

# **The Dutch Tulip Mania: The Social Foundations of a Financial Bubble**

**A. Maurits van der Veen**  
*Assistant Professor*  
*Department of Government*  
*College of William & Mary*

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## **Abstract**

The Dutch tulip mania of 1636-1637 is the first well-documented instance of a financial bubble. In recent years, however, some economists have argued that bulb prices, while reaching extreme heights, nevertheless reflected underlying economic fundamentals. Presenting the most complete dataset of tulip prices compiled until now, this paper demonstrates that attempts to explain away the bubble in this manner cannot be justified with the available data: the tulip mania really did produce a bubble. Available price data are too scarce and unreliable to permit a conclusive explanation of the bubble, but evidence from contemporary accounts suggests that a model based on social networks and information cascades best explains the emergence and collapse of this bubble: a dense, localized social network made the bubble possible, but also served to limit its impact on the broader economy.

## **Keywords**

Tulip mania, financial bubbles, social networks, information cascades

JEL codes: N23, E30, G12, G14

## The Dutch Tulip Mania: The Social Foundations of a Financial Bubble

I shall eliminate...  
Those who ran with rabid lust after filthy profit,  
And poured so much of their poisoned juice  
That they nearly corrupted the real [flower-loving] people  
To no longer revere my flowers as they used to  
But weigh trash with pounds and bulbs by weight  
— Flora [the goddess of flowers], in  
*De verstoorde en noyt gestorven flora* (1637a).<sup>1</sup>

The Dutch tulip mania of the 1630s has long served as the epitome of the financial bubble. In his book *Irrational Exuberance*, Shiller calls it “the most famous bubble of all” (Shiller 2000, see also Kindleberger and Aliber 2005). No asset bubble is too small or too large or its bursting will be compared to the Dutch tulip craze. Indeed, references to tulips abound in discussions of the contemporary financial crisis (e.g. 2009, Nocera 2008). In recent years, however, some authors have called into questions its status as an early example of a financial bubble, instead characterizing pricing patterns as normal for novel luxury goods (Garber 1989, pp. 535-560, Garber 2000) or as reflecting a to a shift in market instruments from standard futures contracts to options (Thompson 2006, pp. 99-114, cf. Szpiro 2011).

Although there is no universally accepted definition of a bubble (O'Hara 2008, pp. 11-17), Shiller's characterization — “a situation in which temporarily high prices are sustained largely by investors' enthusiasm rather than by consistent estimation of real value” — appears relatively uncontroversial (Shiller 2000). The challenge lies in its operationalization: how does one judge whether “consistent estimation of real value” is taking place? The fact that single bulbs sold for more than the price of a house during the

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<sup>1</sup> The pamphlet title translates as ‘The angry and not-yet-dead Flora.’ All translations are by the author.

tulip mania appears foolish today (e.g Szpiro 2011), but it may well reflect the value placed on those bulbs by contemporaries.

This paper contributes to the existing literature in two ways. First, it presents a more complete and systematic chronology of bulb prices than has been available until now. Combined with contemporary accounts, the data demonstrate that the Dutch tulip mania clearly meets Shiller's definition of a bubble. Second, although the price data by themselves are too scarce and unreliable to permit a conclusive explanation of the bubble, I argue that evidence from contemporary accounts suggests that a model based on social networks and information best explains the emergence and collapse of this bubble. Specifically, a dense, localized social network made the bubble possible, but also served to limit its impact on the broader economy. The episode thus sheds a valuable light on a feature of speculative bubbles often ignored by market fundamentalists: the impact of social networks and norms. The tulip mania illustrates the ease with which a bubble can emerge within comparatively small and densely connected social networks.

The remainder of the paper is divided into four parts. The first part briefly presents the key features of the tulip craze. Next I analyze the available evidence on tulip prices during the mania, which demonstrates that a bubble did arise, and that claims to the contrary cannot be sustained by the data. The third part proposes a social and informational explanation for certain types of bubbles. Finally, the fourth part applies this model to the tulip mania, highlighting the social context that made the bubble possible, but also limited its scope and duration.

