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A world of flowers: Dutch flower auctions and the market for cut flowers

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Abstract

This paper gives an overview of international flower production, consumption and trade, focusing on the Dutch flower auctions in Aalsmeer, the world's leading flower trading centre. Data on prices and traded volumes for three important species of cut flowers (roses, chrysanthemums and carnations) for the period 1993–2008 are analyzed. Flower prices and traded volumes are extremely volatile. Although part of this volatility is predictable, because of regular seasonal variations in demand, a large proportion of the observed volatility is due to sudden shifts in supply. The real prices of cut flowers declined during this period, and there was a clear shift in consumer preferences toward roses and away from carnations. In addition, consumption of roses and carnations shifted from clearly seasonal toward more year-round consumption, while consumption of chrysanthemums followed consistent seasonal cycles throughout the period. During this period, non-European producers increased their market shares. This development can be traced to a significant decrease in cut flower prices relative to energy prices, especially after 2003.

Key words: Flower markets, flower production and trade, volatility, Dutch flower auctions, price analysis

Introduction

Cut flowers belong to a very special class of commodities. Flowers, like newspapers or fresh bread, are extremely perishable. Furthermore, the intrinsic value of flowers differs from that of most other commodities. While almost all agricultural commodities are produced and bought to satisfy nutritional or energy requirements, flowers are demanded solely to satisfy emotional needs. As such, flowers are in the same category as the arts, *e.g.*, a theatre performance or a music concert. Performing arts differ in that they may be stored as audiovisual recordings. Furthermore, flowers are bought to convey sentiments of different, sometimes completely opposite, types. Flowers are used both to signal sympathy in times of grief and as a token of joy and happiness. Bolle (2001) discusses such signals in the light of cooperation and exploitation, in terms of transaction cost economics. The combination of flowers' extreme perishability and their being demanded for multiple emotional and aesthetic reasons makes the market for cut flowers an interesting and challenging object for economic analysis.

The aim of this paper is to give an introduction to the international flower markets, with a focus on the Dutch flower auctions. First, we put flower prices in a historic perspective. The so-called 'tulip mania' in the 16th century is often referred to as history's first financial bubble. With the tulip mania as a historic backdrop, we move to the recent history of flower markets, presenting some vital statistics on production, exports, imports, consumption and prices since the 1990's. The two decades since 1990 represent the globalization of floriculture. Flower production requires labour and capital, in particular energy (heat), light (sun- or artificial light) and fertilizer. Energy comes as oil, gas or electricity, or alternatively as heat generated by the sun. The latter is more available in the southern countries, and increasing oil prices have gradually reduced the relative production costs of flowers in countries like Kenya and other African countries where major energy source is the solar energy. This process will be illuminated through some simple statistical relationships between flower prices and oil prices.

Flower prices: 500 years of roller coaster: The history of Holland as a flower-trading and flower-producing country dates back to the end of the 16th century. The history of the Dutch flower trade is discussed in, *e.g.*, van Lier (2005). In 1594, botanist Carolus Clusius (1526-1609) planted the first tulips in Dutch soil, only to see the whole collection stolen from the university garden that same year (van Lier, 2005). From then on, exotic plants were imported in increasing quantities from the Dutch East and West Indies to merchants in Amsterdam, who acted as suppliers to the great gardens of Europe. Some of the merchants also commissioned drawings and paintings of the flowers they had for sale, which were published in books. By 1630, dozens of books existed depicting flowers, especially tulips; these served as catalogs of the flowers for sale (van Lier, 2005).

The demand for tulips rose dramatically and between 1610 and 1637 the tulip trade developed into a so-called "fever", affecting the whole country. Garber (2000) gives an extensive analysis of the development, subsequently labeled "the tulipmania".

The mania soon reached the middle classes and, according to Mackay (1841), a popular tulip could cost as much as an Amsterdam townhouse. Why tulips only became the focus of a mania is hard to understand, as there were many flowers at the time that were considered more beautiful than the tulip. It has been suggested (*e.g.*, Garber, 2000) that the fact that the tulip was difficult to grow and susceptible to disease made its cultivation a challenge at which only the best succeeded (Pavord, 1999). In addition, some of the tulips developed striped flowers, where the pattern of stripes was unique for each bulb; this became the focus of great attention. At that time, it was not known that the stripes were due to mosaic virus attacks (Lesnaw and Ghabrial, 2000).

What makes tulips different from most flowers is that they can be harvested and moved only between June and September; consequently, spot market trading could take place only in this period. During the rest of the year, futures contracts were made before a notary. In 1636, these contracts were formalized, but no deliveries were made, as the market collapsed in February 1637.

However, as a result of the tulip trade, the Dutch developed many of the techniques used in modern finance. In 1636, regular markets were opened in many Dutch cities. Foreigners entered the market and money flooded into Holland. Eventually, it became obvious that the capital inflow and rising prices would come to an end. Confidence vanished and panic spread. Prices fell abruptly and bulbs could not be sold at even a fraction of their previous value.

The price differences across the different bulb cultivars were huge. Therefore, Thompson (2007) developed a standardized, quality-weighted price index for tulip bulbs in the period from November 12, 1636, to May 1637. The bulbs were sold by weight, and prices were calculated as guilders per aas (aas = 1/564th of an ounce). The calculation of the index is explained in detail in Thompson (2007). The price per aas increased from less than 10 guilders to approximately 200 in less than three months. From February 3 to February 9, 1637 (*i.e.* seven days), the price decreased by 50 guilders, and by the beginning of May 1637, the price had returned to the November 12 level.

According to Mackay (1841), several public meetings were held to try to pressure the government to bail out the unfortunate traders but without success. The problem ended up at the Provincial Council at The Hague, but a remedy was beyond the power of the government. The judges assumed this to be debt contracted in gambling, and therefore not debts in law.

So, according to Mackay (1841), the story ended. The final buyers had to carry their losses as best they could, and those who had gained from the high prices were allowed to keep their profit. The Dutch flower business suffered a severe shock, and it took years to reestablish confidence.

