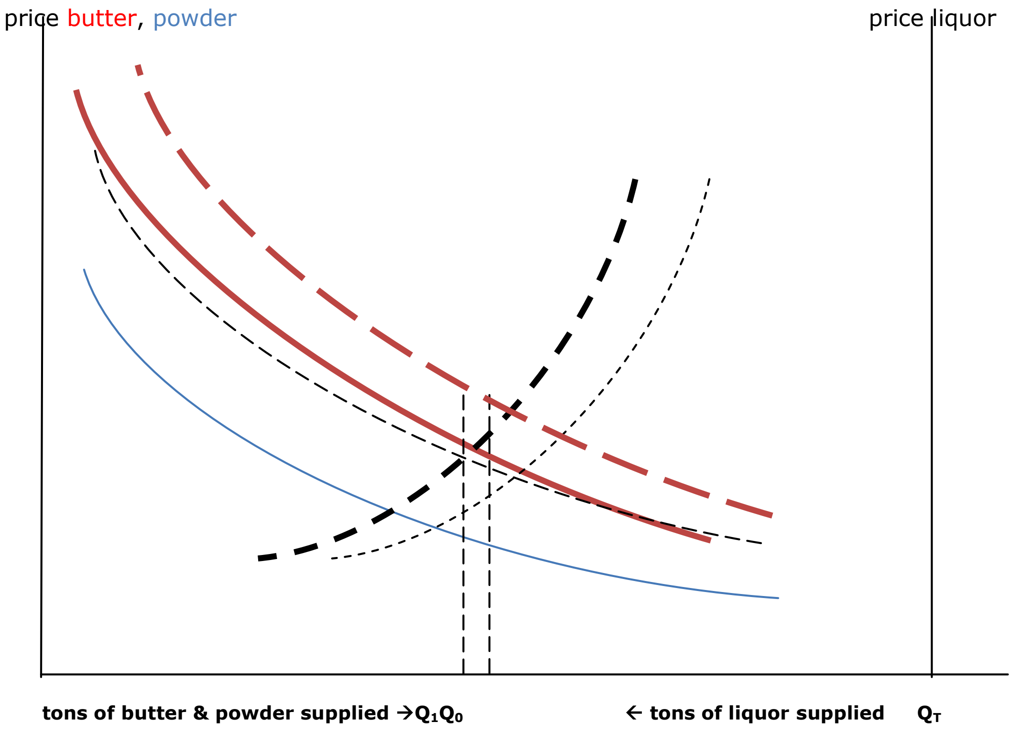



**Figure 2 A rightward shift of butter demand, combined with a leftward shift of liquor demand, leads to a new intersection of the (black, dotted) lines for liquor and for average powder-butter demand, that generates higher prices for all three products.**

### 3. Algebraic model

We can work out these relationships algebraically, following Henk Kox (2000), by distinguishing demand for butter $D_b=b_0-b_1P_b$, demand for cocoa powder $D_c=c_0-c_1P_c$ and demand for liquor $D_k=k_0-k_1P_k$. At a given quantity of cocoa Q, supply of cocoa liquor for pressing is what is left after demand for liquor is met: $Q- k_0-k_1P_k$. This quantity is split into (let's say) two equal quantities of powder and butter.
Demand must equal supply, so we have
for butter: $\frac{1}{2}[Q-(k_0-k_1P_k)] = b_0-b_1P_b$,
for powder: $\frac{1}{2}[Q-(k_0-k_1P_k)] = c_0-c_1P_c$

The system is completed by the equality of returns to pressing and selling the liquor:

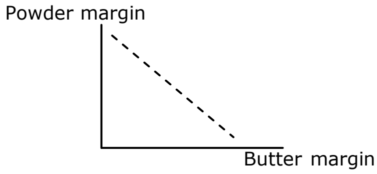
arbitrage: $\frac{1}{2} (P_b + P_c) = P_k + x$,

where x is the cost of processing liquor into powder and butter.

Note that this arbitrage relationship by itself already implies that the powder margin and the butter margin stand in a fixed relation to each other: the formula implies namely that

$$(P_c - P_k) = -(P_b - P_k) + 2x,$$

so that – in a diagram of the two margins – they would form a straight $45^O$ line.