**I**

Tulips arrived in Western Europe from Turkey during the sixteenth century. They rapidly came to be prized above all other flowers, and the well-to-do were willing to pay extraordinary sums to obtain the latest, most spectacularly colored variety.<sup>2</sup> Particularly prized were tulips with darker colored stripes and “flames” on a lighter background. Many of the most valuable striations were created, we now know, by a virus. This was not understood at the time, however, hampering the systematic development of new varieties. Moreover, such “flaming” tulips were always a risky investment, since it was never certain whether their patterns would be as desirable, and valuable, from one year to the next (Roman 1637b). To minimize uncertainty, serious tulip collectors contracted to buy and sell bulbs while they were in bloom, making payment and taking delivery only later, once the bulbs were dug up.

Tulip prices were high because supplies of the most exciting new varieties were extremely limited. The supply of the most famous tulip of the 1620s, the Semper Augustus, was in the hands of a single owner, who held on to the bulbs as prices offered rose from 1000 *gulden* per bulb in 1623 to 3000 *gulden* per bulb in 1625.<sup>3</sup> When a

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<sup>2</sup> Indeed, a 1614 book of emblems displays a tulip alongside the proverb “A fool and his money are soon parted” (Visscher 1614, see also Hondius 1621).

<sup>3</sup> (van Wassenaer 1625, Krelage 1942a) The Dutch currency at the time was the *gulden*, often translated as guilder. The annual earnings of a skilled artisan such as a carpenter around 1630 were about 300 *gulden* (Goldgar 2007). At 3000 *gulden*, the Semper Augustus was valued at about 10 times the annual income of someone in the lower middle class.

Semper Augustus bulb was finally sold some time later, the owner attached the stipulation that the buyer could sell neither the bulb itself, nor any of its offsets — small bulbs that develop on the outside of the main bulb — without permission of the original seller (Roman 1637a). The problematic combination of uncertainty about the quality of a bulb's next flower and mostly informal contracts inevitably resulted in some failed transactions. Indeed, much of our reliable knowledge about tulip trades during this period derives from such transactions, since the disappointed party would often approach a notary to file an official complaint. Records of these complaints are still kept in the city archives of many cities in Holland, whereas almost no original transaction records remain.<sup>4</sup>

The number of different varieties of tulips increased very rapidly during the 1620s and 1630s. By the peak of the mania in early 1637, about 500 different varieties had been developed in Holland alone.<sup>5</sup> Many were named for the bulb's original owner or town, along with words suggesting high quality. Thus we find many tulips whose name begins with *Admirael* or *Generael*, applying military ranks to signify quality.<sup>6</sup> Despite the large number of varieties, supplies remained restricted, as new bulbs needed to grow for a number of years before they bloomed for the first time. Though there were dozens of

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<sup>4</sup> The first of these complaints show up in the city archives as early as 1611 (Posthumus 1927, pp. 1-85).

<sup>5</sup> (Krelage 1942a). Few of these same varieties still exist today, but we have contemporary pictures of about 80% of them.

<sup>6</sup> (Krelage 1942a, see also Roman 1637a) Inevitably, name inflation occurred: one of the most famous varieties during the tulip craze was the Gouda bulb, named for the Dutch town. However, its original name was actually *Generael der Generaelen van Gouda*, i.e. "general of generals."

highly prized varieties, the total supply for any given variety was frequently only a handful of bulbs, in the hands of an even smaller number of growers.

Until the early 1630s, the market for tulips was composed almost entirely of aficionados trading amongst themselves. These were mostly wealthy merchants whose financial fortunes would not be negatively affected by the occasional disappointing purchase of a bulb that turned out to be less fine than expected. Moreover, as bulb lovers they also had a thorough knowledge of tulip growing and of the characteristics of different varieties. Most importantly, since transactions took place during the time when bulbs were in bloom, the quality of the flowers could be assessed. By 1634, however, sales had begun to take place throughout the year (Velius 1648). A futures market developed shortly thereafter: people began to sell bulbs for which they had signed a contract but which they did not yet have in their possession (Goldgar 2007). This permitted traders to make a profit without ever having to plant a bulb of their own. Not surprisingly, it took little time for speculators to enter the market.