Until the 1980s, Mackay's presentation of the tulipmania, or "bubble", went unchallenged and mostly unexamined. More recent studies suggest that Mackay's research was incomplete and inaccurate. Goldgar (2007) argues that the tulipmania phenomenon was far more limited than previously thought, that only a handful of people experienced severe economic problems in this period, and that even for these people it could not be proven that the problems were due to the tulip trade. Even if prices had increased enormously, money had not changed hands. Therefore, profits were not realized and, unless they had made other deals on credit, the price collapse did not incur losses to traders.

Garber (1989) claims that one reason for the extreme price increase at the end of 1636 was that the bulbs had already been planted by then, which meant that the producers could not increase production as a response to the price increase.

Thompson (2007) argues that Garber's model cannot explain the abrupt price decrease. He believes that the dramatic price movements can be explained by changes in laws related to the futures contracts. According to Thompson, the essence of these changes was that futures contracts written after November 30, 1636, were to be interpreted as options. This meant that whereas the buyers were previously legally obliged to buy the bulbs, they could now choose to compensate the sellers with a fixed small percentage of the contract price (Thompson, 2007). Thompson argues that the mania was a rational response to legal changes. In any case, the tulipmania is still seen by many as a large economic bubble.

In any case, the early experience with tulip trading laid the foundation for elaborate and advanced trading institutions and pricing mechanisms in the flower business, notably the Dutch flower auctions.

Recent history of the world market for cut flowers: As recently as 40-50 years ago, the demand for cut flowers and potted plants around the world was generally satisfied by local production. In Europe, growing per capita income caused increased demand for flowers for everyday use and as gifts for special occasions. As transportation systems improved, more flowers were shipped from southern to northern Europe and the size of the European trade grew considerably. This was the start of the commercial flower industry as we know it today (Wernett, 1998).

The energy crisis in 1973 strengthened the comparative advantage of flower producers in southern Europe because of the large energy costs of greenhouse flower production. Energy costs constitute approximately 30-40 percent of the total variable costs in cut flower production in northern Europe, and significantly less in southern Europe. Increasing amounts of flowers from the south of Europe were therefore moved to the Dutch flower exchanges to meet the demand after 1973.

Later, increasingly, flowers bought in Europe were produced by Israeli producers. In Israel, flowers may be grown outdoors or in plastic tunnels all year round, eliminating both the energy costs and the fixed greenhouse costs that the European producers face. The Israelis faced two other limiting factors, however: transportation costs to Europe and water supply. These limitations were reduced through transport subsidies and research into watering systems to reduce water consumption in agricultural production (Wernett, 1998).

Starting in the 1970s, big marketing campaigns financed by the Holland Flower Council started to influence consumption patterns outside of Europe, and cut flowers from the Dutch flower exchange entered the American market, mostly through New York. At the same time, Miami developed as a base for flower imports from Colombia, for onward distribution in the USA. This led to strong competition for local American producers that the Europeans used to their advantage. South American producers bought plant varieties from Europe, and North American producers were persuaded to buy production systems from Europe in order to counter the competition from the south (Wernett, 1998).

During the 1990s, African countries, in particular Kenya, exported increasing quantities of cut flowers to the European market. Together with the Israeli flower industry, Kenya is now a major competitor to the European producers.

As African producers entered the European market, European flower traders started to expand into Asia, especially to Japan, exporting cut flowers as well as production systems and technology. This drive into Asia was helped by aggressive marketing campaigns. Commercial flower production in Asia started to develop because of increasing demand for low-priced flowers from the European market and European, mainly Dutch, producers started to produce in East Asian countries.

What makes flower production in Asia different to that in Africa and South America is that the latter produce flowers almost exclusively for export, whereas in Southeast Asia there is a growing market for local consumption because of growing incomes.

In the future, the largest potential for development and expansion of the flower industry is assumed to be in Asia, both for local consumption and for export. An in-depth analysis of the history of flower markets and the potential of Asian commercial flower production has been made by Wernett (1998).

Flowers by numbers - *International production and trade*

In 2008, the total area used for cut flowers and potted plants in the world was approximately 532,000 ha, an increase of 33 percent from 2005. The biggest producers in terms of land use were China with 286,000 ha (2006) and India with 70,000 ha (data from 1999 only). China almost doubled its flower production acreage during the last three years of the study period; the same is probably true for India. Almost 75 percent of all flower production land was in Asia, a 12 percent increase during the last three years. South America had almost the same area as Europe, approximately 50,000 ha, both stable since 2005. The data included on flower production, exports, imports and consumption are collected from International Statistics Flowers and Plants, 2005 and 2008.

If we look at the value of production, the picture is somewhat different. The total value of the world's flower production was approximately €24 billion in 2008, a 33 percent increase from 2005. European production constitutes almost half that value; the value of Asian production is approximately €7 billion.

The total value of world imports of cut flowers and potted plants in 2007 was estimated at €10.3 billion, Germany being the single biggest importing country with €1.5 billion (the EU data for 2007 include data for two new member countries, Bulgaria and Romania). By comparison, USA and Japan imported flowers for €893 million and €241 million, respectively (International Statistics Flowers and Plants, 2005 and 2008).

The total value of flower exports in 2007 was €10.9 billion, of which the Netherlands was responsible for almost half. European exports constituted approximately two-thirds of total exports. The Americans were the second biggest exporters with €1.8 billion, (with Colombia, Canada and Ecuador as the biggest exporting countries). Asia was exporting approximately €1 billion and Africa €820 million. Kenya was the biggest flower exporting country in Africa with €500 million, up approximately 100 percent from 2004.

Table 1. Value (€ 1000) of imported cut flowers from Africa, Latin America, Asia and the Middle East to the Netherlands and EU (total).

Exporting county	The Netherlands		EU total	
	2004	2007	2004	2007
Africa, total	288,806	312,365	347,569	447,371
Kenya	144,226	205,029	235,378	312,703
Latin America, total	64,844	105,615	171,934	235,533
Colombia	18,268	27,274	84,297	115,586
Ecuador	42,648	72,158	79,167	110,421
Asia (Middle East excluded)	4,546	5,394	21,490	26,574
Middle East, total	65,574	46,961	101,225	91,015
Israel	60,713	40,942	85,510	73,989
Total	423,770	470,335	642,218	800,493

Table 1 shows the value of imports from the major non-European flower producers into the Netherlands and the EU. More than half of the imports in 2007 came from Africa, with Kenya as the dominant exporting country. Almost 40 percent of total EU imports came from Kenya and together with Israel, Colombia and Ecuador these countries supplied 77 percent of EU imports (€613 million out of approximately €800 million in 2007). Total imports to Europe from non-European countries increased by 25 percent from 2004 to 2007, and the imports from Kenya by 75 percent in the same period. More than half of Europe's flower imports went through the Netherlands (in 2007). This amount increased by approximately 60 percent during the 10 years to 2007. In 2007, Great Britain and Germany imported flowers valued at approximately €170 million and €50 million, respectively, from non-European countries.