The whole system can be solved for the three prices, yielding these expressions:

$$P_k = [2b_1c_0+2b_0c_1-(Q-k_o)(b_1+c_1)-4b_1c_1x]/N$$
$$P_c = [2c_0-(Q-k_o)-k_1P_k]/(2c_1)$$
$$P_b = [2b_0-(Q-k_o)-k_1P_k]/(2b_1)$$

where

$$N = 4b_1c_1+k_1(b_1+c_1)$$

Using these expressions we can table, how each of the prices would change in response to a shift of the demand curves, and of supply of cocoa:

**Table 1. Effects of demand shifts on butter, powder and liquor prices**

| Shift | Effect on $P_b$ (times N) | Effect on $P_c$ (times N) | Effect on $P_k$ (times N) |
|---|---|---|---|
| $\Delta c_0=1$ | $-k_1$ | $4b_1+k_1$ | $2b_1$ |
| $\Delta b_0=1$ | $4c_1+k_1$ | $-k_1$ | $2c_1$ |
| $\Delta k_0=-1$ or $\Delta Q=1$ | $-2c_1$ | $-2b_1$ | $-(b_1+c_1)$ |
| $\Delta x=1$ | $2c_1k_1$ | $2b_1k_1$ | $-4b_1c_1$ |
| $\Delta b_0=1$ & $\Delta k_0=1$ | $6c_1+k_1$ | $2b_1-k_1$ | $3c_1+b_1$ |

For example, a shift of the demand for cocoa powder by 1 ($\Delta c_0=1$) leads to an increase in powder prices by $(4b_1+k_1)/N$, and a decrease in butter prices by $k_1/N$, while the liquor price increases by the average of these two changes, $2b_1/N$.

If total supply of cocoa increases, all prices go down, but note that the butter margin ($p_b$-$p_k$) changes by $b_1$-$c_1$ and the corresponding powder margin by its reverse, $-b_1+c_1$; if processing costs increase ($\Delta x=1$), butter and powder become more expensive while liquor prices fall.
The last row shows the effect of a simultaneous shift in demand for liquor and butter, as would result from an increase in demand for chocolate. This pushes up prices of these two cocoa products, as well as prices of cocoa powder, depending on whether $2b_1$ exceeds $k_1$, i.e. if butter demand is twice as sensitive to prices as liquor demand.

## 4. Empirics

Armed with these theoretical insights we now look at the changes in butter and powder prices in recent years. Figure 3 shows the changes in monthly export prices of cocoa butter and cocoa powder from and import prices of cocoa beans into the Netherlands.

