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Cost Pass-Through in the Swedish Chocolate Industry

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Abstract

There are many factors - such as manufacturing costs, margins and market demand - that play a part in setting the consumer price of chocolate. Manufacturing costs and margins are however the base for the price setting. The most important commodity in chocolate production is cocoa. Data sets of different chocolate prices were used to determine the impact of changes in commodity costs on the retail prices of chocolate. Due to unavailable data, variables had to be left out and the regressions failed to give a reliable answer to the problem. It could however be seen that cocoa cost pass-through was small and there was no evidence of a quicker response in chocolate prices to increases than to decreases in costs. The main conclusion of the study is that the cost pass-through of cocoa is rather small.

Keywords: cost pass-through, retail prices, commodity costs, chocolate, cocoa.

We would like to offer our sincere gratitude to our tutor, Richard Friberg, for his availability and good advice throughout the processing of our Bachelor's Thesis.

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1. Introduction

The chocolate consumption has increased over the last decade and more cocoa intense chocolate has grown in popularity. Chocolate is a refined product sprung from cocoa. Chocolate can contain from 30 percent cocoa up to 99 percent. The consumer price is set by manufacturing costs, margins and demand for chocolate. It is interesting to see how sensitive this price is to change in commodity costs.

1.1 History

The cocoa plant originated millions of years ago, around the Andes in South America but it was only in 1528 that Hernan Cortés, famous for the fall of Aztec Empire, introduced the Aztec recipe for chocolate drink in Europe. The drink became an exclusive yet popular drink in the Spanish court. Chocolate remained a handmade luxury consumed only by the upper class for centuries (ICCO 2009).

It was not until the nineteenth century, that the industrial revolution made it possible to produce solid chocolate bars through inventions such as the cocoa press. Mass production was also a way of producing chocolate in a quick and cheap way, spreading the possibility of consumption to a larger audience. The explosion in demand which was created thus required more cocoa to be cultivated, leading to the introduction of cocoa to several African countries situated close to the equator (ICCO 2009).

Today, cocoa has reached an incredible popularity worldwide and not only under the form of a classical chocolate bar. Chocolate can now be bought under many different appearances and with countless tastes, filled with everything from caramel to cognac. A new market for chocolate with single-origin cocoa has evolved in the industrialized countries. This growing demand and new market has put a lot of quantitative and qualitative pressure on cocoa producers. How does this affect the prices of cocoa and thus of chocolate?

1.2 Purpose

The aim of this report is to estimate how changes in commodity costs affect Swedish chocolate prices. The paper more specifically examines what effects price fluctuations in cocoa have had on this progression and whether the cost pass-through is different for different chocolate segments.

The impact of commodity costs on a refined good like chocolate can be of interest as it can help companies set pricing strategies in both the short run and the long run. The study can contribute the Swedish central bank, *Riksbanken*, with information on how often they need to check on commodity prices in order to foresee coming inflation.

1.3 Theoretical Framework and Previous Studies

1.3.1 Previous Studies

No previous study on the chocolate or cocoa industry was found. From previous studies conducted on the U.S. coffee industry, it has been demonstrated that changes in costs pass through into manufacturer and retail prices. It was found that both manufacturer and retail prices adjust approximately one-for-one in levels with changes in commodity prices in the long run. The study believed that the pricing pattern for the U.S coffee industry could be applicable to similar manufacturer and retail markets as changing prices or costs move along through a vertically organized production process (Leibtag et al. 2007). We know that the chocolate industry has a similar production process to the coffee industry and could therefore conclude that its prices follow a comparable outline to the latter.

In 2006/2007, world production of cocoa beans experienced a severe drop from the previous season, mostly due to unfavorable weather conditions in many cocoa-producing areas. West Africa, for example, was hit by dry weather and sandstorms coming from the Sahara desert, causing crops to dry out. In Asia and in South America, the cocoa production was slowed down due to El Niño-related weather conditions. At the same time, cocoa consumption, as measured by grindings, experienced increased demand over the five previous years, suggesting an important world cocoa production deficit. This deficit is known to have been the main cause for an increase in average international cocoa prices during this period (ICCO 2008). An increase in cocoa prices should thus, according to previous studies on the coffee industry, lead to an increase in chocolate manufacturing and retailer prices.

1.3.2 Theoretical Framework

A basic economic assumption consists in supposing that all firms want to maximize their profits. However, we know that the chocolate industry, in general, has high margins. Profits are maximized according to the formula: $p = (\frac{n}{n-1}) \times mc$. An increase in the marginal cost should lead to an increase in price under ceteris paribus conditions. However the margins can be adjusted which leads to changes in price. Margins can be adjusted to meet demand in order to maximize profits according to the actual market situation (Perloff 2007, pp. 354-356).

This information is not sufficient in order to conclude that changes in cocoa commodity costs affect Swedish chocolate prices. We additionally need to perform a regression of Swedish chocolate prices on different commodity costs in order to prove that a similar relationship exists for the chocolate industry as well.

1.4 Issue

What impact do changes in cocoa costs have on retail chocolate prices? How does this impact differ between different segments of the chocolate industry?

1.5 Delimitations

We have chosen to delimit our study to the Swedish market as the retail market is nationally divided. As there are many different smaller brands competing on the market in Sweden, we have

chosen to focus our study on two of the market leading brands in the country: Marabou and Lindt. Together, they stand for more than 50 percent of the total market and offer both "classical" chocolate such as milk chocolate or flavored chocolate and "more exclusive" chocolate like single-origin or high cocoa content chocolate. The time period has been delimited into yearly quarters and covers the period from January 2005 to December 2008. This period was chosen as it offers a set of more complete data.

We have chosen to concentrate our studies on the cost pass-through of cocoa prices and will, thus, not go into further discussion of any other commodities nor factor that could influence chocolate prices in Sweden. Some of these factors will although be included in the models we are testing for and this with the sole goal of creating a more complete model that properly reflects the impact of cocoa on Swedish chocolate prices.

2. Data and Methodology

2.1 Collection of Data

Data from the Swedish chocolate industry was used. It was mainly supplied by the market research company, **Gfk**, who provided us with data on sales for the different products from two of the bigger chocolate brands in Sweden: Marabou and Lindt. The company collects data from different consumers and stores in different geographical and socioeconomic areas in Sweden. Sales and promotions are included in the data collection. The data was supplied in Excel-format and presents, in a first tab, the market share that each product has on the total market for chocolate bars in Sweden. A second tab shows the average retail prices, in Swedish Krona (SEK) per kilogram (kg), for each brand and for each of their products. The data is given in yearly quarters and stretches from the first quarter of 2005 to the last quarter of 2008.

We used the database system **Datastream** in order to obtain data sets on cocoa and sugar prices. The data set on cocoa prices was created through a compilation of daily cocoa prices provided by ICCO (the International Cocoa organization). The figures were in SEK per tonne. The data set on sugar prices was created through a compilation of daily sugar prices provided by ISO (the International Sugar Organization). The figures were given in SEK per pound. Both the sugar and the cocoa prices were presented under the form of yearly quarters during the period of 2005 to 2008.

SCB, Statistics Sweden, provided us with monthly data on the inflation rate through the consumer price index (CPI) from 1990 up to January 2009. They also supplied us with data on total household consumption in Sweden during the period of 2005 to 2008. The data is divided into yearly quarters and the numbers are given in millions of Swedish Krona (MSEK).

2.2 Organization of Data

Through the CPI we were able to obtain the inflation rate, which hence made it possible for us to adjust all the prices and numbers to inflation. The adjustment was made in order to make comparison across time and between numbers possible.

We reorganized the data given to us by Gfk, on Marabou and Lindt chocolates, in Excel into four different segments: milk chocolate, flavored chocolate, chocolate with a high cocoa content and chocolate with single-origin cocoa. This reorganization was made in order to estimate if the cost pass-through is different for the different segments. It also enabled comparisons with the total average prices and made it easier to transpose into the statistical software STATA (Intercooled STATA 9) which was used in order to test the data.

The available data set is recognized as a panel data set, since it has both a cross-sectional- the data was collected across stores- and a time series dimension as it stretches from 2005 to 2008. The same groups of interest are followed across time. The observations cannot be assumed to be independently distributed across time; unobserved factors that affect the outcome in one time period will continue to affect the outcome in the next period as well. A panel data model can be written as:

$y_{it} = \beta_0 + \delta_0 d2_t + \beta_1 x_{it1} + \ldots + \beta_k x_{itk} + \alpha_i + u_{it}$, $t = 1, 2, \ldots, n$, i = cross-sectional unit

When it is suspected that the unobserved factor α_i, which remains constant over time, is correlated with the explanatory variables, it is easy to difference the error away. We then obtain the equation:

$\Delta y_{it} = \delta_0 + \beta_1 \Delta x_{i1} + \ldots + \beta_k \Delta x_{ik} + \Delta u_{it}$, u = time varying error term

$\Delta y_{it} = y_{it} - y_{it-1}$

To apply the usual OLS statistics, three key assumptions have to be satisfied:

- Δu_{it} must be uncorrelated with Δx_{ik}
- Δx_{ik} must have some variation across i
- The Homoskedasticity assumption (Wooldridge 2006, p. 444-462).

2.3 Choice of Variables

From economic thinking, factors that affect the outcome have been identified. A trade-off between high variance and the risk of omitted variable bias has to be made. Bearing in mind that the available data has few observations, it is preferred to keep the number of independent variables low in order to obtain significant answers. What factors influence the chocolate price?

Margins: there is no reliable data on margins since the data for this is unspecific and unavailable. Therefore, margins cannot be included as a factor in the regression.

Manufacturing costs consist of ingredients, transport, packaging, machine maintenance and labor. As we strive to find the relationship between cocoa prices and chocolate prices, the focus of manufacturing costs will be on the ingredients. The head ingredients are cocoa and sugar and they are common for all sorts of chocolate. Lags of cocoa allow the model to show if past changes in cocoa price have any effect on today's chocolate price. A one period lag together with the current price change covers a six months period, which allows for slow reactions to changes in cost.

Societal economic development may also affect the price of chocolate. The disposable income of households will influence the demand. Increased demand leads to a raise in prices. GDP can illustrate general market growth and decline, something that may affect the price of goods. A variable that relates to both of the above mentioned is household consumption. Consumption is strongly correlated with GDP as Production = Private Consumption + Government Purchase + Investments + Trade Balance. Consumption also shows how much households spend, illustrating the change in consumption ability and customer demand (Mankiw 2007, p. 118).

The regression model will include the following variables:

y_{it} = chocolate price
x_{it1} = cocoa price
x_{it2} = one period lag of cocoa price
x_{it3} = sugar price
x_{it4} = household consumption in Sweden

The relationship of interest is the one between cocoa and chocolate. Other variables are included in order to give the estimated coefficients more correct values.

2.4 Choice of Model

Two models will be used:

Model I shows the change in the logarithm for each variable, illustrating the percentage impact of the independent variables on the dependent variable.

$$\Delta\log(y_{it}) = \delta_0 + \beta_1\Delta\log(x_{i1}) + \ldots + \beta_k\Delta\log(x_{ik}) + \Delta u_{it}$$

$$\Delta\log(y_{it}) = \log(y_{it}/\ y_{it-1})$$

A second version of this model includes a time variable in order to investigate the possibility of trending. Economic time series often grow over time and it is possible that some series contain a time trend. Ignoring the possibility that two sequences are trending in the same or opposite way may lead to false conclusions about the relationship between them. Having a time trend in the model recognizes that the dependent variable may be growing or declining for reasons not connected to the independent variables (Wooldridge 2008, p. 360-365).