There is also a significant intra-European flower trade with the Netherlands as the focal point. Almost half of Germany's imports, more than 60 percent of Great Britain's imports and roughly 40 percent of the flower imports to France, by value, come from the Netherlands.

Fewer than 10 species make up the bulk of the cut flower trade: roses, chrysanthemums, tulips, lilies, gerberas, cymbidium, freesias, anthurium and alstromeria. While the value of cut flower species traded at Dutch auctions increased by 25 percent during the period 1998-2008, the value of the rose trade in the same period increased by more than 70 percent.

Table 2. Per capita consumption (€) and market value of consumption (million €) of flowers, 2006

Country	Per capita consumption			Population	Estimated market value		
	Cut flowers €	Plants €	Flowers (total) €	(Million)	Cut flowers (€ million)	Plants (€ million)	Flowers, total (€ million)
Germany	36	48	84	83	2,988	3,984	6,972
Netherlands	54	32	86	16	864	512	1,376
Norway	62	62	124	5	310	310	620
Russia	5	1	6	143	715	143	423
Switzerland	82	43	125	7	574	301	875
Europe	23	16	38	680	15,755	10,740	26,060
Japan*	54		54	128	6,912		6,912
USA*	21		21	306	6,426		6,426

*Cut flowers only

Table 2 shows the consumption of flowers (cut flowers and total) per capita in 2006, as well as the value of consumption. When it comes to total demand for flowers, Switzerland and Norway had the highest per capita total consumption of flowers in the world. The average per capita consumption of cut flowers (in 2006) in Europe (€23), even including the relatively low consumption in Eastern Europe and Russia, is higher than the per capita consumption in the USA (€21), but considerably lower than in Japan (€54). When we take into account the population of the different countries, Germany is by far the biggest consumer in Europe with a total consumption of flowers and plants of almost €7 billion. Of this, the value of cut flower consumption is €3 billion, which is approximately half the value of cut flower consumption in the USA. Japan is the biggest cut-flower-consuming country in the world with a value of €6.9 billion.

The Dutch flower auctions: The history of today's Dutch flower auctions dates back to 1911-12, when flower producers in the city of Aalsmeer established two flower auctions: "Bloemenlust" on the east side and "Central Aalsmeer Auction" in the city centre. The auctions were established because producers felt they were in the hands of agents who manipulated prices and that the agents were not always reliable payers (van Lier, 2005).

The concept of the cooperative auctions was adopted from the fruit and vegetable industry. The producers hoped they would collectively become stronger and, by offering their product exclusively at the auctions, they forced the buyers to trade through the so-called auction clock. On a "one-armed clock", the clock arm moves counterclockwise, starting at a high price, which falls until the first buyer stops the clock at the price he or she is willing to pay. Thus, the introduction of the auctions seemed to shift power from agents to growers.

The aim of the clock auction was to generate a fair price. It increased competition on the demand side, because the buyers could get information about the prices and quantities of their competitors. On the supply side, it led to higher quality of the flowers offered at the auctions.

In 1972, Bloemenveiling Aalsmeer was established through the merger of several smaller auctions; most recently, in 2007, Bloemenveiling Aalsmeer and FloraHolland, the two largest flower auctions in the world, merged. The merged company, called FloraHolland, started its operations in January 2008.

The main reason given for this merger was the threat from developments in the international flower market, especially the opening of a flower market in Mumbai, India, and another one in Dubai. As India has evolved to be a very big flower producer, as well as a substantial consumer, and as Dubai is closer to the African flower producers than the Netherlands, there was a fear in Aalsmeer that trade would shift toward Dubai.

The Dutch flower auctions have so far managed to develop and sustain a leading position in traded volume as well as in research, production, marketing, standardization, information and education (Wernett, 1998). In 2008, the merged FloraHolland had a turnover of €4.07 billion.

The flower auction in Aalsmeer is today one of Floraholland's six auction sites in the Netherlands but, because of its history and size, Aalsmeer requires some special attention. In 2008, Aalsmeer had a clock turnover exceeding 11 billion cut flowers and 800 million plants, amounting to a turnover of some €2.4 billion, more than half of the total clock turnover of Floraholland. The auctions take place in a huge trade centre covering approximately 1 million square meters, which is roughly comparable to 250 soccer fields. Within this trade centre, very complex logistical processes and auctions take place, which in turn determine world prices for flowers.

In any given week, around 100 species of cut flowers are traded in Aalsmeer and for many of the species there are several varieties. As many as 30 to 40 different varieties of roses are traded, with each variety possibly having different colours and lengths. There are also quality differences. Therefore, in contrast to many agricultural and industry products, fresh flowers cannot be treated as a well-defined, homogeneous product. Cut flowers are very fragile, they cannot be stored, the supply is relatively unpredictable and price variations over time and among cultivars are substantial. Trip *et al.* (2000) examined the price-predicting abilities of Dutch chrysanthemum farmers, finding evidence that predicting relative price positions (relative to other cultivars) was a skill. They also found that price differences among cultivars were nonrandom in time and that growers could adapt their production planning and cultivar choice to benefit from expected price variations.

Approximately 9,000 individual producers market their flowers at the auctions of FloraHolland, of whom 5,000 are exchange members. Since 2007, producers from non-European countries can become members of the cooperative. The new members are mostly "off-shore" Dutch producers located in Kenya and Uganda as well as Israeli growers. Each member has to make a deposit to the cooperative equal to 1 percent of their sales. The cooperative pays interest to members and the deposit is fully returned after nine years. Members can also give interest-bearing loans to the cooperative. The general assembly meets twice a year and members' voting power is determined by their sales (deposit).