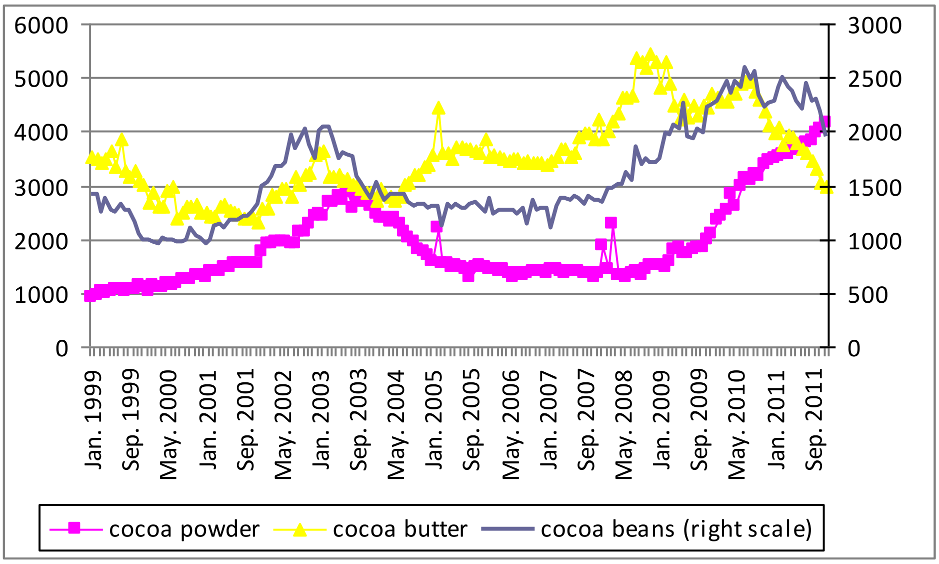



**Figure 3 Prices of beans, butter and powder (Netherlands' trade data, Eurostat) €/ton**

In these 13 years, prices of beans reached historical lows in 2000, then rose to €2/kg in 2003, entered into a slump period until 2008, after which bean prices rose again to unprecedented high levels, and started to dwindle after Mid 2010. Butter and powder prices show strong movements in this period, with contrary changes for these two in the period until 2001, around 2005, and very strongly after mid 2010. In a diagram of butter against powder prices, this looks as in Figure 4, where we set butter prices against powder prices, both diminished by the price of beans in the same month in order to make the prices comparable over time.
The colours, lay-out and lines reflect periods in which the powder prices rose or fell relative to beans. We distinguish:

up1 the first period of rising relative powder prices until Feb 2001
down1 the period until July 2002
up2 the period until December 2003
down2 the long period until February 2009
up3 the period since then

The angles of the lines show a similarity: three lines show the contrary movements of powder and butter: up1, down2 and up3, with angles as represented by the coefficients of a simple regression of the Y against X: -0.67, -0.52 and -1.16. The other two lines reflect movements of powder and butter prices in parallel: down1, followed by up2 with coefficients of 0.37 and 0.84.

The earlier analysis suggests what explains these movements: The angles for the negative relationships should be -1. For we take the change in powder price minus the change in bean price (which represents – assumedly - the change in liquor price): hence, if we look at a change in $c_o$, the numerator has $2b_1+k_1$ and in the denominator $-k_1-2b_1$.
The positive relationships may seem to result from larger supply of beans or lower demand for liquor (these lead to both lower powder and lower butter prices), but in this graph we look at the difference between product prices and bean prices. For lower supply of cocoa beans, the numerator would change by $c_1-b_1$ and the denominator by $b_1-c_1$, so that (again) a negative relationship would result.
The alternative explanation is a change in x, the processing costs: in this case the powder margin changes by $2b_1(k_1+c_1)$ and the butter margin (the denominator) by $2c_1(k_1+b_1)$, which results in a positive slope for the relationship between the two margins..

The movements along these two directions (negative and positive) are now investigated.
The movement along a positive slope first went in the direction of the origin and then back again. Basically, an increase in x increases both product prices, while reducing bean (or liquor) prices, thus increasing the margins: this suggests a change to the North-East. A fall in processing margins reduces both margins, bringing the points in the powder-butter diagram closer to the origin. Then, down1 followed by up2 should correspond to a fall in processing costs followed by an increase. The fall should have been in the period until July 2002 and the rise afterwards until December 2003. This is indeed what the price difference between products and beans shows. But why would the industry not have been able to compensate for the rising beans prices in the initial period between Feb 2001 and July 2002?