Model II: $\Delta\log(y_{it}) = \delta_0 + \beta_1\Delta\log(x_{i1}) + \ldots + \beta_k\Delta\log(x_{ik}) + t + \Delta u_{it}$

The inflation has been corrected for – all variables are measured in real prices and equal units hence in SEK or SEK/kg.

The estimated coefficients of the cocoa variables indicate the fraction of the change in commodity costs at a certain time that is reflected in current price changes. The sum of the coefficients shows the long run response of prices to costs (Goldberg & Campa 2004 through Leibtag et al. 2007).

2.5 Validity of the Models

Several tests are conducted in order to investigate the suitability of the models.

A multiple regression model that does not have the true relationship between dependent and independent variables is said to suffer from functional form misspecification. **RESET** (Ramsey's regression specification error test) detects general forms of functional form misspecification but "has no power for detecting omitted variables whenever they have expectations that are linear in the included independent variables in the model" (Wooldridge 2006, pp. 300-305).

The residuals should be independent, normally distributed and preferably small and evenly spread over time. A cyclic behavior may indicate autocorrelation and growing residuals may indicate heteroskedasticity. The appearance of the residuals tells how well the regression estimation fits and how trustworthy it is (Wooldridge 2006, pp. 209-210).

R^2 estimates the amount of variation in the dependent variable which is explained by the independent variables. A small R^2 indicates that some factors affecting the dependent variable have not been accounted for. A small R^2 is however not a big problem in this case as the interest lies in the relationship between cocoa and chocolate prices (Wooldridge 2006 pp. 80-83).

All types of chocolate selected for investigation are in turn regressed on the independent variables. The above mentioned tests are conducted in order to evaluate the models, where after the results are evaluated.

3. The Market for Chocolate

3.1 The Cocoa Value Chain

Cocoa trees prosper only in tropical environments, that is to say where the climate is hot and humid. Cocoa is mainly grown in countries that are situated within a 10 degree radium both South and North from the Equator. Around 70 percent of the world's cocoa production originates from the western coast of Africa. The largest producing countries are the Ivory Coast, Ghana and Indonesia. Smaller amounts are also produced in Central and South America, in countries such as Brazil, Ecuador and Venezuela. Three different varieties of cocoa trees exist: Criollo, Forastero and Trinitario. The Criollo and Trinitario beans are considered "fine and flavored" whereas the Forastero bean is regarded as "bulk or ordinary". The Forastero bean represents around 70-80 percent of total world cocoa production (ICCO 2009).

Swedish companies do not buy directly from cultivators but from subcontractors or processors. Kraft Foods, for example, solely purchases processed cocoa products such as cocoa substance, cocoa butter and cocoa powder. The products are manufactured either by a sister company in the corporate group or by external processors (Söderberg 2009).

The producer price is determined in advance of the harvest season and a number of quality controls are performed in order for the cocoa beans to be accepted for processing and to secure a certain price premium. The organization of the cocoa marketing channels in the different producing countries is tailored to the particular context of each country; however beans are usually not bought directly from the local farmers. One scenario consists in small local trading companies buying beans from the different farmers. They then trade the beans to wholesalers who in their turn re-sell them to exporters. Other scenarios consist in the cocoa beans being sold directly to exporters by farmers' cooperatives or exported directly by these cooperatives. During any of these transactions, the beans from the farmers go through buying posts where they are accepted only after examination of their levels of dryness, smell, color, infestation and size consistency. The beans are, at later stages, transported to ports from where they are shipped off overseas. Quality controls are also usually realized on arrival at ports and again before shipment (Fold 2002).

Grinding does not usually take place in the producing countries but rather in bigger seaports in the western states. An example is the Zanstreek-Amsterdam area in the Netherlands that comprises some of the more important grinding companies and holds a significant role in the global chain, "both in quantitative and qualitative terms" (Fold 2002).

Cocoa beans are exclusively traded on the London International Financial Futures exchange (LIFFE) and on the Intercontinental exchange (ICE) in New York (formerly known as NYBOT, the New York Board of Trade). The ICE futures U.S Cocoa contract functions as a benchmark for world cocoa prices. The futures contracts are used to counteract for the risk of adverse price movements. They function as an assurance for the delivery of a specific quantity and quality of cocoa beans at a predetermined place and time in the future. Cocoa commodity prices are highly volatile due to

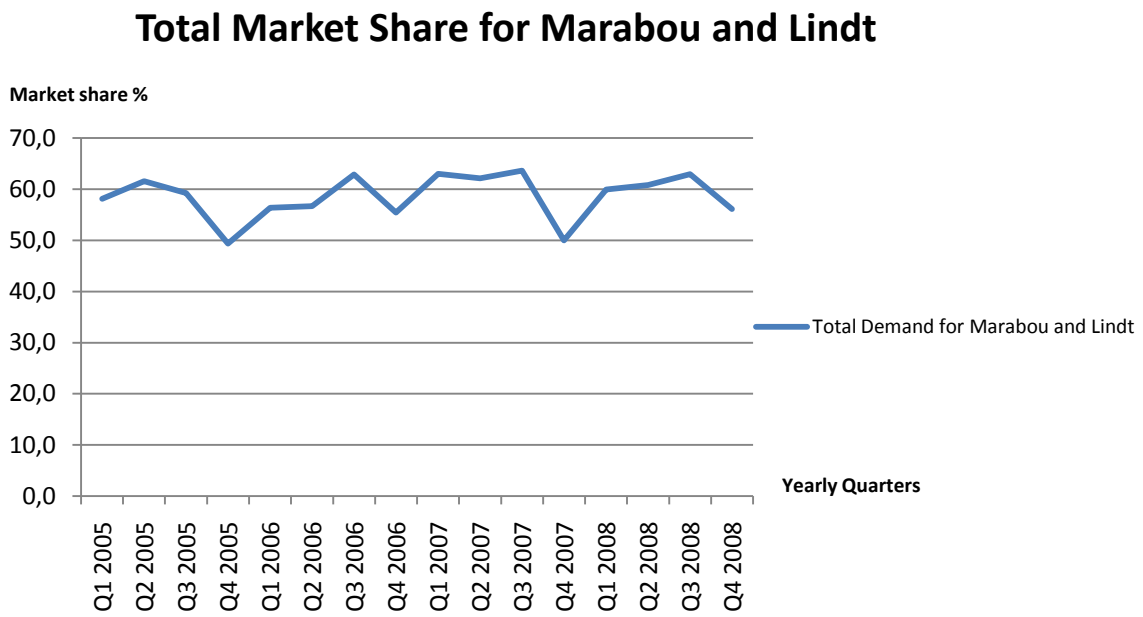
cocoa's seasonal demand cycles and concentrated production sources (very few countries serve the global demand for cocoa) (ICE 2009).

The major companies in the Swedish chocolate market include big food companies such as Kraft Foods, Nestlé, Cloetta Fazer and Lindt. Kraft Foods is market leader in the chocolate industry in Sweden and represents brands like Marabou, Toblerone and Daim (Kraft Foods 2009). Some of Nestlé's biggest brands are After Eight, Kit Kat and Smarties. Cloetta Fazer detains around 24 percent of the Swedish market with brands such as Kex Choklad, Center, Plopp, etc. (Cloetta Fazer 2007).

3.2 The Chocolate Market Development from 2005 to 2008

We have chosen to focus our study on two of the bigger brands, **Marabou** and **Lindt**, which encompass a large part of the Swedish chocolate supply. *Figure 1* presents a graph of the two brands' joint market share from January 2005 to December 2008. The market share is here defined as the number of percentages of total sales of chocolate bars that each brand stands for.

Figure 1: Total Market Share for Marabou and Lindt

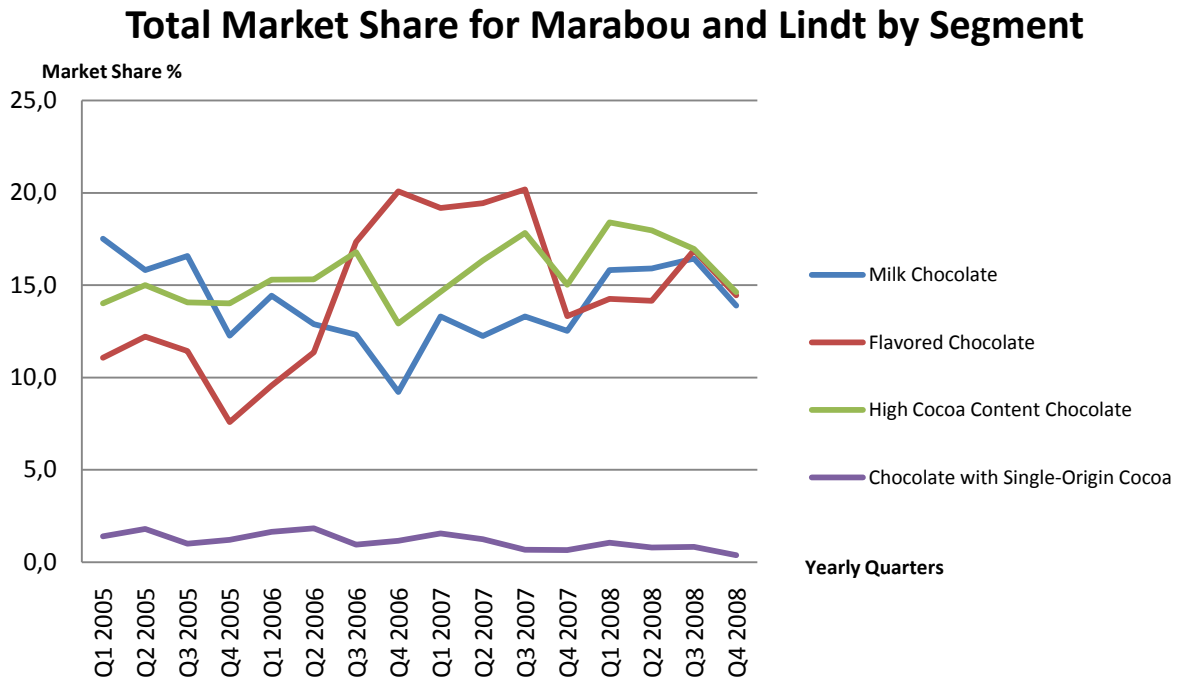


Source: Gfk (2009a)

We can observe that Marabou and Lindt together account for more than 50 percent of the Swedish chocolate market. The total market share has been more or less constant over the 4 years the data accounts for, lying in an interval between 50 percent and 65 percent. A common trend which can be distinguished is that the lower shares are experienced during the fourth and last quarter of each year. We can explain these lows with the fact that our data only comprises chocolate bars: during these celebration times, one is more likely to buy seasonal chocolates such as pralines or special

"Christmas-chocolates" than the classical chocolate bars. By looking at *figure 2*, we are able to get a more detailed explanation of the market share by segment.

Figure 2: Total Market Share for Marabou and Lindt by segment



Source: Gfk (2009a)

We can observe that flavored chocolate has undergone a distinguished increase between October 2005 and September 2007. The increase can be explained by the introduction of the Marabou Daim/ Mjölkchoklad bar, on the Swedish market, during the third quarter of 2006 (Gfk 2009). The Marabou Daim bar experienced great popularity when first launched, inducing a great boost in Marabous sales before declining in order to stabilize at a share similar to the other bars in the segment.