One important objective of the FloraHolland cooperative is to sustain and improve its market position by offering quantity, quality and variety. The declared objective of FloraHolland, a nonprofit service organization, is to offer their members the best sales possibilities at a low cost (FloraHolland, undated).

The auctions: The day starts early at the Dutch flower auctions. The night before each trading day (Monday-Friday), flowers are unloaded from numerous trucks at the auction halls. The cut flowers are stored in carts in cold rooms. At 4:30 a.m., the flowers are transported to the huge collection halls and sorted by species and quality.

Each unit is quality checked and given a unique number. Then the carts are connected to each other and dragged into the auction rooms on small electrical trains. The auctions start at exactly 6:30 a.m.

As mentioned above, the auction mechanism is the so-called Dutch auction. As opposed to an English auction, the starting price is high rather than low. The auctioneer announces the flowers to be sold, including batch size, minimum buying quantity, name of the producer and comments, if any, from the quality inspector.

The bidding is controlled by a huge clock-like screen indicating the unit price (*e.g.*, €100, €10 or €1). A blinking light on the screen marks the starting price, which then moves downward on the clock. A buyer will press the button at his or her desk in the auction room to stop the clock when the light hits the price he or she is willing to pay.

When a buyer stops the clock, he or she must immediately communicate to the auctioneer the quantity purchased at the given price. Soon afterward, the clock moves to a slightly higher price before it again starts its downward move. This procedure is repeated until the whole batch is sold. The procedure then re-starts for the next batch of flowers to be auctioned. Each unit of flowers has a minimum price. If the minimum price is not achieved, the whole batch is withdrawn and destroyed immediately after the auction.

Thus, during the auction, each of the bidders must choose a reservation price, which is where the bidder would stop the clock if the price should fall to that level without exhausting the offering. The bidder with the highest reservation price wins the object at his or her chosen price. This type of auction is often described as an “open first-price auction” and a more precise definition is “A sequential, private value auction of identical objects” (van den Berg *et al.*, 1999). It is considered strategically equivalent to a “first-price sealed-bid auction”. There is a huge body of literature on auction theory (set ups, outcomes and so on). A classical reference on auctions and bidding is McAfee and McMillan (1987). Van den Berg *et al.* (1999) analyzed the presence of declining prices at the auctioning of roses at the Dutch flower auctions. In addition, Kambil and van Heck (1995) performed an in-depth study of the features, strengths and weaknesses of the Dutch auctions and the effects of the introduction of new trading mechanisms based on information technology. Usually, there are only data on winning bids, but van den Berg and van der Klauuw (2007) performed an interesting structural empirical analysis of the auctions of potted plants using data on losing bids.

The buyers at the auctions mostly represent large flower wholesalers, exporters and large retailers. Up to 90 percent of flowers sold reach their final destination within 24 hours. Transportation within Europe mostly takes place in cooled trucks. Flowers are sent to the USA by plane; they usually reach New York during the evening or night of the sales day, and wholesalers in the New York flower district receive them as early as 3:30 a.m.

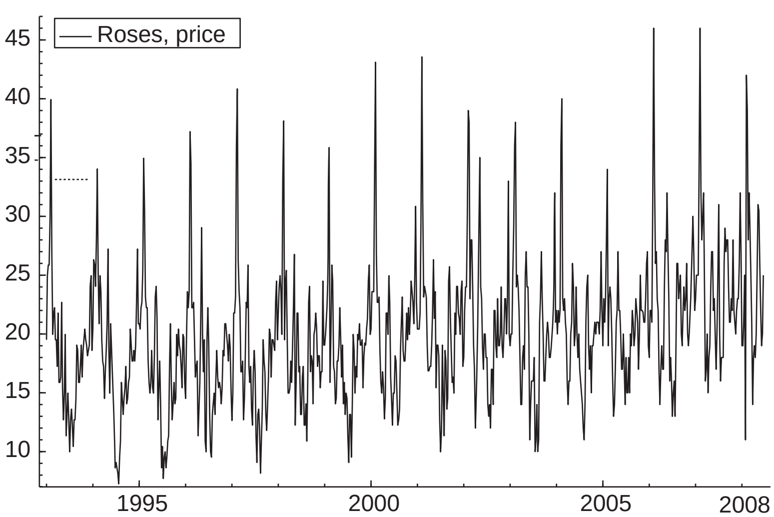

Fig. 1. The nominal price of roses (Eurocent per stem) week 1, 1993 to week 25, 2008.

The 39 auction clocks of Floraholland are at the heart of the auction system. Every sales day, roughly 1,000 buyers gather in front of the clocks to follow the prices of the different flowers for sale. Different products are offered at different clocks. Each transaction takes only a few seconds. The auctions are therefore carried out at a tremendous speed, which is important for a highly perishable product. The FloraHolland auctions have approximately 125,000 transactions per day, which amounts to more than 12 billion cut flowers and more than 800 million potted plants traded each year (Floraholland, undated).

More than 60 percent of the world flower trade goes through the Dutch auctions. It is also possible to trade at the auctions without being physically present, following the clock via the Internet. There is also a gradual transition toward the flowers being presented through pictures rather than live at the auction, so that the flowers do not have to leave the cooled storage until they are transported directly to the buyer.

Floraholland employs 4,500 people, 2,000 of whom are in Aalsmeer. A further 12,000 people (in Aalsmeer) are employed in supporting activities such as wholesaling and exporting. The flower sector in the Netherlands is a significant sector, economically and socially. The contribution of the Dutch flower trade to the balance of trade is 20 percent. The direct and indirect employment in the flower sector is approximately 250,000 full-time jobs (Floraholland, undated).

Prices, price volatility and turnover at the Dutch flower auctions 1993-2008

Prices and traded volumes at the Dutch flower auctions are published weekly in “Vaakblaad vor der bloemisterij”. Here, weekly data for the period January, 1993 to June, 2008 are analyzed.

Flower prices: Fig. 1 shows the weekly nominal rose prices, measured in Eurocent per stem, during the period 1993-2008. The rose price trended upward by 1.9 percent annually, as compared to the price of carnations, which increased by 1.2 percent annually. Chrysanthemums, however, saw stagnating prices during this period. The average inflation (CPI) in the Netherlands for this period was 2.3 percent annually, which means that the real price of cut flowers fell by 0.5-1 percent annually.