A number of factors served as catalysts for speculation. First, Dutch commerce in general was flourishing during this period, creating new wealth not only at the elite levels but also among an increasingly prominent middle class.<sup>7</sup> Second, the large profits generated by the East India trade — as well as speculation in the shares of the Dutch East India Company (VOC) — generated not only high incomes, but also a level of comfort with risky futures contracts (Goldgar 2007). Third, no guild controlled the tulip trade, so

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<sup>7</sup> A near-contemporary account characterizes the tulip craze as a “remarkable example” (verwonderenswaardig exempel) of the growth in wealth and participation associated with commerce (Aitzema 1669-1672)

barriers to entry were comparatively low (Schama 1988). Fourth, the free coinage policy of the Bank of Amsterdam may have attracted additional capital to Holland (French 2006, pp. 3-14).

One final contributing factor deserves separate mention: the plague which ravaged Holland in 1635-1636. Amsterdam lost about 20% of its inhabitants over two years. Haarlem, one of the centers of the bulb trade, lost more than 20% in 1635 alone (Noordegraaf and Valk 1996). In fact, several contemporary authors drew a causal link from the tulip craze to the plague (Theuniszoon van der Lust 1637). Recent analyses reverse the causal arrow: the ever-present threat of a rapid death may have inclined people towards greater risk-taking (e.g. Garber 2000, Goldgar 2007).

As prices began to rise and new, less knowledgeable traders entered the market, three new types of deals were introduced. First, transactions began to make explicit reference to a bulb's weight. The first recorded disputes to mention bulb weights concerned contracts signed in the late summer of 1635 (Posthumus 1927, pp. 1-85). Bulb weights were expressed in *azen*, with one *aas* equivalent to about 0.05 grams. Next, a lively trade developed in the offsets of bulbs. For example, buyers would offer a certain price per *aas* for the largest offset of a particular bulb. The total payment would be determined when the bulb was dug up and its offsets examined and weighed (Posthumus 1927, pp. 1-85). Finally, bulbs began to be sold in bulk, by weight. The archives record many deals for

1000 *azen* of a particular variety — usually about 3-6 bulbs. Lesser-valued cultivars could also be traded by the pound, roughly 30-60 bulbs.<sup>8</sup>

This last innovation in particular fueled the bubble. As the epigram opening the paper indicates, contemporary observers recognized this too, and many looked askance (partially out of envy) at those who traded primarily in so-called ‘pound goods.’ Earlier contracts had always been linked to specific bulbs. However, a contract for 1000 *azen* Gouda, for example, could be filled with any set of Gouda bulbs the seller chose. With the link to specific bulbs severed, it became possible to engage in transactions in which neither party had any idea about the eventual source of the bulbs. Moreover, no real knowledge of either tulips or their bulbs was required, only a sense of the going rate per *azen* for a particular tulip variety. Where prices had risen steadily over the preceding years, the trend accelerated once these bulk contracts were introduced into the market, in the last few weeks of 1636 (Roman 1637b).

Eliminating the need to have one’s own bulb garden or even to be a connoisseur of tulips, combined with the lure of quick and easy profits, drew new entrants into the tulip market in growing numbers as early as the fall of 1635. As new entrants multiplied, a system of ‘colleges’ developed across the main towns of Holland. Composed of a core of regular traders, these met at a specific inn two or three times per week, usually in the evening (most traders held on to their day jobs). Outsiders were welcome, but needed to be introduced first. Deals took place with the mediation of one or two “neutral”

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<sup>8</sup> An Amsterdam pound was equivalent to 10240 *azen*; a Haarlem pound equaled 9728. The average bulb weight for the 67 individually described bulbs auctioned on 5 February 1637 was 283 *azen*. (1637b).

observers, and all sales were sealed with the payment of a small surcharge called the “wijnkoop” (wine purchase/fee) of about 2.5%. These funds were spent immediately by the members of the college in attendance, not only on wine, but also on food, tobacco, lamps and a fire, tips for the inn staff, and some alms for the poor (Roman 1637b).