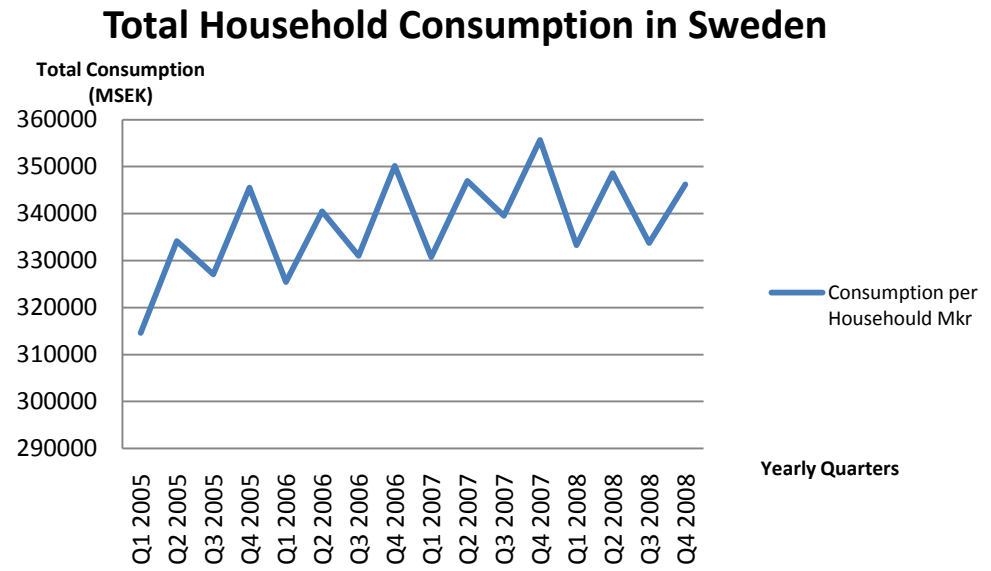
The demand for milk chocolate started decreasing in the beginning of the period until reaching an especially low dip in the last quarter of 2006. It has then started rising again, attaining the same levels as before the low. Chocolate with a high cocoa content has fluctuated up and down around 15 percent, experiencing the same low dip in the last quarter of 2006. It has from then on kept over 15 percent with falls every last quarters. At the end of 2008 the market shares for milk chocolate, flavored chocolate and chocolate with a high content of cocoa developed to the approximate same levels (cf. *figure 2*). On the other hand, we can observe that chocolate differentiated by origin has a very low percentage of the market share, below 2 percent. Our data in this segment comprises four different types of Lindt chocolates, one originated from Cuba, a second from Madagascar, a third

from Ecuador and the last one from Ghana (Gfk 2009). We only have data from the second quarter of 2006 and onwards, suggesting that this category was launched in Sweden during that period.

3.3 The Development of the Chosen Variables from 2005 to 2008

During the period of 2005 to 2008, we can observe strong yearly variations in the **total consumption of Swedish Households**. We can suppose that the peaks are due to tax refund periods (Q2) and Christmas (Q4), and the lows to taxpaying periods (Q3) and recovery periods after the December festivities (Q1). If we disregard from these quarterly variations, we can say that consumption experienced a light increase between 2005 and 2007 but seems to have recessed during the outburst of the financial crisis in 2008 (cf. *figure 3*).

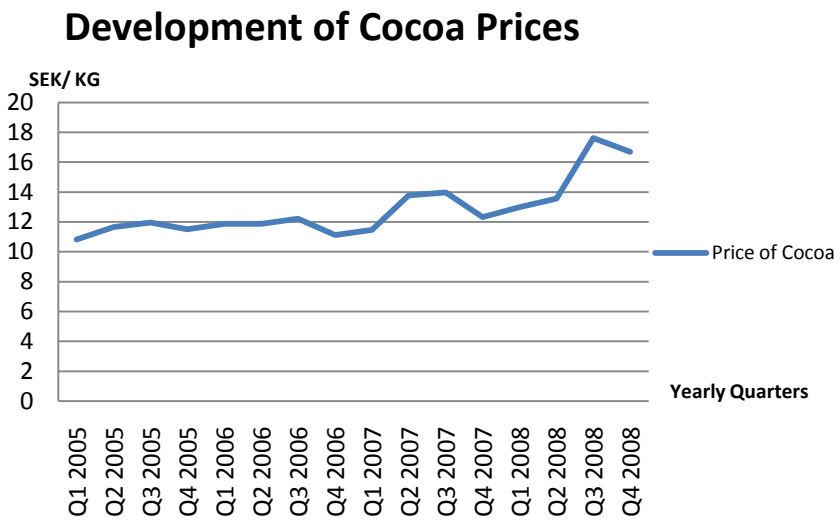
Figure 3: Total Household Consumption in Sweden



Source: SCB (2009b)

Cocoa has during the period of 2005 to 2008 been subject to increasing prices. From 2005 to the first quarter of 2007, the prices remained reasonably stable before experiencing a rise during 2007. In 2008, the prices suddenly shot off, leaving a level of approximately 12 SEK/KG at the end of 2007 and reaching a level close to 18 SEK/KG in the third quarter of 2008. The previously mentioned production deficit in the 2006/2007 cocoa season has been identified as being the main factor leading to this development in the market.

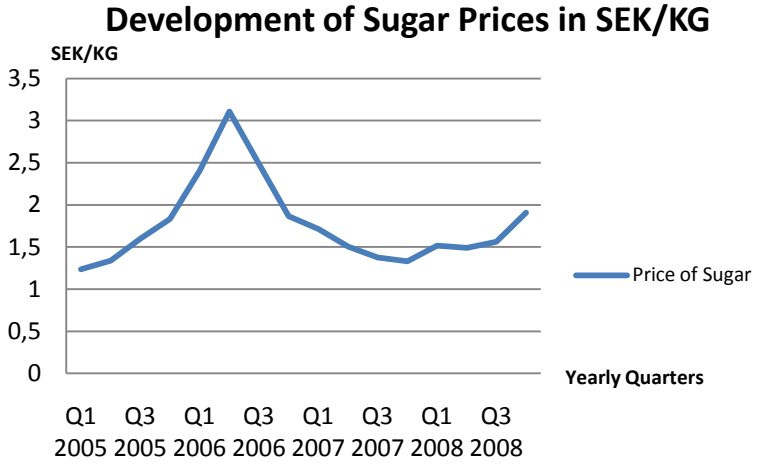
Figure 4: Development in Cocoa Prices



Source: Datastream (2009a)

The price of **Sugar** has had a peculiar progression (cf. *figure 5*). We can observe the normal average price per kg to lie around 1.5 SEK. In the second quarter of 2006, the price experienced a sudden boom and reached levels (approximately 3 SEK/Kg) that were two times as high as the normal average price. The price level quickly fell back again to levels around 1.5 SEK/Kg but started experiencing a light increase in 2008, leaving the price at a level close to 2 SEK/Kg.

Figure 5: Development of Sugar Prices



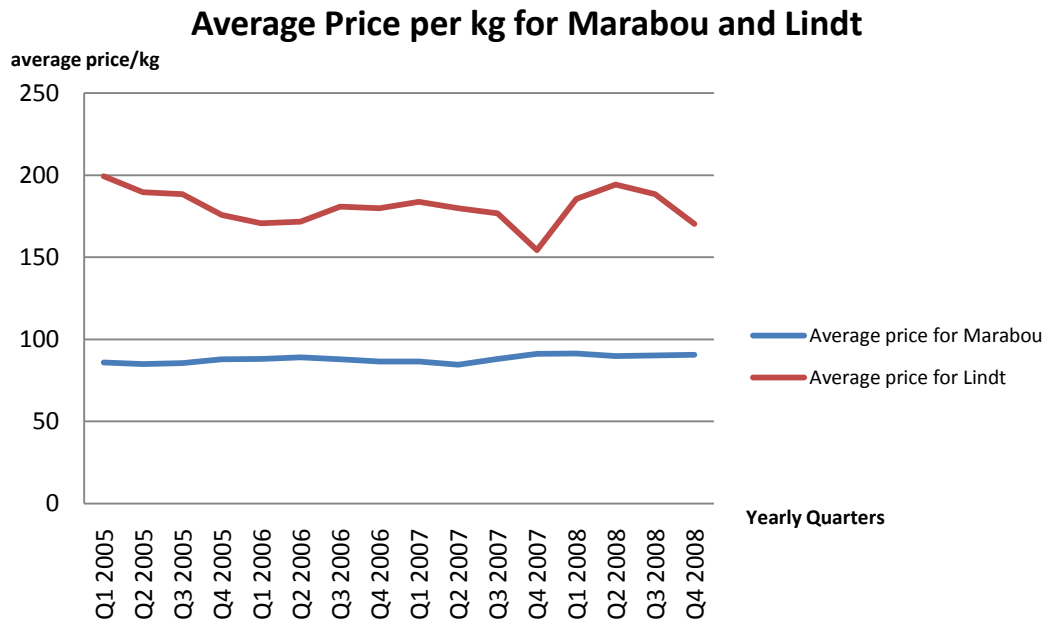
Source: Datastream (2009b)

3.4 An Estimation of the Chocolate cost structure

To get detailed information on a chocolate bar's cost structure is an almost impossible mission as it is something chocolate manufacturers are not willing to give out. Hence estimations have to be made. We can first of all say that the cost structure varies between the different chocolate segments and different brands as they use different recipes, different valued cocoa beans, etc.

The total average prices for one kilogram of Lindt chocolate and for one kilogram of Marabou chocolate differ a lot. Prices are nearly two times as high for Lindt chocolate compared to Marabou (cf. *figure 6*). Prices for chocolate with single-origin cocoa and with high cocoa contents are even higher, letting us suppose that cocoa stands for a large part.

Figure 6: The average price per kilogram for Marabou and Lindt



Source: Gfk (2009b)

Margins for retail prices of confectionary products generally lie in a span of 20 percent to 40 percent. The lower percentage concerns products that are more exposed to competition than others, e.g. bulk candy (Kroon 2009). Chocolate is considered a more luxurious confectionary product and we can therefore estimate the margins for Marabou and Lindt to lie in between 30 percent and 40 percent (the lower for Marabou and the higher for Lindt).

According to Livsmedelsverket, in order for a chocolate bar to be designated as "dark chocolate", in Sweden, it must contain at least 69 percent of cocoa substance. In order to be denoted "milk chocolate", a chocolate bar has to contain at least 30 percent of cocoa substance and 18 percent milk substance (Livsmedelsverket 2004). Depending on the brands, these percentages can be

higher. Other ingredients contained in the chocolate bars are, amongst others, sugar, milk and vegetable-based fats (Livsmedelsverket 2004). These extra ingredients are low-cost goods and thus, do not stand for a very large part of the cost structure. Some recipes also include different flavors that have to be accounted for. Some examples are Marabou Schweizernöt which requires hazelnuts or Lindt Excellence Orange which requires an orange taste. The more special ingredients or the more cocoa, the more expensive the chocolate's production cost and hence a higher retail price. Other factors that weigh in the cost structure are transportation, packaging and labor.

The chocolate is mainly manufactured in Sweden or at least in Europe which induces the transportation costs per chocolate bar not to be so high. The high transportation costs come with the cocoa beans being imported from "equatorial" countries, thus contributing to the high price of cocoa beans instead. We believe the packaging costs to be fairly constant and not to account for a very large part of the chocolate price as the marginal cost probably is low. Wages in the food industry increase moderately and we suppose that machines account for most of the production (SCB 2008). We know that marginal costs are usually low for one unit in a mass production like the chocolate industry. We hence believe that transportation, packaging and labor do not stand for a very large part of the cost structure of a chocolate bar and estimate these factors to make up for approximately 10 to 20 percent of the total cost structure.

In order to resume, we believe the cost structure of chocolate to be composed out of 40 to 50 percent ingredients (cocoa, sugar, milk, vegetable fats), whereof cocoa represents approximately 20 percent for milk chocolate and 35 percent or more for dark chocolate of the total cost. We know that 30 to 40 percent constitute margins which leave up to 10 to 20 percent for wages, packaging and transportation.