The demand for cut flowers is extremely seasonal, generating regular calendar patterns in prices. Therefore, to describe prices in a somewhat longer run, the series are smoothed (12-month moving average). Fig. 2 visualizes what can be labeled the business cycles in the flower trade.

Disregarding the sharp seasonal price movements, rose prices trended quite steadily upward, particularly after 2005. Chrysanthemums, with no long-term price increase, saw some large fluctuations with price peaks in 1998 and 2001. The long-term price growth for carnations is mainly a result of a price surge after 2000; at the end of the 1990s, carnation prices dropped dramatically.

Traded volumes: From Fig. 3, we can see the cycles and trends in traded volumes during the study period. For the auction as a whole, there was a growth of 1.1 percent on an annual basis, mainly due to the increased demand for roses (+ 2.6 percent annually). For chrysanthemums, the traded volume during this period was stable; for carnations, there was a strong negative trend (12.4 percent on an annual basis).

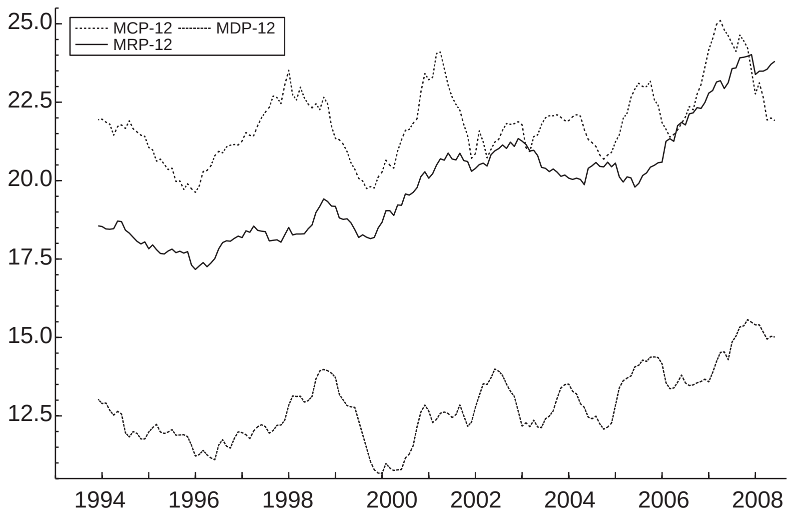

Fig. 2. Smoothed prices (12-month moving average) for roses (MRP-12), chrysanthemums (MCP-12) and carnations (MDP-12); Eurocent/stem, 1994-2008

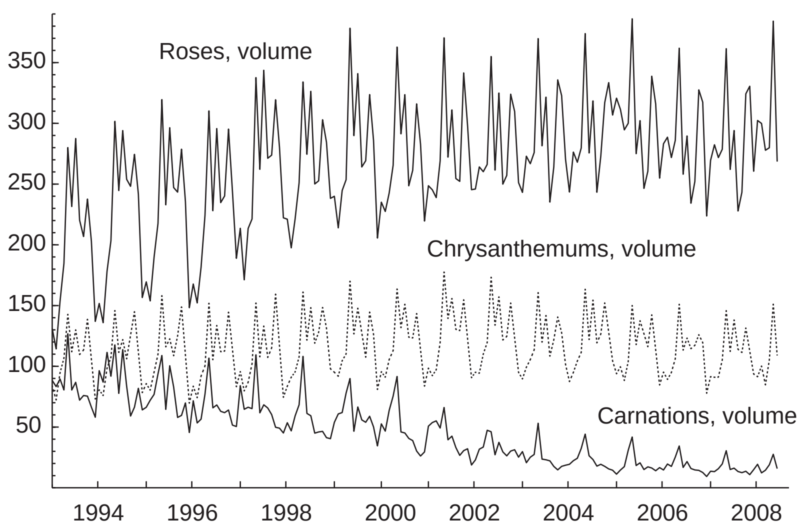

Fig. 3. Traded volumes (million stems) of cut flowers per month in the period January, 1993 - June, 2008.

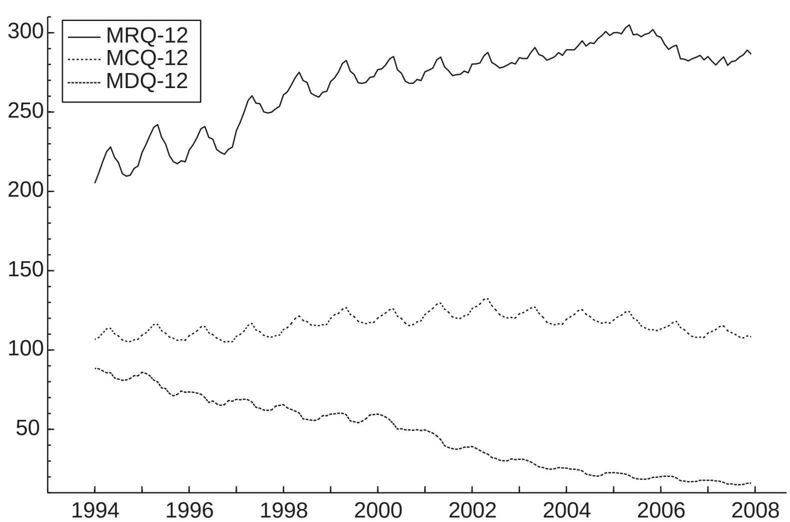

Fig. 4. Smoothed volumes (12-month moving averages) for roses (MRQ-12), chrysanthemums (MCQ-12) and carnations (MDQ-12); million stems, 1994-2008

The calendar patterns in prices are obviously reflected in volumes. Fig. 4 shows the smoothed (12-month average) volumes.

As can be seen, all three species had distinct calendar cycles up to 2000/2001. After that date, demand for roses and carnations appeared to be smoother, while chrysanthemums maintained strong seasonalities throughout the period. Thus, the consumption pattern for roses and carnations seems to have changed over time, toward a more year-round, or "everyday" consumption, while the demand for chrysanthemums is still quite traditional, linked to the time of the year and to events occurring each year.