Prominent collectors and growers regularly attended these colleges, and some of the more successful traders developed ties to a number of collectors, further tightening the social networks within which all were embedded (Goldgar 2007).

The real speculative bubble did not last long. Prices began to rise faster once the bulbs had been planted in October 1636. Bulk contracts started appearing in December 1636, and this appears to have set off the real bubble. Peak prices were paid during the last few days of January and first few days of February 1637. From the beginning of this three-month period to the end, some individual bulbs were sold as many as 5-10 times, and increased more than ten-fold in price. Prices for bulk quantities of cheaper goods increased as much as twenty-fold. Even common and plain varieties for which there had been no demand previously were now sold for large sums (Roman 1637b).

Although disquiet about excessive prices had been building, the end still arrived suddenly and unexpectedly, with plummeting prices for some of the most common pound goods in Haarlem on February 3<sup>rd</sup>. A public auction of choice bulbs in Alkmaar on February 5<sup>th</sup> still garnered peak prices, but by February 7<sup>th</sup>, it had become clear throughout the main trading centers that the market had crashed (Krelage 1942a).<sup>9</sup>

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<sup>9</sup> Though distances between Holland towns were not great, people did not travel frequently. As noted earlier, most bulb traders had other professions and traveling did take time away from their other pursuits. As a result, the peak did not occur on the same day all across Holland.

## II

Accurate data on tulip prices are quite scarce. Most tulip contracts were informal, and many were probably not even written down. Those that were committed to paper were generally torn up once completed. Moreover, there were no regular newspapers to cover the crisis as it unfolded: weekly newspapers only emerged in most Holland towns in the 1660s. However, the tulip bubble fascinated contemporary observers, who produced a wealth of — mostly critical — pamphlets on the craze. These constitute one key source of empirical data on tulip prices (Posthumus 1926, pp. 3-99, Krelage 1942b). In fact, contemporary historiographers relied almost exclusively on these pamphlets, even where access to the principals and other original documents would have been feasible (e.g. Aitzema 1669-1672). Unfortunately, pamphlet authors were usually more interested in critiquing the bulb trade than in explaining it; most of the useful specific information about the tulip mania we have today is drawn from a series of just three pamphlets, all published — and likely written — by Adriaen Roman in Haarlem, between February and May 1637 (Roman 1637b, Roman 1637c, Roman 1637a).

Each of these pamphlets is presented in the form of a dialogue between two main characters, Gaergoedt (GreedyGoods) and Waermond (Truemouth). Gaergoedt is a well-to-do weaver who has been active as a bulb trader, and who undertakes to educate Waermond about the tulip market, in order to explain and defend his actions. Waermond, in response, offers moralistic tales intended to highlight the folly of various aspects of the tulip mania. Crucially, the dialogues reproduce sample bulb sale contracts as well as data on the prices fetched for particular bulbs near the beginning and towards the end of the bubble. There is little firm corroboration for the data provided in these

dialogues, and they can be shown to contain some errors. Accordingly, no specific individual price or weight should be considered entirely reliable. Nevertheless, there is no reason to suspect any systematic distortion of the price information, and most students of the tulip mania have accepted it as valid.<sup>10</sup>

Similar problems hamper the use of the main other source of price data: complaints and legal cases whose records survive in town archives. Few students of the tulip craze have consulted these archives themselves (notable exceptions are Dash 1999, Goldgar 2007). Instead, most rely on the collection of transcriptions published during the 1920s and 1930s by Posthumus (Posthumus 1927, pp. 1-85, Posthumus 1934, pp. 229-240).<sup>11</sup> All in all, the available price evidence is both thin and somewhat uncertain. I have compiled the most complete dataset available until now, containing 400 price points, the vast majority of which refer to peak prices only. About 75 data points provide pre-peak prices, from before late January 1637. Of these, all but 20 concern the three month-period