3.5 Pricing Strategies

In order to understand how pricing strategies affect the chocolate prices, the buying division, *Sortiment & Inköp,* at **ICA**, one of Sweden's largest groceries retail chains, was used as a model. ICA buys large quantities of the different products and sells smaller amounts to the retail stores in the network. This model can be seen as representative for the Swedish grocery market in general (Kroon, 2009).

The pricing strategies vary depending on the size of the store. There are four different sizes of stores. For each size, eight price profiles exist to choose between. Once a price profile has been chosen by the store owner, ICA suggests a consumer price. The decision of what price to set is however up to the store owners'.

ICA considers chocolate to be a luxury product and thus suggests higher margins for these products than for other groceries. According to Johan Kroon at ICA, there is no craving for keeping prices constant. There is however a desire to maintain the same price for whole brand series, even though the costs within the brand assortment differ.

Prices at ICA are potentially changed every week. They claim that the same principles are used for both price raises and cuts. The most common reasons for changing prices are changes in purchase prices or in competitor prices, alternatively due to changes in strategy. Regarding purchase prices,

increases are accepted if they are connected to increased commodities costs or exchange rates. If the product is strategically important to the store, the price usually remains constant taking a cut in store margins. According to Johan Kroon, changes in manufacturer prices generally pass through, raising the consumer price.

It is important to stress that the recommendations from ICA functions as guidelines for each store and are not final. In the end, the price setting is up to each individual store owner but within the frame of the chosen price profile. A newspaper article gives examples of how chocolate prices are kept constant while the margins are allowed to fall; “we tried to hold back” is one comment from a candy store owner regarding the increasing cocoa prices (Flood 2009).

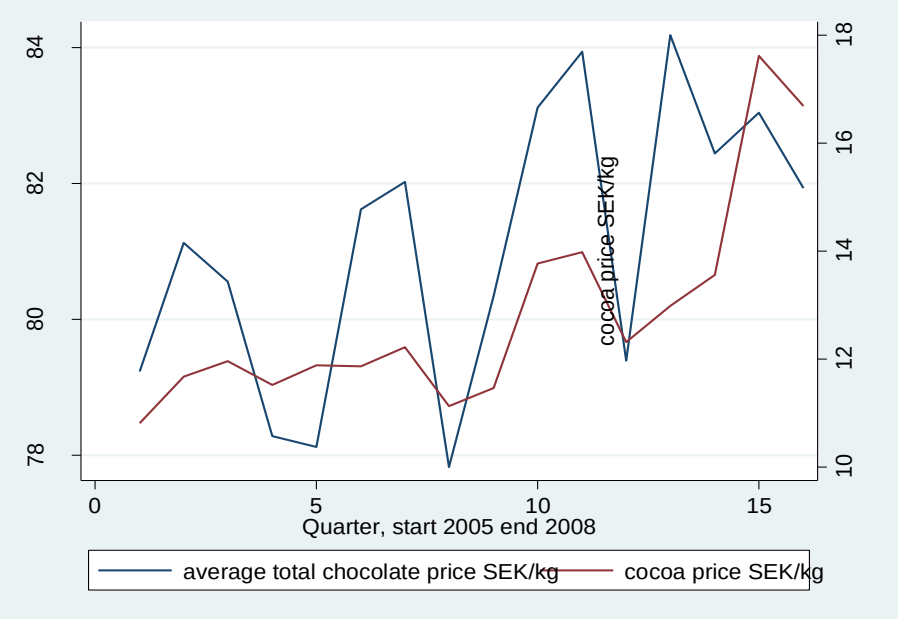
4. Statistical analysis

4.1 The Regressions

We specified the three assumptions for unbiased OLS estimators. Each model in every segment was also tested for heteroskedasticity and the null hypothesis of homoskedasticity was never rejected. Unless anything else is mentioned, the models passed the RESET-test for each segment. The interpretation of all regression results are conducted under the ceteris paribus assumption.

4.1.1 The Average Price of Chocolate

Figure 7- Average Chocolate and Cocoa Prices



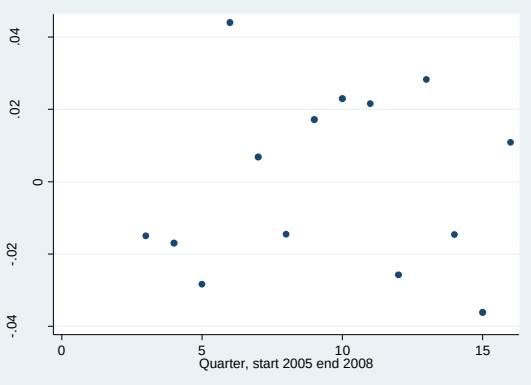
Source: Gfk (2009) and Datastream (2009)

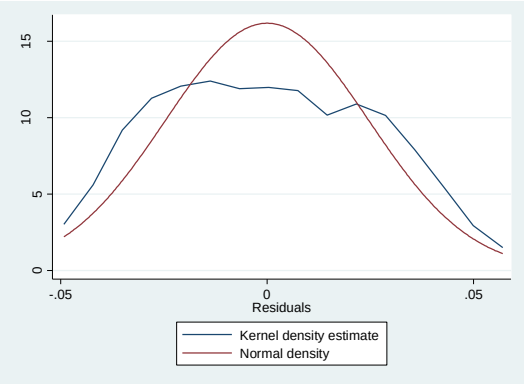
The graph illustrates a similar pattern for cocoa prices and average chocolate prices: increases and decreases in prices take place simultaneously. The fluctuations in the chocolate prices are however much bigger than the changes in cocoa prices.

Model I

The distribution of the residuals was quite similar to a normal distribution, showing that the model was fairly successful. The residuals did not show any suspicious pattern, such as a cyclic behavior or a growing tendency. They weren't very big, lying within a range of (-0.04, 0.04).

Figures 8-9: Residuals over Time and the Distribution of Residuals





Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

There were however no significant coefficient estimators at a 10 percent level but the estimator of the change in cocoa price had a t-statistic of 1.66, which is a considerable value. The p-value is not high above the 10 percent significance level which shouldn't be overlooked. Under ceteris paribus conditions, a 1 percent increase in cocoa price leads to an increase in chocolate price by 0.149 percent. The variation in chocolate price changes is explained to 47.42 percent by the independent variables, as shown by R^2.

Table 1: Regression on Average Chocolate Prices

Variable	Coefficient estimator	t-statistic	p-value
ΔCocoa	0.149	1.66	0.132
ΔCocoa_lag	-0.066	-0.71	0.495
ΔSugar	0.041	0.87	0.407
ΔExpenditure	-0.157	-0.77	0.463
Constant	-0.157	-0.16	0.874

Number of observations = 14, R^2 = 0.4742

Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

Model II

The results from this regression were similar to those of model I. Adding a time trend to the model showed no drastic differences: the distribution of the residuals did not change; the R^2 remained more or less the same. An interesting result of adding a time variable is however that all of the OLS estimators became less significant.

Table 2: Regression on Average Chocolate Prices

Variable	Coefficient estimator	t-statistic	p-value
ΔCocoa	0.146	1.49	0.176
ΔCocoa_lag	-0.070	-0.67	0.524
ΔSugar	0.042	0.82	0.433
ΔExpenditure	-0.156	-0.72	0.493
Time	0.000	0.10	0.919
Constant	-0.004	-0.16	0.877

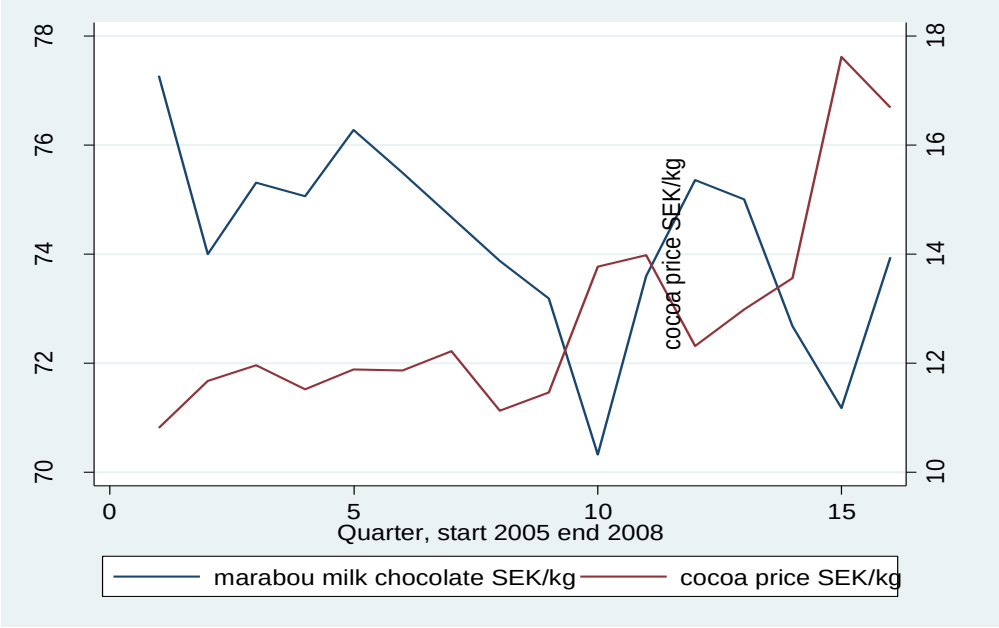
Number of observations = 14, R^2 = 0,4606

Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

4.1.2 Milk chocolate

Within this type of chocolate, Lindt has no position on the market, except for at special occasions such as Easter, why the price of Marabou milk chocolate was the only one used in the regressions for this segment.

Figure 10: Milk Chocolate and Cocoa Prices



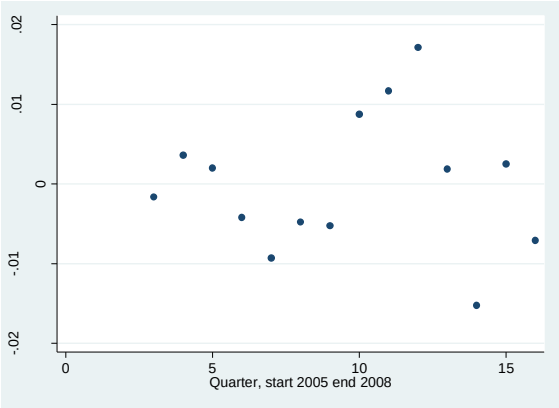
Source: Gfk (2009) and Datastream (2009)

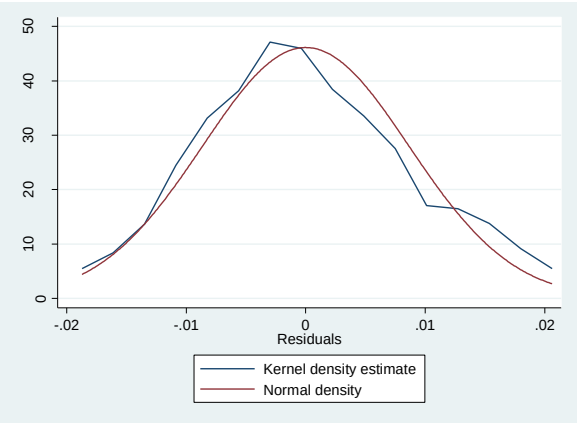
There is no obvious positive relationship between the prices. Cocoa prices are growing over time and the prices for milk chocolate are to some extent declining over time. On the contrary, the price changes seem reversed – an increase in cocoa prices seems to occur at the same time as a fall in the chocolate price and vice versa.

Model I

There seems to be a risk that the residuals follow a cyclic behavior, which is a sign of autocorrelation. There is also a slight tendency of a growing trend over time but the appearance of the distribution is close the normal distribution.