Seasonalities in prices and volumes: The seasonal patterns are further illustrated in Fig. 5, displaying the mean prices for three main species of cut flowers over weeks 1-52. The overall mean prices of roses, chrysanthemums and carnations were approximately 20, 22 and 13 Eurocent/stem, respectively. Around these averages, the coefficients of variation (CV) were between 18 and 30 percent on a monthly basis, which makes flowers an extremely volatile commodity. The seasonal variation in prices was much higher for roses and chrysanthemums where the average price in the winter was as high as 2-2.5 times the average price in the middle of the summer.

Fig. 5 shows very strong seasonal cycles in the prices, but the cycles were not identical for the three groups of cut flowers shown. Roses were the most extreme, with a high of 39 Eurocent/stem before Valentine's Day down to 13 at the end of July. Again, chrysanthemums showed a similar pattern to roses. Chrysanthemums usually had a lower price than roses in weeks 14-38 and higher prices the rest of the year (with the exception of Valentine's Day sales).

Carnations had very different cycles to those of other cut flowers. Prices were relatively higher in February, June and October and lower in December and April. The differences between the high and low prices were smaller for carnations than for the other cut flowers.

Fig. 6 shows the demand cycles over the year for roses, chrysanthemums and carnations. For all species, traded volumes were relatively low during the winter period with the exception of sales around Christmas time. Thus, during the last couple of weeks of each year, traded volumes were up. For roses, January was a month with relatively low sales, but in February, there was a distinct peak, particularly in week 6, coinciding with Valentine's Day and then Mother's Day. The traded volume of roses increased steadily until it reached a maximum at the beginning of May. It then decreased slowly until July/August. After a slow increase in early fall, the sales decreased again until the beginning of December; finally, there was the Christmas sale.

Chrysanthemums followed roughly the same pattern as roses, but the peaks were less distinct. For cut flowers seen as a whole, the spring turnover was remarkably higher than the turnover during the rest of the year. This was mainly

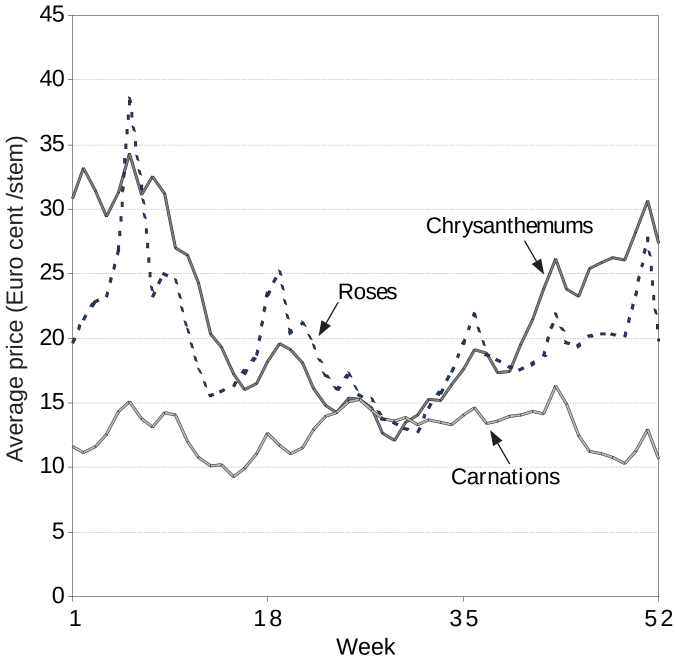

Fig. 5. Average prices (Eurocent/stem) of cut flowers each week, weeks 1-52, 1993-2008

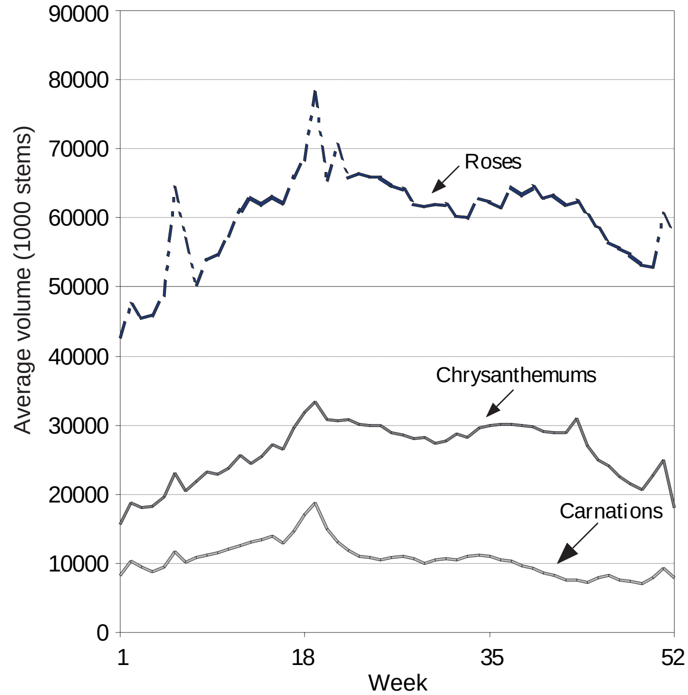

Fig. 6. Average weekly volume of different groups of cut flowers, week 1, 1993 – week 25, 2008

due to the demand for tulips and other bulbs in early spring.

Relative prices and consumer preferences: No big changes in relative production costs across different flower species occurred during the past 15-20 years. Hence, changes in relative prices may be interpreted as changes in consumer preferences.

Fig. 7 compares long-run changes in prices of different species using December 1993 as a common base. For most of the 1990s, prices tended to move together. Then, in 1998-99, a general reduction in prices took place, particularly for carnations. After that time, the rose price increased clearly more than the price of the two other species. While rose prices were up by almost 30 percent at the middle of 2008 compared with the 1993 level, carnations were up by only about 15 percent and chrysanthemums down by roughly 5 percent.

Fig. 8 illustrates this from a different angle, showing the scatter plot for the relative rose/chrysanthemum price together with a series for the smoothed average (exponentially weighted, alpha = 0.3) and the trend line. While a rose stem in the early 1990s was priced on average at 80-90 percent of a chrysanthemum stem, the rose stem attracted roughly the same price as a chrysanthemum after 2005. Thus, there seems to be a long-term trend in consumers' preferences toward roses relative to chrysanthemums. However, the huge and regular gyration in the relative price clearly show that the two species have their separate high weeks when the relative price may move by as much as 30-40 percent over very short periods.