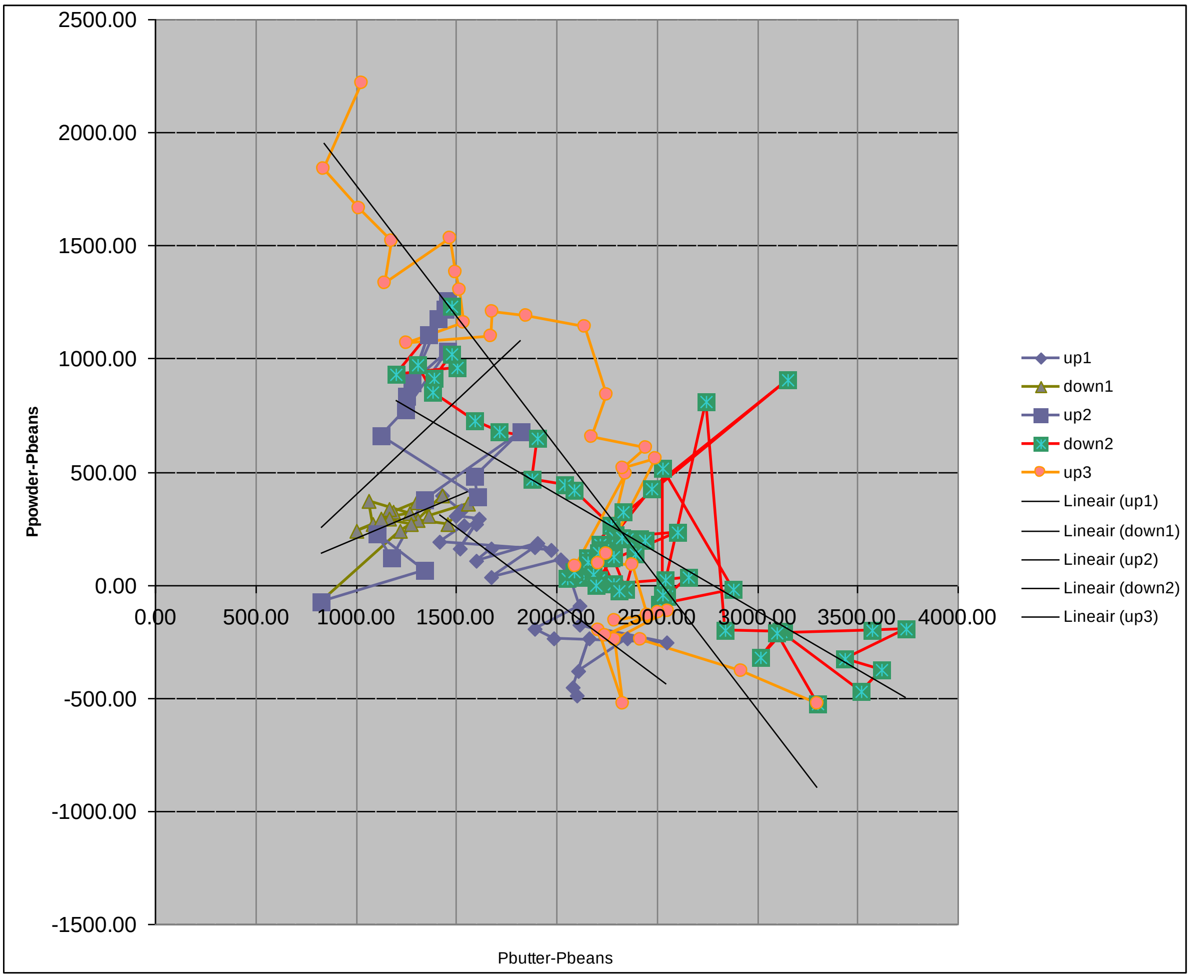



**Figure 4 Dutch powder margins against Butter margins in Euro/ton, monthly prices, 1999-2011**

The more important movement is along the line in a NW-SE direction. This is not just a phenomenon of the recent decade. The figure below is similar to Burger & Smit (2003) and shows the movements of the margins between 1980 and 2009. The prices used here are in SDR terms. In 2002 one SDR was equal to €1.42; in 2012, one SDR equals €0.85. Two differences with the above Figure stand out: One is that the slope of the line in the Dutch case is steeper: at world market prices, a decrease in butter margin of 100 units coincides with an increase in powder margin of around 50. In recent years and Dutch data, such a decrease comes along with an increase in powder margin of almost the same size. One (unlikely) explanation is that in the Netherlands less powder is made from beans than globally. If 100 tons of beans would lead to, say, 33 tons of butter and 67 tons of powder, profitability would be kept constant if a decrease in butter price by 100 would be met by an increase in powder price by 50. A more likely cause can be that the (gross!) powder margin might have been associated with lower costs than in the Dutch case.
The most likely explanation for the lower slope at world market prices is however based on different technologies: let, in addition to the technology in which an equal division between butter and powder is made, another technology be used (such as by an expeller) leading to relatively little powder being

marketed, and let this supply of butter be more sensitive to the butter margin, then we would see that lower butter margins lead to a stronger reduction in butter supply than in that of powder, thus inducing only a small rise in powder prices.
In addition to the difference in slope of the line, the Dutch data reflect an upward shift of the line: powder margins were globally normally negative with powder selling at prices below those of beans. The Dutch line now represents a locus where powder margins are generally positive, while butter margins remained around 2000 (SDR or euro). This movement reflects a change in the processing costs (or profits). Whereas 20 years ago 50 tons of butter and powder generated 1500 SDR as gross butter margin and -400 as gross powder margin resulting in 1100 SDR (or 1550 euro using the 2002 exchange rate) as gross margin overall, the same quantities in the centre of gravity of the above cloud would generate 2000 euro butter margin plus 500 euro powder margin for a total of 2500 euro.