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<sup>10</sup> The dialogues are fictional, and their publisher/author does not pretend otherwise. Moreover, they have an agenda, which is to highlight the folly of the tulip mania. However, no contemporary pamphlet authors challenged the data provided in these dialogues. Significantly, more than 70 of the prices listed in the dialogues match those printed in a broadside reporting the results of the Alkmaar auction of 5 February 1637, at which some of the highest prices for any bulbs were recorded (1637b). In addition, some further prices in the dialogues are faulty transcriptions from that same Alkmaar auction. For example, example, a bulb of 171 *azen* that sold for 173 gulden is likely the same as one listed in the dialogue as weighing just 71 *azen* and selling for 175 gulden.

<sup>11</sup> Goldgar criticizes Posthumus' transcriptions as "extremely sloppy" and riddled with errors (Goldgar 2007), but does not indicate whether the errors are minor or serious, nor whether they are systematically biased in a particular direction.

of the bubble from November through January, referencing 30 different varieties of tulips. On the far side of the peak, we have data on only 7 transactions for the remainder of 1637 and the first part of 1638. In addition, we have a few general statements in the third dialogue about the drastic drop in value after the crash. A full list of transactions and their sources appears in the appendix.

Writers on the tulip mania have adopted different strategies to overcome the challenge of drawing solid conclusions based on such limited data. The simplest tactic is to rely heavily on the hyperbole found in the pamphlets. For example, the post-script to the first dialogue between Gaergoedt and Waermondts claims that “some goods ran so high that one or two *guldens* became one hundred, sometimes more” (Roman 1637b). If true, this would be strong evidence for a bubble. However, the prices listed in the dialogues — which are explicitly intended to illustrate the dramatic nature of the price increases observed — do not support the dialogue’s own claim, and only the most superficial treatments of the tulip mania take it seriously.

A more promising approach is to interpolate based on the available data, as Garber does (Garber 1989, pp. 535-560, Garber 2000). Garber generates 16 charts showing the price evolution of different tulip varieties, connecting observations in a straight line. However, each chart has only a few data points; three have only an initial and a final price. While the charts demonstrate that prices rose a lot, they cannot be used to draw any conclusions about the price trajectory between the individual observations. Simply imposing a straight line contradicts all contemporary accounts, which refer to a gradual increase at first, with a far steeper slope near the end of the bubble.

Table 1 shows a breakdown, by bulb size, of the price development for the Gouda tulip. Offsets and small bulbs, which were the most commonly traded in the early years — tulip lovers would hold on their own main bulbs, but sell the offsets they produced — more than doubled in value from late 1634 to mid 1636, doubled again by the end of November 1636, and appear to have reached peak value in mid December of that year. Very small offsets, which were at first not traded individually, increased between four- and ten-fold in price between early November 1636 and the peak in early February 1637. Large bulbs, for which we have just one contract prior to the peak, appear to have increased in value five-fold over the course of the last month prior to the bubble's bursting. Finally, the single price we have for a bulk lot of Gouda bulbs suggests that unidentified bulbs in quantity were worth just half as much as single, identified bulbs.

<i>Date</i>	<i>&lt; 10 azen</i>	<i>&lt; 100 azen</i>	<i>&gt; 100 azen</i>	<i>bulk</i>	<i>source</i>
12/1/34		1.50			1
1/1/36		2.10			1
5/15/36		3.75			1
10/31/36	14.29				1
11/5/36	5				2
11/25/36		6.76			1
12/12/36		10.83			3
1/9/37			1.5		1
2/5/37	56.25				2
2/5/37		10.08			4
2/5/37		9.33			4
2/5/37			8.12		4
2/5/37			7.47		4
2/5/37			7.28		4
2/5/37			7.11		4
2/5/37			6.15		4
2/5/37				3.60	5

Table 1. Transactions for Gouda tulips, arranged by date and bulb weight. Bulbs under 100 *azen* in weight are almost certainly off-sets; those over 100 *azen* are mature bulbs. Sources: 1 – (Posthumus 1927, pp. 1-85); 2 – (Roman 1637b); 3 – (Roman 1637c); 4 – (1637b); 5 – (Roman 1637a).