Roses saw a price increase relative to chrysanthemums during the study period. Disregarding the seasonal price variations, roses became roughly 20 percent more expensive during the period. Carnations also became more expensive than chrysanthemums in this period, by approximately 10 percent.

Changes in consumer preferences are also revealed through changes in realized demand. Figs 9 and 10 show the relative traded volumes of roses versus chrysanthemums and carnations, respectively.

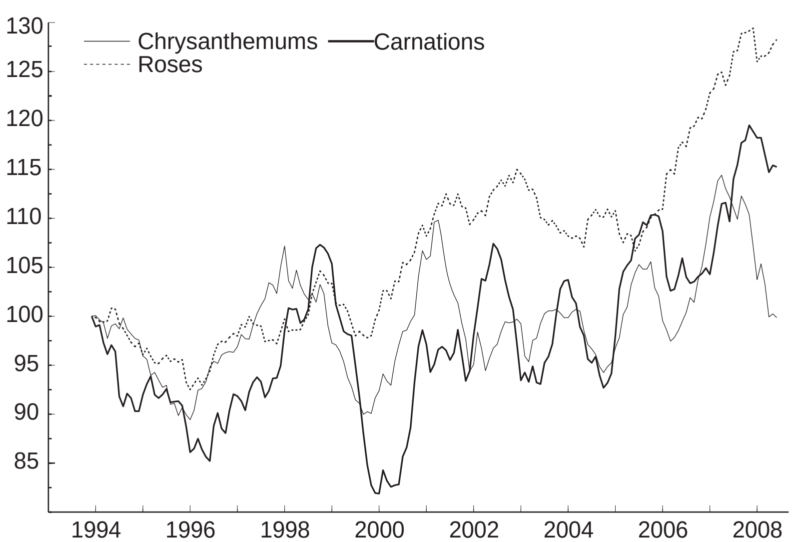

Fig. 7. Price indices (smoothed) for roses, chrysanthemums and carnations 1993-2008 (December 1993 = 100).

Disregarding seasonal variation in demand, the volume of roses traded in 1993 was about twice that of chrysanthemums. By the end of the period, in 2008, the volume of roses traded increased to more than 2.5 times that of chrysanthemums.

Roses clearly outpaced the other two species in terms of turnover and for carnations, even at an accelerating pace. For roses versus carnations, the change was extreme. At the beginning of the period, the volume of roses traded was about twice that of carnations, while at the end of the period (2008), the volume of roses traded was more than 20 times that of carnations. Therefore, rather than a linear trend as in roses versus chrysanthemums, we observed an exponential trend.

Flower prices, energy prices and the international flower trade: Cut flowers are beautified energy. During photosynthesis, carbon dioxide and water, in the presence of light and energy, are transformed into organic material and oxygen.

Energy costs form a large proportion of the variable costs of floriculture in Holland, as in other North European countries. The Dutch greenhouse industry accounts for 7 percent of the total energy use in the Netherlands, and approximately 4 percent of total CO_2 emissions (Lansink *et al.*, 2001).

Energy costs can be reduced by investments in energy-saving technologies. The Dutch greenhouse sector has signed an agreement with the government aiming to reduce the energy use per unit of production by 65 percent between 1980 and 2010 (Stuurgroep Landbouw en Milieu, 2000). Energy use has been reduced since 1980 but, according to Stuurgroep Landbouw en Milieu (2000), it will be very difficult to achieve that target.

Net present value calculations evaluating the profitability of investments in energy-saving technologies in Dutch floriculture predict a much higher rate of adoption of such technologies than is actually observed (Diederen *et al.*, 2003). One possible explanation for this is that the profitability of the investment is uncertain because of the stochastic nature of energy prices (Hasset and Metcalf, 1993). There is also uncertainty about the effects of increased production in other countries, *viz.* in Africa.

Another way to reduce energy use in the floriculture sector is to substitute solar power for oil, gas and electricity through imports from flower producing countries better endowed with sunlight and not using much oil, gas and electricity for flower production.

If we observe large reductions in the long-term flower price/energy price ratio, this can be interpreted as the effect of changing production location, *i.e.*, imports from countries in Africa, South America and Southeast Asia.

Fig. 11 shows the ratio of monthly rose (Eurocent/stem) to crude oil (USD/bbl) prices. The Fig. shows that until 1998 this ratio fluctuated around 1. From 2002 to 2003, this ratio decreased dramatically, and by 2008 it had fallen to approximately 0.25. Other cut flower prices show the same trend. We also observed less seasonal variation in the flower-oil price ratio. In other words, the price of cut flowers decreased dramatically relative to the price of energy (oil) after the 1990s. There has been a indirect change in use of energy sources in flower production and through increased imports, solar power has substituted for oil and gas requirements.

As shown in Table 1, from 2004 to 2007 there was 25 percent increase of imports from non-European (African, Southeast Asian and South American) countries to Europe. Rose imports from these countries to the EU countries increased by 46 percent in the period 2004-2007. This clearly supports the hypothesis that changes in the output price/energy price ratio can be used to explain shifts in location of flower production. This is not the focus of this paper, but would be an interesting extension of this work.

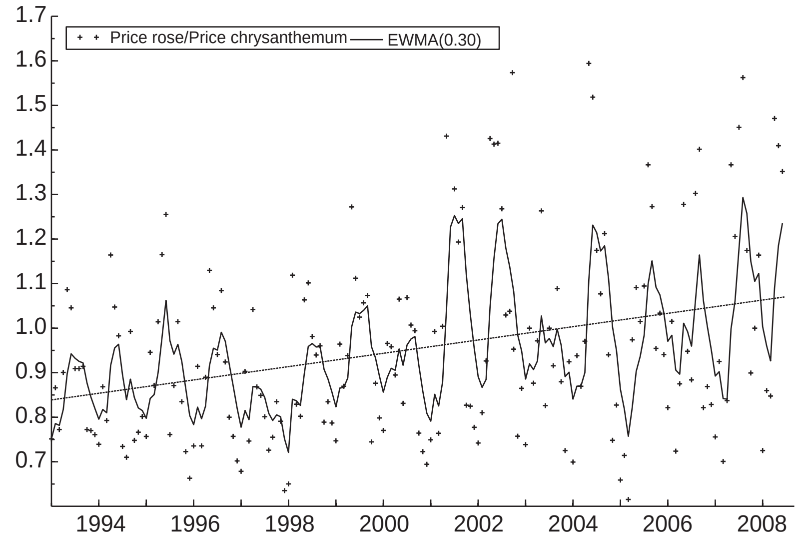

Fig. 8. Relative prices roses/chrysanthemums, January 1993 to June 2008 (monthly data). Scatter plot; trend and smoothed (exponentially weighted moving average, alpha = 0.3).