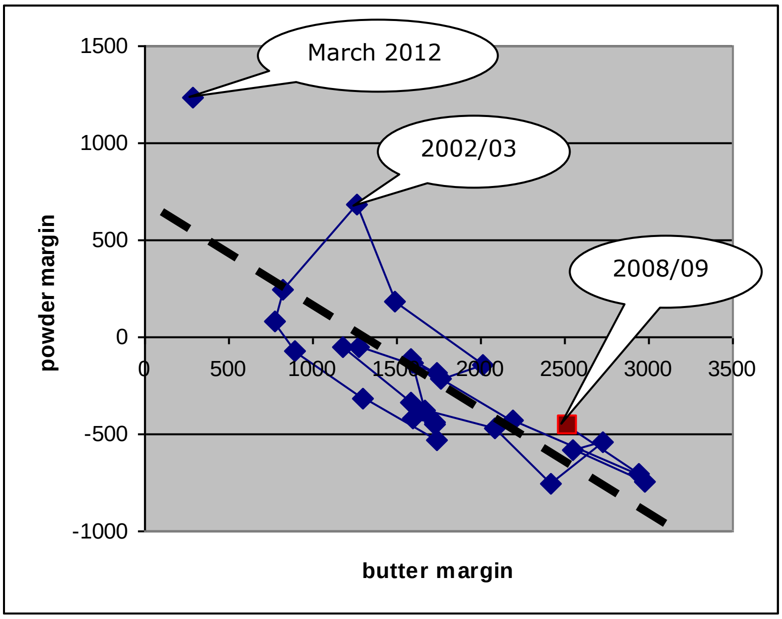
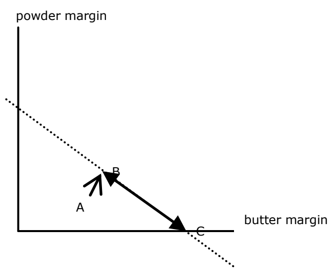



**Figure 5 Powder against butter margins in SDR, 1980 – 2009, and March 2012 (ICCO)**

Thus, margins for Dutch exports are higher, but in a particular way: not by larger butter margins, but only by larger powder margins.

The position on the line is what interests us. This position is captured by the projection of any point in the graph onto the 45 degree line. Of any point A in the powder-margin x butter-margin graph we can make its projection on the 45$^o$ line, yielding point B.
We can then calculate the distance from B to the point of intersection of the line with the horizontal axis, point C. Straightforward arithmetic
leads to the following relationship for this distance, where point A is given by the co-ordinates ($p_b$-$p_k$,$p_c$-$p_k$).




distance from point C = C-$p_b$+$p_c$

Hence, in this relationship the price of paste no longer plays a role. Point C would typically be equal to twice the processing costs X.
As point C is more or less fixed, to explain a position along the 45$^o$ line we should take $p_c$-$p_b$ as the dependent variable.

Given the formulas above we can derive how this difference is influenced by changes in the shifters of the demand functions (b0, c0, k0, and the supply conditions Q). We can derive the following expressions:

| Table 2. Effects of demand shifts on $P_c$-$P_b$. | |
|---|---|
| Shift | Effect on $P_c$-$P_b$ (times N) |
| $\Delta c_0=1$ | $4b_1$ |
| $\Delta b_0=1$ | $-4c_1$ |
| $\Delta k_0=-1$ or $\Delta Q=1$ | $-2(b_1-c_1)$ |

Let powder demand be influenced by income with a coefficient of $c_2$ and let butter demand be influenced with a coefficient of $b_2$, both typically positive. The effect of a unit change in income on the demand shifters of powder and butter (so on $\Delta c_0$ and $\Delta b_0$) would then be $c_2$ and $b_2$, so that $P_c$-$P_b$ would change by $4b_1c_2$-$4c_1b_2$. This sign of this effect is unclear. If butter is more sensitive to its own price than powder (so, $b_1>c_1$), and powder more sensitive to income than butter (so $b_2<c_2$), then the effect of an income change is clearly positive. Under these conditions, the effect of a supply change on the distance would be negative: the higher the supply, the more the position on the line would shift to the South-East.