Garber's argument about price trends on the other side of the peak suffers the same flaw. As noted earlier, we have very little data from the period immediately following the bubble. Garber chooses to rely, instead, on prices from a sale in 1642/43. All one can do with such data is calculate average annual depreciation; they say nothing about the actual shape of the price curve. Nevertheless, Garber concludes that "the crash of February 1637 for rare bulbs was not of extraordinary magnitude" simply by assuming a linear price decline for the period between the end of the crash and 1642 (Garber 2000). However, if we trust the peak price data offered in the dialogues — as Garber does — we must also take seriously the evidence they provide on the values of bulbs after the crash.

Gaergoedt notes that it is hard to estimate price levels "since there is no demand for bulbs; everybody is silent" — good evidence, in and of itself, of a severe crash. Nevertheless, he also states that a garden filled with common varieties of tulips — bulk goods, in other words — brought only about one hundredth of the price it might have fetched at the peak. Even more specifically, he mentions that a sale of several individual bulbs only fetched one *ducaton*, or about 22 *gulden*, whereas they might have been worth 400 *gulden* at their peak (Roman 1637a). Table 2, which estimates the value of these bulbes at the height of the bubble, suggests that Gaergoedt may have been conservative in this estimate. Prices of individual bulbs thus appear to have fallen by as much as 95%

within a few months, contradicting Garber's assumption of a steady, linear drop in prices over the course of the six subsequent years.<sup>12</sup>

<i>Variety</i>	<i>Approx. price/aas at peak</i>	<i>Value of 283-aas bulb</i>
Gheel ende Root van Leyden	0.7	198.1
Cent	0.4	113.2
Switser	0.13	36.79
Witte Croon	0.3	84.9
Gheele Croon	0.08	22.64
Audenaerde	0.5	141.5
Coorenaer	0.03	8.49
<i>Sum</i>		<i>605.62</i>

Table 2. Estimated value of 1 bulb each of 7 different varieties, assuming average bulb weight and average price per aas at the peak. Source: (1637b)

Interpolating from one observation to the next would be less problematic if we had more data points, with less time elapsing from one to the next. This might be possible if we could generate an index of relative prices that permits comparisons across different tulip varieties. Thompson's argument about the price developments in the tulip market relies on such an index (Thompson 2006, pp. 99-114). However, Thompson fails to address some fatal problems with this approach. First, an index must be based on price observations taken at the same point in time, but Thompson derives his baseline from a book of tulip paintings for which neither the source nor the date of the prices listed are

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<sup>12</sup> Garber does acknowledge the price surge and decline in the more common bulbs, sold in bulk, but waves away the problem by blaming it on the lack of regulation of contracts within the colleges (Garber 2000).

known.<sup>13</sup> Second, not all bulb sales are directly comparable. Transactions may involve offsets, bulbs, or bulbs in bulk; the value per *aas* is not the same across these three transaction types, with bulk goods worth the least and offsets the most, as we saw in table 1. Nor does the value of a bulb increase linearly with its weight — the results of the February 5<sup>th</sup> auction suggest that a doubling in weight is associated with a roughly 50% increase in price (1637b). Garber ignores this problem as well (2000). The third problem, fatal all by itself, is that an index can only be used to compare prices for different varieties at different points in time if we assume, against all the available evidence, that the shape of the price curve over time is identical for every tulip variety, so that relative prices remain constant.