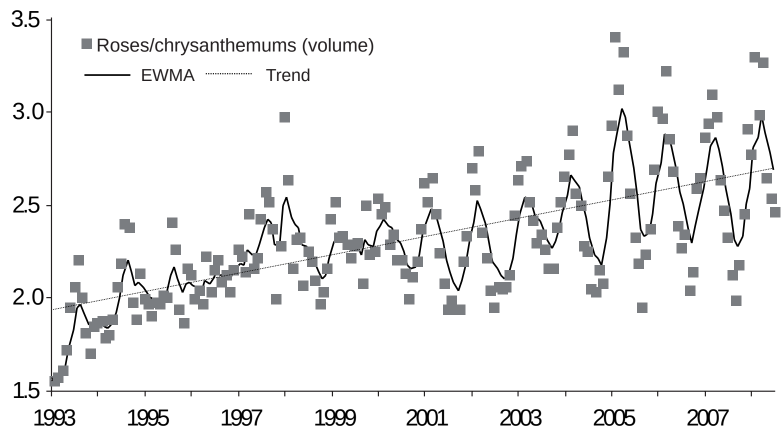

Fig. 9. Relative traded volumes of roses/chrysanthemums from January 1993 to June 2008 (monthly data), scatter plot, trend and smoothed (exponentially weighted moving average, alpha = 0.3).

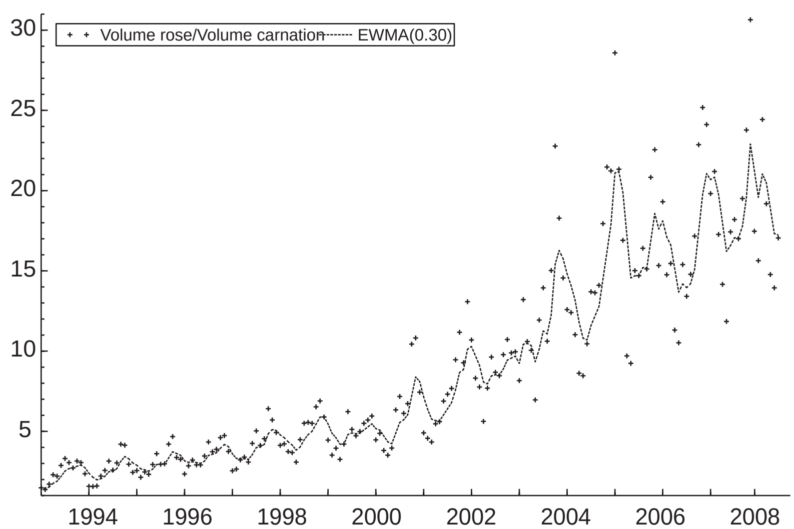

Fig. 10. Relative traded volumes roses/carnations from January 1993 to June 2008 (monthly data), scatter plot, smoothed (exponentially weighted moving average, alpha = 0.3).

Prices and traded volumes at the Dutch flower auctions during the 15 years from 1993 to 2008 reveal a number of distinct patterns and trends. For

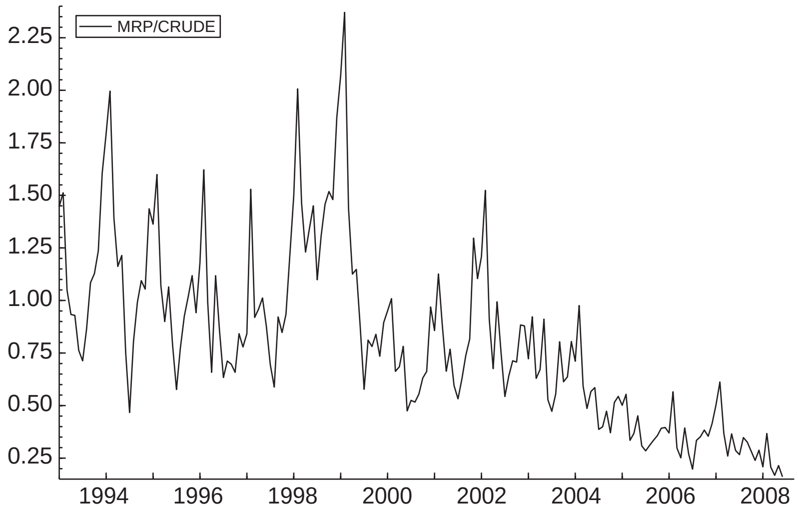

Fig. 11. The ratio of monthly rose prices (MRP) measured in Eurocent/stem relative to the price of crude oil measured in USD/bbl, from January 1993 to June 2008.

one, prices are highly volatile with persistent and strong seasonal patterns. The seasons are largely unique to each species of flowers. However, for some species the seasonality has gradually become less distinct. This is particularly the case for roses, which now seem to be year-round flower, while the demand for chrysanthemums continued to follow a more traditional cycle during the period of investigation. Flowers have become less expensive in real terms since the 1990s. Further, a relative increase in the price and demand for roses compared to other cut flowers indicates shifts in consumer preferences toward roses. Roses are clearly outpacing the two other major species in terms of turnover during the period of investigation, and for carnations, this is happening at an accelerating pace. While production in Europe is stable or declining, it is increasing rapidly in Africa, Asia and South America, and many Asian countries have experienced strong growth in consumption. This shift can also be traced as a decrease in cut flower prices relative to energy prices, especially during the last five years of the study period, due to strong growth in exports of flowers from Africa, notably Kenya, to Europe.

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