A complicating factor is that, while for Dutch exports the line seems to follow the 45° line, this is not the case for world prices and world margins, as Figure 5 shows. The slope of the line is less steep. It is approximately -½. We elaborated on the possible reasons for this above.
In this case, the distance to a certain point on the horizontal axis is proportional to C - $p_b$+½ ($p_c$+$p_k$).
We shall employ both dependent variables in the subsequent analysis.

Figure 6 shows a graph of $P_c$-$P_b$ over time, in this case in US$/ton.

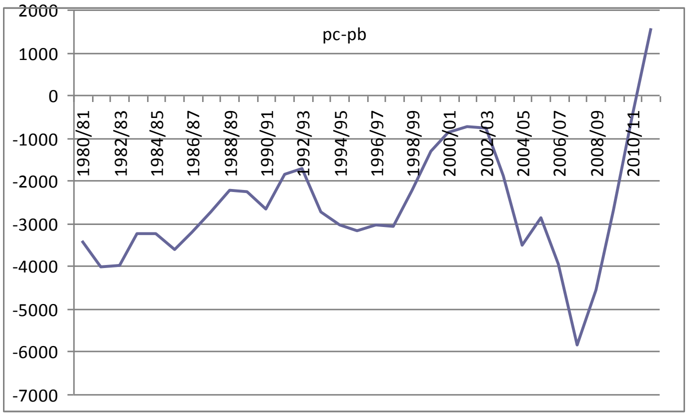



**Figure 6 Difference between powder and butter prices, 1980/81 – 2011/12, US$/ton; source ICCO**

An expression for ½ ($p_c$+$p_k$) - $p_b$ looks almost the same, apart from its final value for 2011/12 which would be -1100.

## 5. Explaining movements along the line

Taking $P_c$-$P_b$ as the dependent variable (converted into real values, using advanced economies' GDP-deflator, source IMF) and relating it to real world GDP (IMF), and supply indicators, such as this year's production and last year's ending stocks (source ICCO), leads to :

| Table 3. Regression results for $P_c$-$P_b$ | | | |
|---|---|---|---|
| *Dependent var=Pc-Pb in real terms* | *Coefficient* | *Standard Error* | *T-value* |
| Intercept | -11493 | 1456.47 | -7.9 |
| Real world GDP | -0.207 | 0.061 | -3.4 |
| Cocoa Supply | 4.181 | 0.870 | 4.8 |
| Stock/Grindings ratio(t-1) | 63.983 | 21.313 | 3.0 |

$R^2$=0.61; N=29 (1981/82-2008/09)

Using this regression outcome, and predicting the values for 2009-2011 yields unsatisfactory results in that the actual values are missed by $1400 and more. Figure 7 shows the results.

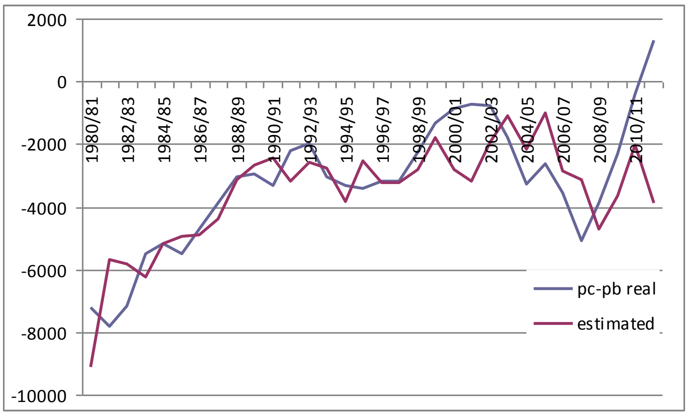



**Figure 7: Regression results for real Pc-Pb**

The estimated coefficients suggest a positive impact of supply conditions on a change toward higher powder prices, and a negative influence of income variables. The positive effect of supply suggests that $b_1<c_1$ (butter less sensitive to price than powder); if this is indeed the case, then $c_2$ must be greater than $b_2$ to enable the income effect to be positive. Powder demand would then be much more sensitive to income changes than butter demand.