Figures 11- 12: Residuals over Time and the Distribution of Residuals





Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

In the regression three estimators were found to be significant at a 1 percent level: the changes in cocoa price, the lagged change in cocoa price and the change in household consumption. It is worth noticing that the changes in cocoa prices and consumption have a negative impact, although small. An increase in cocoa price by 1 percent leads to an immediate decrease in chocolate price by 0.177 percent. The effect from the change in cocoa price in the previous quarter is however positive, which means that a 1 percent cocoa price increase, gives a 0.174 percent chocolate price increase. The long-run effect from changes in cocoa price is negative though: $\beta_{cocoa} + \beta_{cocoa\_lag} = - 0.177 + 0.174 = - 0.003$. A 1 percent increase in household consumption leads to a 0,358 percent decrease in chocolate price.

Table 3: Regression on Milk Chocolate Prices

Variable	Coefficient estimator	t-statistic	p-value
ΔCocoa	-0.177	-5.64	0.000
ΔCocoa_lag	0.174	5.34	0,000
ΔSugar	0.022	1.31	0.223
ΔExpenditure	-0.358	-4.98	0.001
Constant	-0.001	-0.40	0.698

Number of observations = 14, R^2 = 0.8809

Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

The variation in chocolate prices could to 88.09 percent be explained by the changes in cocoa and sugar prices and consumption expenditures.

Model II

The residuals did not differ from the ones in model I. In this regression, the same three estimators- the change in cocoa price, the lagged change in cocoa price and the change in household consumption - were found to be significant, at a 5 percent level this time.

Table 4: Regression on Milk Chocolate Prices

Variable	Coefficient estimator	t-statistic	p-value
ΔCocoa	-0.177	-5.14	0.001
ΔCocoa_lag	0.174	4.75	0.001
ΔSugar	0.022	1.21	0.261
ΔExpenditure	-0.358	-4.69	0.002
time	0.000	-0.00	0.999
Constant	-0.001	-0.16	0.879

Number of observations = 14, R^2 = 0.8809

Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

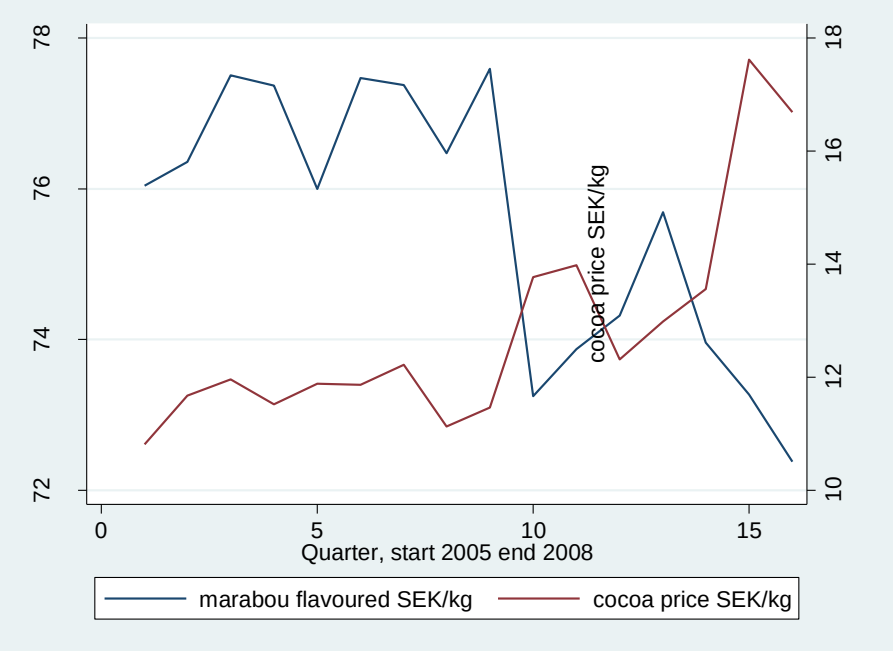
When adding a time trend to this regression, the significance of all the estimators was to some extent lowered.

4.1.3 Flavored chocolate

Both investigated brands have several types of chocolate within this segment, most often flavored with nuts and fruits. Examples are *Marabou Schweizernöt* and *Lindt Excellence Orange*. Marabou and Lindt are however far from each other in terms of price and profile, why it was found necessary to run regressions for each of them separately. An average price of the total segment would be misleading for the impact of the independent variables.

Marabou flavored chocolate

Figure 13: Flavored Marabou Chocolate Prices and Cocoa Prices



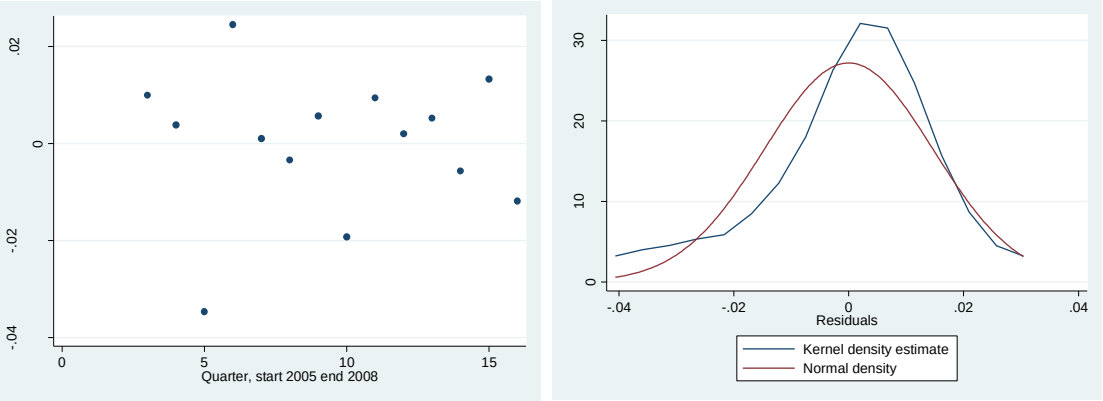
Source: Gfk (2009) and Datastream (2009)

The chocolate price shows a declining trend while the cocoa price is growing and the relationship between the two seems to be negative.

Model I

The RESET-test shows strong evidence that the model in this case is misspecified; the relationship between the chocolate price and the independent variables is not true. The appearance of the residuals is however satisfactory. Apart from two outliers, the residuals are fairly small and have a satisfactory resemblance with the normal distribution.

Figures 14-15: Residuals over Time and the Distribution of Residuals



Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

Despite the evidence of functional form misspecification, there are two significant values: one at a 5 percent significance level - the coefficient estimator of changes in cocoa price – and one at a 10 percent level –the change in household consumption. These both have a negative impact on the change in price of flavored chocolate, implying that an increase in either of these would lower the chocolate price. An increase by 1 percent in cocoa price gives a 0.128 percent decrease in chocolate price. An increase in household consumption by 1 percent leads to a decrease by 0.239 percent in chocolate prices.

Table 5: Regression of Marabou Flavored Chocolate

Variable	Coefficient estimator	t-statistic	p-value
ΔCocoa	-0.128	-2.39	0.040
ΔCocoa_lag	-0.011	-0.20	0.844
ΔSugar	0.023	0.79	0.447
ΔExpenditure	-0.239	-1.96	0.082
Constant	-0.000	-0.03	0.980

Number of observations = 14, R^2 = 0.4993

Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

Model II

The RESET-test showed evidence for misspecification also for this model but the residuals seem fairly good. The estimators have a negative impact on the change in price of flavored chocolate, similar to Model I, implying that an increase in either of these would lower the chocolate price. The time trend lowers the significance of the estimators, resulting in only cocoa being significant at a 10 percent level, even if the t-statistic of household consumption is still considerable and should not be

overlooked. The implication is that a 1 percent increase in cocoa price leads to a 0.127 percent decrease in chocolate price. A 1 percent increase in household consumption leads to a 0.239 percent decrease in chocolate prices.

Table 6: Regression of Marabou Flavored Chocolate

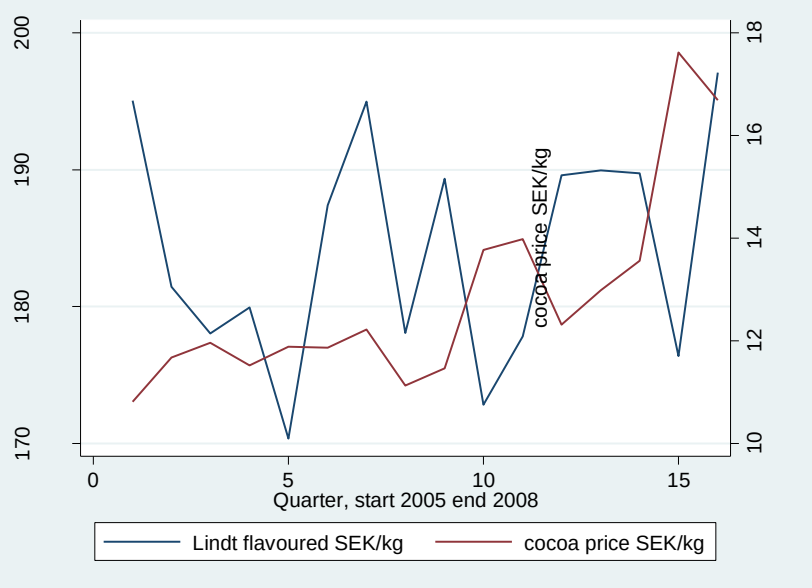
Variable	Coefficient estimator	t-statistic	p-value
ΔCocoa	-0.127	-2.16	0.062
ΔCocoa_lag	-0.010	-0.16	0.879
ΔSugar	0.022	0.72	0.490
ΔExpenditure	-0.239	-1.85	0.102
Time	-0.000	-0.07	0.946
Constant	0.001	-0.05	0.959

Number of observations = 14, R^2 = 0.4996

Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

Lindt Flavored Chocolate

Figure 16: Flavored Lindt Chocolate and Cocoa prices

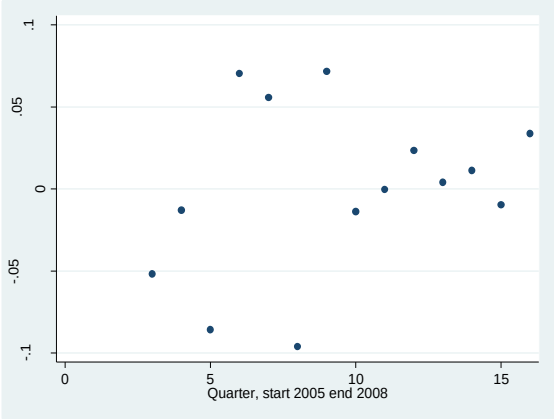


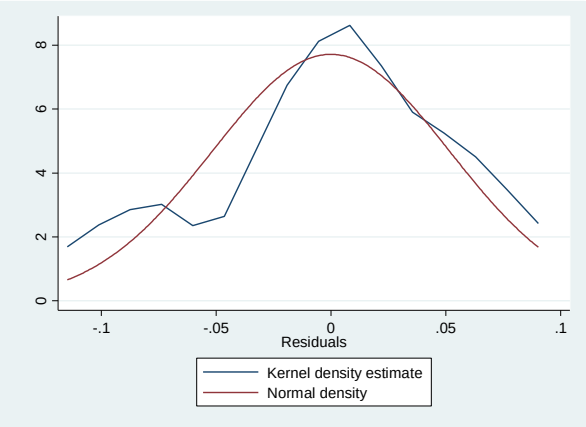
Source: Gfk (2009) and Datastream (2009)

The graph shows a highly volatile chocolate price, going up and down several times with very large differences in price. There is no apparent similarity in the patterns of the prices but the relationship tends to be more negative than positive.