We can compare this with Kox's estimates for the years 1975-1996. He finds a price elasticity for powder (for the USA) equal to -0.30 and an income elasticity of +0.42. Results for other countries were not very different. Elasticities for butter demand are not reported by him, but some insights can be gained from estimates by Burger and Smit (2000a) who estimate that US chocolate demand responds to GDP changes with an elasticity of 0.51, and that US (total implied) cocoa demand responds to chocolate demand changes with an elasticity of 0.9 (Burger and Smit, 2000b). This suggests that total cocoa demand has an income elasticity of 0.45, and that, therefore, butter demand elasticity should not differ much from the powder demand elasticity. For major EU countries, they find lower income elasticities for chocolate demand (0.14 for France, 0.19 for Germany, 0.18 for the UK), and also lower elasticities for cocoa demand in relation to chocolate demand (0.6 for France, 0.35 for Germany and 0.19 for the UK). This suggests that total cocoa demand is little responsive to income change, yet Henk Kox reports sizeable income elasticities for cocoa powder in these countries (0.53, 0.28 and 0.44 respectively). From this, one may conclude that demand for butter plus liquor is less sensitive to income than demand for powder. Although not certain, this may then also hold for the income elasticity of butter demand itself.

As to price effects, Burger and Smit report price elasticities of (total implied) cocoa demand in France, Germany and the UK, conditional on chocolate demand, equal to -0.24, -0.25, -0.10. Chocolate demand itself is responsive to prices to the same extent, approximately. Kox gives price elasticities of powder demand equal to -0.20, -0.03 and -0.27 for the three countries, respectively. If anything can be derived from this, it might be that butter demand elasticities are in the same order of size. As butter prices are normally much higher than powder prices, a similar elasticity implies a much smaller coefficient in a linear equation of butter demand. This could confirm that $b_1<c_1$ in our model.

*Focus on the EU*

In the simple approach taken above, we looked at global effects of GDP and supply on the prices of cocoa powder and butter. This approach fails to take into account that the production of powder and butter is regionally differentiated. Europe, and the Netherlands in particular, is a main exporter of cocoa powder, while cocoa butter is produced and exported in many cocoa producing countries. The joint production of butter and powder is also more relevant for the EU, than for many other countries, that produce cocoa butter but have only low value cocoa cake as by-product.

The powder price that we try to explain is typically a price pertaining to the European export product. This implies that production conditions in the EU, and the export demand facing the EU could play a role in explaining changes in the powder-butter price gap.

As a theoretical exercise, consider a drop in EU cocoa processing leading to less powder, liquor and butter being supplied. Whereas the quantitative reduction in butter supply equals the reduction in powder supply, the relative effect on the powder market will be larger than the effect on the cocoa butter market.
Table 4 shows the production and trade of the EU-27 in 2011.

| **Table 4. Trade and production of cocoa and products EU, 2011** | | | | |
|---|---|---|---|---|
| | Imports | Production | Exports | Intra trade |
| Beans | 1563 | | 4 | 311 |
| Grindings (source ECA) | | 1438 | | |
| Paste (liquor) | 253 | 376 | 91 | 215 |
| Powder | 50 | *600** | 184 | 218 |
| Butter | 175 | 472 | 64 | 285 |

*estimated; Eurostat data; in 1000 tons; imports and exports are extra-EU-27;
Intra-trade is the average of total exports and imports within EU-27

Changes in grindings in the EU would affect the export market for powder, and to a lesser extent, the import markets for beans, liquor and butter. Total world imports for each of the cocoa products are in the order of 640 thousand tons, including the intra-trade within the EU. Similarly, changes in demand for specifically the EU cocoa products would have effects that work out differently for powder than for butter or liquor. Given its importance in the world market, reduced grindings in the EU would affect world supply of cocoa powder and world demand of paste and butter. It would typically push up powder prices, and lower prices of butter and paste. Hence it is a possible candidate for explaining the rise in powder prices relative to butter.

Grindings in the EU and the world are shown in Table 5

| **Table 5. Cocoa grindings in Western Europe, world and apparent in EU-27** | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | 2003 | 2004 | 2005 | 2006 | 2007 | 2008 | 2009 | 2010 | 2011 |
| grindings ECA | 1129 | 1153 | 1220 | 1301 | 1362 | 1381 | 1303 | 1343 | 1438 |
| grindings world | 3078 | 3238 | 3363 | 3522 | 3675 | 3775 | 3531 | 3731 | 3923 |
| *ECA in % of world* | *37* | *36* | *36* | *37* | *37* | *37* | *37* | *36* | *37* |
| cocoa products EU-27 | 976 | 1001 | 933 | 1017 | 1233 | 1434 | 1307 | 1230 | 1449 |
| Grindings EU-27 | 1195 | 1227 | 1255 | 1328 | 1390 | 1409 | 1318 | 1379 | *1478* |

European Cocoa Association (ECA) grindings actually cover EU-15 plus Switzerland. Their share of the world hardly changed in these years. Production in 2009 was clearly less than in surrounding years. This is also borne out by production data for the EU-27: these data are not quite reliable where powder production is concerned. But production of paste, powder plus butter show an increase in 2007 and 2008 followed by a decline in 2009 and 2010 and a strong, but only estimated increase in 2011. While powder production data are only estimated, production of paste and butter showed very little change from 2010 to 2011.

The effect of EU and its trade is reinforced by increased exports from the EU-27 to neighbouring countries, in particular to Ukraine and Russia. Exports of paste, butter and powder to these two countries increased enormously as shown in Figure 8.

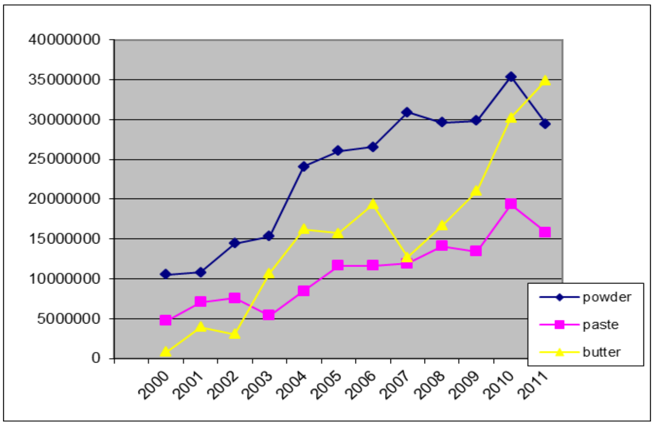


**Figure 8. Exports (in kg) from EU-27 to Russia and Ukraine.**

Apart from these two countries, Turkey spectacularly increased its imports from the EU-27. Over the ten year period, cocoa powder exports to Turkey increased by 10 thousand tons, and exports of butter by 6 thousand tons. Overall, exports of powder by the EU-27 increased: from 2000 to 2010 powder exports grew from 148 to an exceptional 253 thousand tons (exceptional because of US demand), and were followed by 187 thousand tons in 2011.

These data suggest that EU production of cocoa products originally kept pace with the increased demand over the period 2005 to 2008, but did not keep up with (export) demand in later years.
Reason for this is likely to be the downturn in economic growth in 2008 caused by the financial crisis, but the high cocoa prices were another factor: in 2008 and 2009 the rising cocoa prices were not met by higher prices for paste or powder, resulting in lower returns to cocoa processing.

While the story appears plausible, statistical evidence does not confirm the strong relationship. Regressions including EU-27 grindings had to be limited to years since 1990 (for lack of consistent data, and relevance of the EU-27 in early years), and for this era no firm relationship that could explain $P_c$-$P_b$, and thereby the position on the line, could be derived.

## 6. Conclusions

We have derived a case for a straight line linking prices of cocoa powder, butter and cocoa paste (liquor). The empirical evidence to support the straight line is clear. The Dutch export data tend to show a price line that complies more with the simple 50-50 division of paste over powder and butter, than the world price data as released by ICCO.
While we could convert the data on powder and butter prices in a way that does justice to the existence of the price line, this did not help in establishing a clear case for the causes of the recent unprecedented swings in the relative powder/butter prices. The position of the European industry could be key to these changes, given its importance for the powder supply. Further work may establish this case.

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