Model I

Figures 17-18: Residuals over Time and the Distribution of Residuals





Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

The residuals appear to be close to normally distributed but the left hand side shows an abnormal behavior. In addition, the residuals are quite large, lying in a range of (-0.1, 0.1). This decreases the credibility of the model to some extent. Cocoa and the lag of cocoa are significant at a 10 percent level, implying that a 1 percent increase in the cocoa price decreases the chocolate price by 0.358 percent and a 1 percent increase in cocoa price in the previous period increases the chocolate price by 0.157 percent. The long run effect is a 0,201 percent decrease in chocolate price for every 1 percent increase in cocoa price.

Table 7: Regression of Lindt Flavored Chocolate Prices

Variable	Coefficient estimator	t-statistic	p-value
ΔCocoa	-0.358	-1.90	0.090
ΔCocoa_lag	0.157	0.81	0.090
ΔSugar	0.091	0.91	0.385
ΔExpenditure	-0.258	-0.60	0.564
Constant	0.008	0.42	0.681

Number of observations = 14, R^2 = 0.3855

Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

Model II

After having added a time trend, the appearance of the residuals was worsened and deviated from the normal distribution. Adding a time trend term improved significance for cocoa but drastically lowered it for the lag of cocoa, from 0.090 to 0.670. No other variables were significant. R^2 increased to 0.4463. A 1 percent increase in cocoa price gives a 0.404 percent decrease in chocolate price.

Table 8: Regression of Lindt Flavored Chocolate Prices

Variable	Coefficient estimator	t-statistic	p-value
ΔCocoa	-0.404	-2.06	0.073
ΔCocoa_lag	0.092	0.44	0.670
ΔSugar	0.109	1.07	0.317
ΔExpenditure	-0.238	-0.55	0.598
time	0.005	0.94	0.376
Constant	-0.030	-0.67	0.520

Number of observations = 14, R^2 = 0.4463

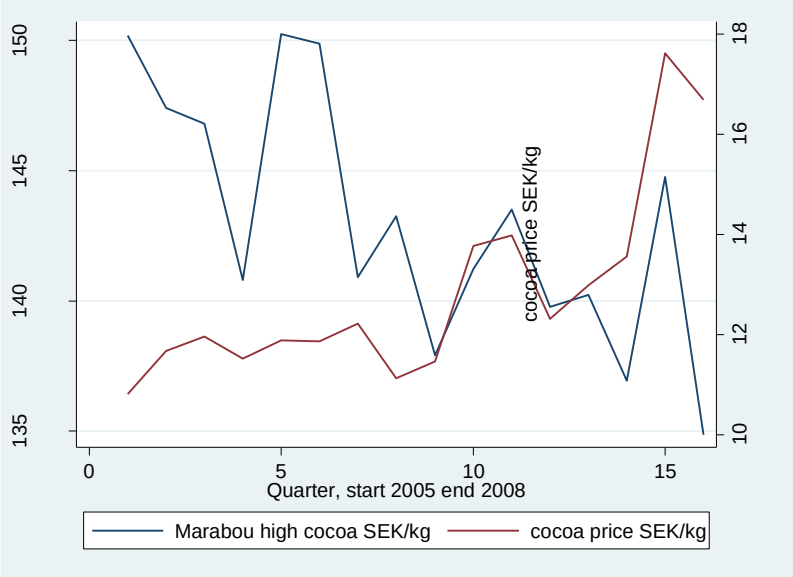
Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

4.1.4 High Contents of Cocoa

As in the case of the flavored chocolate, the chocolate with high contents of cocoa made by Marabou and Lindt are too different to usefully be computed to an average price in a regression, hence two separate regressions were run.

Marabou Dark Premium Chocolate

Figure 19: Marabou Chocolate with High Cocoa Content and Cocoa Prices

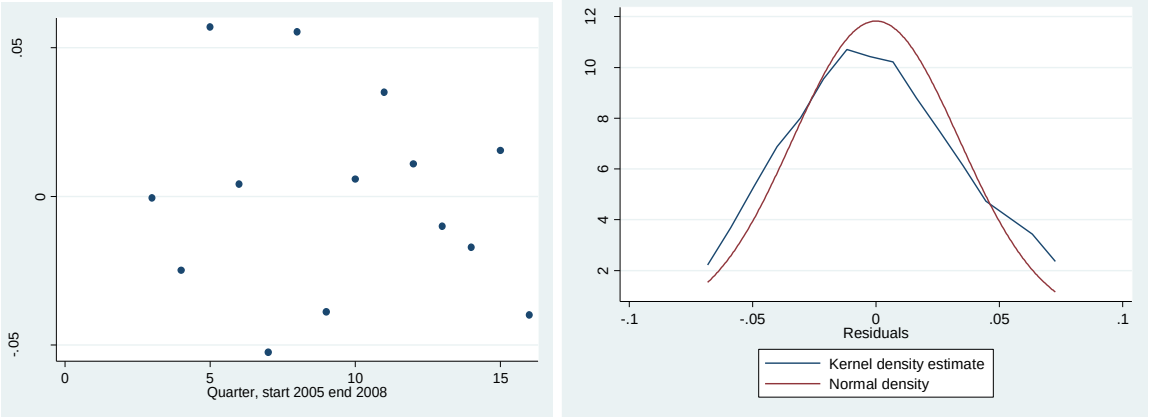


Source: Gfk (2009) and Datastream (2009)

Marabou Dark Premium Chocolate, in its turn, suffers from decreasing prices and changes in prices which are far bigger than those of cocoa. The decreasing trend of chocolate prices is clearly visible.

Model I

Figures 20-21: Residuals over Time and the Distribution of Residuals



Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

The distribution of the residuals was similar to the normal distribution and there was no undesirable pattern of the residuals over time. No estimators were significant at a 10 percent level but the estimator of changes in cocoa price has a t-statistic of 1.54, which should be considered. It is positive, implying that a 1 percent increase in cocoa price leads to a 0.189 percent increase in chocolate prices.

Table 9: Regression of Marabou High Cocoa Content Chocolate Prices

Variable	Coefficient estimator	t-statistic	p-value
ΔCocoa	0.189	1.54	0.159
ΔCocoa_lag	-0.0563	-0.44	0.669
ΔSugar	0.027	0.41	0.689
ΔExpenditure	-0.038	-0.14	0.895
Constant	-0.010	-0.81	0.440

Number of observations = 14, R^2 = 0.2974

Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

Model II

The residuals take on a similar distribution as in Model I. There were no significant estimators at a 10 percent level – on the contrary, the significance of the OLS estimates is lower than in Model I – but the t-statistic of cocoa price changes is still 1.54. Its effect on chocolate price should still be considered. A 1 percent increase in cocoa price gives a 0.204 percent increase in chocolate price.

Table 10: Regression of Marabou High Cocoa Content Chocolate Prices

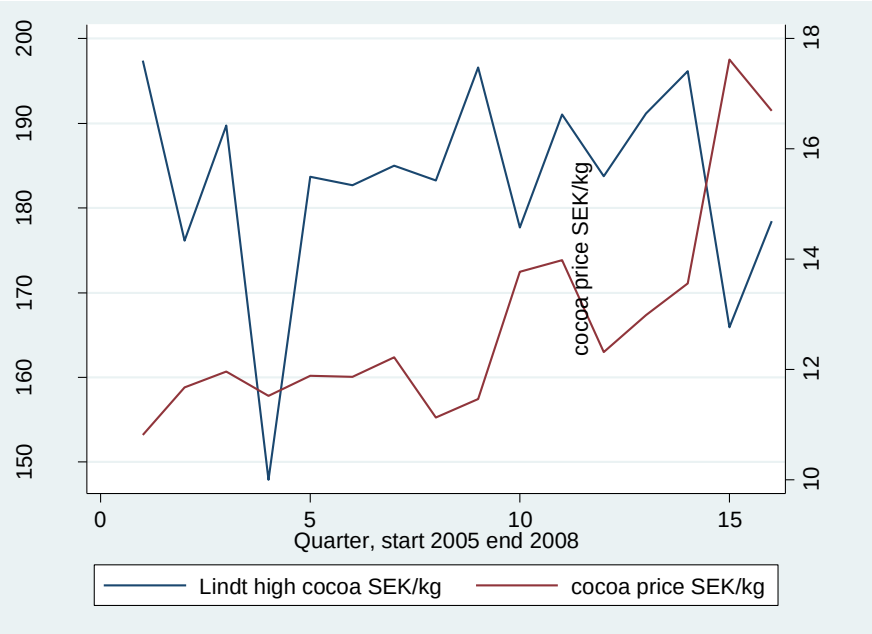
Variable	Coefficient estimator	t-statistic	p-value
ΔCocoa	0.204	1.54	0.163
ΔCocoa_lag	-0.034	-0.24	0.814
ΔSugar	0.021	0.30	0.771
ΔExpenditure	-0.045	-0.15	0.883
Time	-0.001	-0.46	0.656
Constant	0.003	-0.10	0.926

Number of observations = 14, R^2 = 0.3157

Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

Lindt Chocolate with High Contents of Cocoa

Figure 22: High Content Cocoa Lindt Chocolate and Cocoa Prices



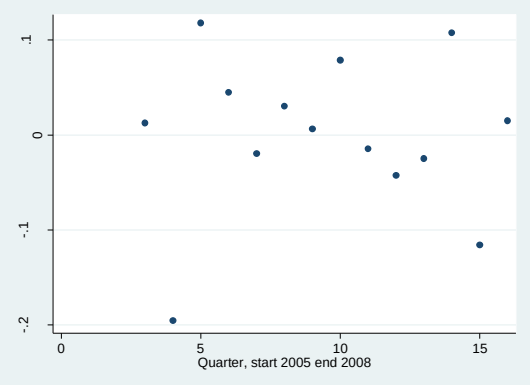
Source: Gfk (2009) and Datastream (2009)

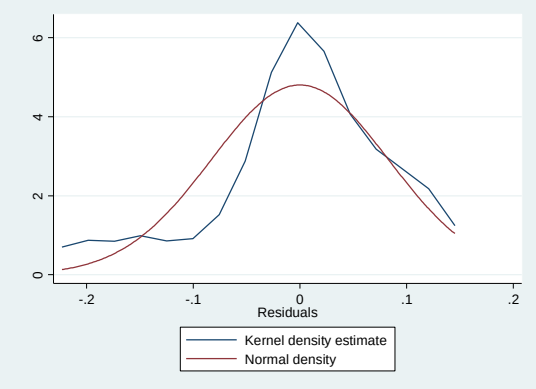
A highly volatile chocolate price can be seen in the graph. The relationship between chocolate and cocoa prices is difficult to distinguish but seems to have negative tendencies.

Model I

The residuals are quite evenly spread over time apart from one outlier but they are larger than in the other regressions. The distribution of the residuals does not match the normal distribution perfectly but seems satisfactory.

Figures 23-24: Residuals over Time and the Distribution of Residuals





Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

The regression shows two variables, change in cocoa price and change in household consumption, which are significant at a 10 percent level. They are both negative, implying that increases in either of these lead to a decrease in the chocolate price. An increase in cocoa price by 1 percent leads to a decrease in chocolate price by 0.582 percent. If household consumption increases by 1 percent, chocolate prices decrease by 1.771 percent.

Table 11: Regression of Lindt High Cocoa Content Chocolate Prices

Variable	Coefficient estimator	t-statistic	p-value
ΔCocoa	-0.582	-1.92	0.087
ΔCocoa_lag	0.280	0.89	0.395
ΔSugar	0.042	0.26	0.798
ΔExpenditure	-1.771	-2.56	0.031
Constant	0.009	0.32	0.759

Number of observations = 14, R^2 = 0.4779

Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

Model II

The distribution of the residuals was identical to model I but adding a time trend lowered the significance of the OLS estimators. In this regression, only the estimator of the change in household consumption is significant at a 10 percent level. However, the estimator of cocoa price changes still had a fairly high t-statistic. A 1 percent increase in cocoa prices gives a decrease of 0.586 percent in chocolate prices. A 1 percent increase in household consumption leads to a 1.769 percent decrease in chocolate prices.

Table 12: Regression of Lindt High Cocoa Content Chocolate Prices

Variable	Coefficient estimator	t-statistic	p-value
ΔCocoa	-0.586	-1.17	0.115
ΔCocoa_lag	0.277	0.78	0.460
ΔSugar	0.044	0.25	0.806
ΔExpenditure	-1.769	-2.41	0.042
Time	0.000	0.05	0.959
Constant	0.006	0.08	0.940

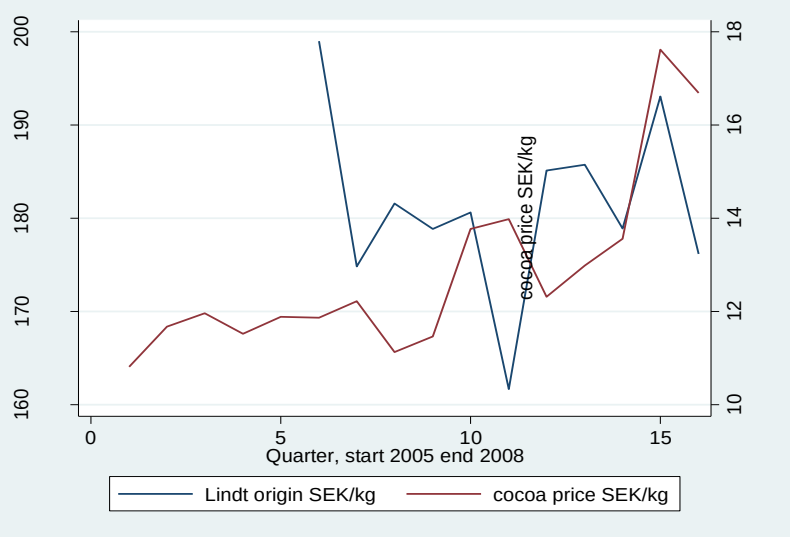
Number of observations = 14, R^2 = 0.4781

Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

4.1.5 Single-Origin Cocoa Chocolate

Of the two investigated producers, only Lindt sell chocolate produced from cocoa with a specific origin. This type of chocolate has not been for sale in Sweden until recently why the time series for this sort is remarkably shorter than for the others.

Figure 25: Single-Origin Cocoa Chocolate and Cocoa Prices

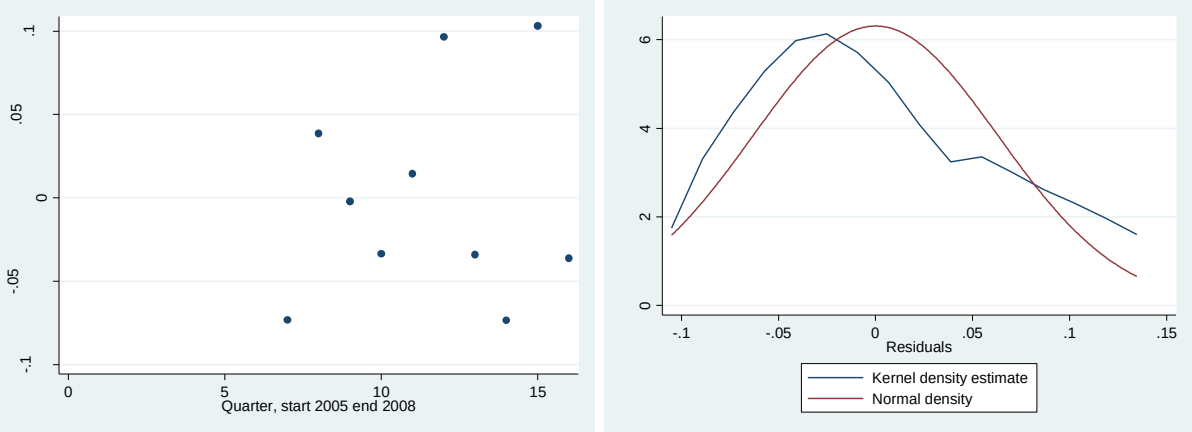


Source: Gfk (2009) and Datastream (2009)

As with the other Lindt chocolates the price curve is highly volatile. The relationship between is difficult to observe but there are negative tendencies.

Model I

Figure 26-27: Residuals over Time and the Distribution of Residuals



Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

The model was seen as correctly specified but the residuals showed a distribution that was shifted a bit to the left. There were no estimators that were significant, but the lagged cocoa price change had a t-statistic of -1.81. The impact of the estimate is negative, implying that a 1 percent increase in cocoa price in the previous quarter leads to a decrease in the current chocolate price by 0.539 percent.

Table 13: Regression of Lindt Single Origin Cocoa Chocolate Prices

Variable	Coefficient estimator	t-statistic	p-value
ΔCocoa	0.091	0.35	0.741
ΔCocoa_lag	-0.539	-1.81	0.130
ΔSugar	0.183	0.88	0.421
ΔExpenditure	1.113	1.52	0.189
Constant	0.013	0.39	0.714

Number of observations = 10, R^2 = 0.4327

Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

Model II

Adding a time trend, improved the distribution of the residuals, taking on a look similar to the normal distribution as the curve was shifted to the right. The R^2 is improved to 0.5741 and the estimator of the cocoa lag is significant at 10 percent (p-value = 0.099). The lagged cocoa price has a

coefficient of -0.651; the percentage change of cocoa price in the previous period lowers the price of chocolate by 0.651 percent if it increases by 1 percent.

Table 14: Regression of Lindt Single Origin Cocoa Chocolate Prices

Variable	Coefficient estimator	t-statistic	p-value
ΔCocoa	-0.095	-0.32	0.767
ΔCocoa_lag	-0.651	-2.14	0.099
ΔSugar	-0.462	-0.78	0.481
ΔExpenditure	0.547	0.63	0.561
Time	0.035	1.15	0.313
Constant	-0.413	-1.11	0.328

Number of observations = 10, R^2 = 0.4843

Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

4.1.6 Re-Runs of Regressions with Adjusted Models

The regressions were run again with some adjustments of the models. First, the models were run in levels. The results were similar: small and mainly negative impacts of cocoa price changes on the chocolate price. Secondly, the models were run without the lag of cocoa. The results were similar in this case as well.

4.2 Discussion of the Significance

In order to get significant OLS estimators the variable variance should be as small as possible. $Var(\beta hat_j) = \sigma^2 / (SST_j(1 - R_j^2))$, where σ^2 is the error variance, SST_j is the total sample variation in x_j and R_j^2 is the proportion of the total variance in x_j that can be explained by other independent variables in the model. Two regressions failed to give any certain relationship between x and y. In the other regressions only some of the coefficient estimators were significant. There are three main explanations for this:

4.2.1 Noise

When looking at the data series, there is little reason to doubt the correctness of the independent variables' data series. The cocoa and sugar prices are the average quarterly prices collected from Datastream, which is connected to the world marketplaces of commodities. The data on household consumption might contain some noise as all purchases are not registered. A large amount of noise is however found in the data series of chocolate prices. This data contains the consumer prices of chocolate collected at different grocery stores. These stores vary in size and therefore have different pricing strategies. They have different margins- percentage markups over marginal cost- resulting in different consumer prices. In addition to that, there are sporadic sales and promotions, e.g. buy two; get the third one for free. This noise can be seen in the high volatility of chocolate price. The volatility of the chocolate price is especially high for the Lindt chocolate. This can be

derived from the fact that their market share was relatively small at the beginning of the data series and promotions and sales have been used to increase the interest for this chocolate. More noise, which means a larger error variance, makes it harder to estimate the partial effect of any of the independent variables on the dependent variable. This means higher variance for the OLS slope estimators (Wooldridge 2006, pp. 95-99).

4.2.2 Micronumerosity

Micronumerosity, too small a sample, will also lead to a high Var(βhat_j). SST_j should be as big as possible to get a small variance. An easy way of increasing the sample variation in each of the independent variables is to increase the sample size (Wooldridge 2006, pp. 95-99).

4.2.3 Multicollinearity

Multicollinearity is high correlation between two or more independent variables. A high level of a linear relationship between independent variables can lead to large variances for the OLS estimators. The higher the correlation between variables and R_j^2 are, the higher the variance will be (Wooldridge 2006, pp. 95-99).

As discussed, the noise in the equation is substantial. Hence the error variance must be assumed to be large. The sample size is unfortunately small and therefore it can be assumed that the sample variation in the independent variables is not very big. Thirdly, the correlation between a variable and its lags is often high. As a consequence, the variances in the regressions are high making the OLS estimators insignificant.

4.3 Asymmetric Cost Adjustment

The general suspicion would be that the chocolate price is more commonly adjusted to cocoa cost increases than decreases. In order to investigate whether chocolate prices are asymmetrically adjusted to the changes in cocoa price, another test was conducted. Firstly, two variables were generated: one for positive cocoa price changes and one for negative cocoa price changes. The chocolate price change was regressed on these two variables, with the intention of finding out how significant the price changes in cocoa are for the price change in chocolate.

$$\Delta y = \beta_0 + \beta_+ \Delta x_+ + \beta_- \Delta x_- + u$$

Finally, the positive and negative changes were tested if they were equal to each other. The null hypothesis is: H_0: $\beta_+ = \beta_-$

The average chocolate price: there was evidence against the null hypothesis at a 5 percent level. Only the negative change was significant and it had a positive coefficient estimator. The value of the negative price change is either negative or zero, implying that a decrease in cocoa price would lead to a decrease in chocolate price.

Milk Chocolate: There was no evidence against the null hypothesis, meaning that the impact of a price change in cocoa did not differ whether it was positive or negative.

Flavored Chocolate: There was no evidence against the null hypothesis for either Marabou or Lindt.

Chocolate with high cocoa content: There was evidence against the null hypothesis for neither Marabou nor Lindt.

Single-Origin Cocoa Chocolate: The null hypothesis is rejected at a 5 percent level. The positive change in cocoa price is significant at 5 percent level, with a coefficient estimator of 7.779508, meaning that the chocolate price increases by that amount for every 1 SEK increase in cocoa price. The negative change is also significant at a 5 percent level, with a coefficient estimator of -18.32211, meaning that a price decrease in cocoa leads to an increase in chocolate price (as the value of the cocoa price change itself is negative).

5. Interpretations

5.1 Interpreting the Regressions

The estimator of the change in household consumption was found significant in three out of seven regressions. The household consumption had a negative estimator in each of these cases, implying that increasing consumption expenditure would lead to a lower chocolate price The estimator of the change in sugar price was positive in each regression but also insignificant. No certain relationships between the change in chocolate price and the change in sugar price could be shown. The relationship of interest is however the one between cocoa and chocolate.

Table 15: A Summary of Model I Results

	$\beta_{\Delta cocoa}$	$\beta_{\Delta cocoa\_lag}$	Long run effect	$\beta_{\Delta consumption}$	R^2
Average Price	0.149*	-0.066**	0.149*	-0.157**	0.474
Milk Chocolate	-0.177	0.174	-0.003	-0.358	0.881
Marabou Flavor	-0.128	-0.011**	-0.128	-0.239	0.463
Lindt Flavor	-0.358	0.157	-0.201	-0.258**	0.386
Marabou cocoa	0.189*	-0.056**	0.189*	-0.038**	0.297
Lindt cocoa	-0.582	0.280**	-0.582	-1.771	0.478
Lindt origin	0.091**	-0.539*	-0.539*	1.113*	0.433

* = close to significant at 10 % level ** = not significant

Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

When we examine the results that were significant at a 10 percent level, the cost pass-through in model I lies between -0.003 and -0.582 for the different segments. An increase by 1 percent in cocoa price leads to a decrease in chocolate price by 0.003 percent to 0.582 percent. The relationship between cocoa and chocolate prices is negative and under ceteris paribus conditions, an increase in production costs would lead to a decrease in price.

The impact of a cocoa price change is positive in two regressions, namely the average price and Marabou high cocoa content price. In these regressions, the estimators have fairly high t-statistics and are significant at a 20 percent level. The average chocolate price increases over time meanwhile the price of Marabou is clearly falling; hence we cannot see any certain relationship between the positive estimates of cocoa and the development of the chocolate price.

In absolute values, cost pass-through is prevalent for the more cocoa intensive chocolate types. Pricing strategies that involve keeping the same price across the whole brand series were thought to dilute this investigation. We could however be believe that Lindt has a stronger relationship between its price changes and the changes in cocoa prices than Marabou. For Lindt, this relationship is stronger for the products including higher cocoa contents than for the ones with more other ingredients. These values are negative, thus showing a greater negative relationship

between cocoa and chocolate prices. We although believe the negative sign to derive from variables not accounted for, like decreasing margins which will be explained further down. It is important to acknowledge that there are greater relationships between the Lindt chocolate and cocoa compared to Marabou.

Absolute values or not, the cost pass-through is however relatively small; at the most approximately half of the cost passes through. It is not certain whether the rest of the cost is passed through later. It is more common with significant values for the estimates of cocoa price changes in the current period than changes in previous periods, which could give some support to a fast reaction to costs in chocolate prices. In six of the seven regressions, the lags of changes in cocoa prices were found to reducing the size of the cost pass through. This finding further accentuates that the long run cost pass through of cocoa is small.

Table 16: A Summary of Model II Results

	$\beta_{\Delta cocoa}$	$\beta_{\Delta cocoa\_lag}$	Long run effect	$\beta_{\Delta consumption}$	R^2
Average Price	0.146*	-0.070**	0.146*	-0.156**	0,461
Milk Chocolate	-0.177	0.174	-0.003	-0.358	0,881
Marabou Flavor	-0.127	-0.010**	-0.127	-0.239*	0,499
Lindt Flavor	-0.404	0.092**	-0.404	-0.238**	0,447
Marabou cocoa	0.204*	-0.034**	0.204*	-0.045**	0,316
Lindt cocoa	-0.586*	0.277**	-0.586*	-1.769	0,478
Lindt origin	-0.095**	-0.651	-0.651	0.547**	0,484

* = close to significant at 10 % ** = not significant

Source: Statistics from Gfk (2009), Datastream (2009) and SCB (2009) processed in STATA

The results of Model II are quite similar to the ones in Model I. The relationship between changes in cocoa and chocolate prices is mainly negative. It is negative for the same segments as in Model I and vice versa in the case of positive results. The size of the cost pass-through, in absolute numbers, is larger for the more cocoa intensive chocolate segments. In addition, most lags of changes in cocoa prices are insignificant and reduce the long run cost pass-through. Since almost all lags are insignificant it could be interpreted as the reaction to price changes in cocoa is fast and the impact from earlier price changes is small.

When adding a time trend, the significance of the OLS estimators were often worsened, which implies that the estimated relationships between the dependent and independent variables had been given too much significance. In one case, adding a time trend did however improve the significance of the cocoa lag, which implies that there in fact was a relationship between cocoa and chocolate prices that had disappeared in the regression not adjusted for the possibility of trending. Although the size of the coefficient estimators experienced a slight increase in Model II, the long run effect of cocoa on chocolate prices is relatively small.

5.2 Cost Adjustment Asymmetry

The results of this test were inconclusive. The two chocolate types that appeared to adjust asymmetrically to costs also had less successful regression results. The data of the average chocolate price contained a lot of noise, why also the results of the cost adjustment asymmetry test must be examined with critical eyes. The data on prices for chocolate with single-origin cocoa contained fewer observations than other data series (10 observations) which requires caution before coming to any conclusions. All five other chocolate types showed no evidence of cost adjustment asymmetry.

5.3 Consistency with Expectations

5.3.1 Economic Theories

The negative relationship between cocoa and chocolate price changes is not consistent with economic theories. Rational behavior of firms would be to increase prices as production costs increase in order to maximize the profit. To decrease prices when production costs increase is completely irrational, and must be assumed to derive from fierce competition or decreasing demand. Since the demand for chocolate has increased over the examined period this is most likely not the reason.

5.3.2 Previous Studies

The studies conducted on the US coffee industry showed a positive relationship between changes in costs and changes in retail prices; increased costs lead to increased retail prices. As the production process for chocolate has similarities with coffee, similar results (a positive relationship between cocoa and chocolate) were expected. The results were inconsistent with similar studies. Prices in the coffee business proved to be highly persistent and it is possible that this also applies to chocolate. This is however difficult to examine from the available data but the insignificance of the lags suggest that the chocolate prices respond fast to changes in commodity costs. The results of the cost adjustment asymmetry test were inconclusive, which is in line with the results of the US coffee study.

5.3.3 The Cost structure

The patterns recognized in the regressions were consistent with the estimation of cost structure of a chocolate bar. Even though the cocoa-chocolate relationship is negative for all significant estimators, and the positive relationships are insignificant, it is possible to identify a pattern in the size of the relationship. The cost pass-through is higher for segments whose ingredients consist of more and better cocoa.

5.4 Discussion

It is a big problem that the results show a negative relationship between changes in cocoa and chocolate prices. There are two possible scenarios to why the results of the regressions are contradictory to economic theories and previous studies. Firstly, it could be argued that existing theories and studies are inadequate or insufficient for reality. Secondly, it is possible that the models, and the data they are based upon, are inadequate or insufficient. The first scenario is rejected through economic thinking; the main ingredient and a substantial part of the

manufacturing cost cannot inflict a price decrease by increases in price itself. Instead, there are several problems with the data and the model.

5.4.1 The Data

There is a large amount of noise in all data on chocolate prices. Many of the graphs illustrating chocolate prices compared to the cocoa price show a volatile behavior of the former. The noise comes partly from collecting prices from different stores in different socioeconomic and geographical areas with different pricing strategies (creating a large price range) and partly from seasonal offers, sales and promotions.

The main problem is however the small number of observations. For a model with four independent variables at least a couple of hundred observations would have been desirable. With a larger sample size the noise would be acceptable and the estimates would still be significant.

5.4.2 The Model

On an overall basis, the appearance of the residuals is relatively good considering the small sample size. This gives some credibility to the models and the results. In most cases, the residuals do not differ much between the models, suggesting that there was no serious problem of trending.

The goodness-of-fit R^2 generally lies around 50 percent or below inducing that approximately 50 percent of the variation in y is explained by variables not accounted for. These factors could help explain the decreasing behavior of the chocolate price. There is also a possibility that the unobserved factors are correlated with included independent variables, causing an omitted variable bias. Hence the size of estimators should be viewed upon with a certain error margin.

The RESET-test most commonly did not show any evidence of functional form misspecification, it, however, did in the Marabou flavored chocolate segment. This could mean that the model in this case is either underspecified or overspecified. Most likely it is underspecified, since variables accounting for flavor ingredients were not included. This leads to a bias in the results from this regression. Even if RESET shows no evidence of misspecification it is not fully certain that the model is correct.

By only including four independent variables in the model, we can conclude that important variables were left out. For example, flavored chocolate accounts for extra ingredients like fruit and nuts. Since these extra ingredients cannot be assumed to be uncorrelated with all independent variables, this will lead to an omitted variable bias. This was inevitable and must be kept in mind when studying the results. The estimators are likely not unbiased. The regressions tell us that increases in both cocoa prices and household consumption lead to a decrease in chocolate prices. As this contradicts basic economic theories, we believe that omitted variables are to blame for cocoa and consumption having to take on a negative sign.

The cocoa prices have increased while the chocolate prices, in most cases, have decreased over the same time period. When controlling for the possibility that a certain relationship between the two is shown only because they are trending in opposite directions, it was most often found that the significance of the estimators decreased. This suggests that estimated relationships are given a too high significance because of factors not controlled for, in this case for example a time trend.

5.5 Possible Explanation of the Results

The explanation of the contradictory behavior of chocolate and therefore the surprising results of the regressions lies in the omitted variables.

The profit maximization formula $p = \left(\frac{n}{n-1}\right) mc$ shows that the margins and the marginal cost are responsible for the price setting. Since the marginal cost has not decreased but rather increased, falling margins must be responsible for the falling chocolate prices. The margins are known to be high and there is, thus, room for adjustments. These margins have most likely decreased over the time period, in order for the retailers to offer even, competitive prices to customers. A decrease in margins is supported by statements from candy retailers. We assume that decreasing margins could help explain the decline in real chocolate prices. We also believe cocoa prices and chocolate prices to be falsely negatively correlated due to this omitted variable. It would have been desirable to include margins as a variable in the regression models in order to get proper estimates of the real relationships.

Out of all types of chocolate investigated, only the average chocolate price is growing over time. Even though there was no certain relationship between the sign of the cocoa estimate and the direction of the chocolate price development, we believe that there is no coincidence that the relationship between cocoa and chocolate prices is positive in this case. As there is no need to explain a declining behavior of the chocolate price, there is no need for more explaining variables. Changes in cocoa price are shown to have a positive impact on chocolate prices, namely a cost pass-through of 0.15 percent.

5.6 Criticism of sources

A problem in this kind of study is that it is not possible to get data without noise- sales and promotions could not be excluded- which strongly affects the appearance of the price development. A longer data series would have helped reducing these problems. In addition, only two brands have been examined, leaving half of the chocolate market out.

Another problem is how well the model measures the relationship between changes in cocoa and chocolate prices, that is to say the validity. The model has been formed from economic theory but it was formed to fit all segments of interest. The model was thus forced to be basic and it is plausible that variables of importance have been left out. The results have been analyzed with economic theory, previous studies and reliability of the regressions in mind. Hence the validity and reliability of the paper conclusions is seen as satisfactory.

6. Conclusion

According to profit maximization theories, the consumer price is set up by margins and marginal costs. On the level of marginal costs, ingredients play a major role, and the most important commodity in chocolate production is cocoa.

As the cost pass-through of cocoa in the chocolate price was examined, it was expected to come across results similar to those of earlier studies within the area. The results were however different, showing a negative cost pass-through, standing in conflict with economic theories, earlier studies and our estimations. These surprising results were identified as being due to a large amount of noise in the data, too few observations and especially omitted variables, resulting in biased and insignificant OLS estimators. Omitted variables were thought to cause a false relationship between cocoa and chocolate as well as creating biases in the estimators. Margins were recognized as being the most important omitted variable. Decreasing margins that were omitted from the model are suspected to be the main reason for the contradictive relationship.

The results can however show the approximate size of the cocoa cost pass through. The cost pass through is believed to be small for the industry as a whole, but to some extent larger for high cocoa content chocolate than for regular chocolate. We believe that the size of cost pass through is equally small in similar industries.

This conclusion can be of some value for the central bank of Sweden and companies in the chocolate industry. In a short perspective, there is no need to worry about commodity costs. The inflation rate will not be severely affected and the pricing strategy of companies can be set for longer periods than quarters.

This report was delimited to the impact of changes in cocoa costs on the chocolate industry in Sweden, but there exist other reasons for why changes in chocolate prices could occur. One important reason could be explained by basic microeconomic theories on supply and demand: an increase in the quantity demanded makes the demand curve shift to the right, creating a new equilibrium with a higher price and vice versa (Perloff 2007).

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