To give just one counter-example, the Gouda more than doubled in price between late 1634 and the summer of 1636. On the other hand, the *Admirael van der Eyck* appears to have lost value over the same period. In addition, from the summer of 1636 to the peak, the Gouda's value seems to have increased between three- and five-fold; whereas that of the *Admirael van der Eyck* rose at most three-fold.<sup>14</sup> More generally, if we have only one pre-peak price for a bulb, there is no way to know where on its price curve to locate it — has it already gained most of its value, or is the steepest rise still to come? The evidence suggests that relative prices across different bulbs changed day by day.

In sum, the available data contradict both Garber's and Thompson's attempts to explain away the tulip bubble. Arguing that price fluctuations did not exceed those

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<sup>13</sup> A number of the prices derive from the February 5th auction, but most do not. The book has been digitized and can be seen at [http://library.wur.nl/tulips/blauw\\_content.html](http://library.wur.nl/tulips/blauw_content.html) (accessed 5 January 2012).

<sup>14</sup> Gouda data from table 1; *Admirael van der Eyck* data from (Posthumus 1927, pp. 1-85) and (1637b).

supported by market fundamentals, as Garber does, requires ignoring key points of evidence from the post-crash period, as well as assuming that prices increased and decreased linearly prior to and after the peak, an assumption contradicted by every contemporary account. Making more precise claims about the timing of particular aspects of the bubble, as Thompson does, requires ignoring the problems inherent in aggregating price information for bulbs of different weights and varieties at different points in time, as well as placing complete faith in the accuracy of each individual price observation. Instead, though the data are limited, they quite clearly indicate a rapid rise in prices, accelerating through December 1636 and January 1637, followed by a steep and sudden decline after the first week of February. Contemporary accounts unanimously support this picture (see, in addition to the pamphlets already cited, Schrevelius 1648). Moreover, these same accounts strongly suggest that the “temporarily high prices” were sustained almost entirely by “investors’ enthusiasm” rather than by any well-informed (or even myopic — see Campbell 2012, pp. 75-91) estimation of value.

### III

How, then, can we explain this bubble? Lacking the kind of extensive and detailed trading information available for other famous episodes such as the South Sea bubble (e.g. Temin and Voth 2004, pp. 1654-1668, Dale 2004, Frehen et al. 2011), it is not possible to offer any definitive analysis. On the other hand, contemporary accounts do strongly suggest one particular explanation: I argue that the key lies in the dense social networks and strong social norms within which commerce in Holland was embedded at the time.

Efficient market models — including those proposed by both Garber and Thompson — assume that those who bought and sold rare as well as bulk bulbs used their own private knowledge about the fundamental supply of and demand for various bulbs. Prices might rise while increases in fundamental (non-speculative) demand exceeded increases in supply, but they would be kept under control. Bulb traders would begin selling once prices threatened to deviate from underlying fundamentals. As we have seen, however, in the winter of 1636/37 people behaved differently. Still, the bubble did not develop because the traders' private knowledge about the actual supply of particular bulbs was faulty. In fact, the market was quite localized, and those active in the trade were generally familiar with the gardens where the tulips were planted and with the tulips themselves.

A key factor appears to have been this very connectedness among tulip traders, who were often linked to one another by religion, marriage, and/or profession. As a result, market participants assigned a greater weight to the decisions of other traders than they would have if they had interacted only through arms-length transactions (cf. Uzzi 1999, pp. 481-505). Aggregated across the entire market, those decisions came to outweigh the influence of private knowledge, helping set in motion an information cascade that made the bubble possible. Significantly, in such contexts lack of knowledge need not be an impediment to a rational actor's entrance into a market (Bikhchandani et al. 1992, pp. 992-1026, Chamley 2004, Hong et al. 2008, pp. 268-287, cf. Nairn 2002).<sup>15</sup>

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<sup>15</sup> This does not imply that no market participants relied on their own valuable — and accurate — information. The argument presented here is compatible with (and complementary to) models explaining the persistence of bubbles because those with accurate private information about the overvaluation of an asset are able (and hence have an incentive) to “ride the bubble” (Temin and Voth 2004, pp. 1654-1668, Abreu and Brunnermeier 2003, pp. 173-204). My focus, however, is on

In some models, information cascades are made possible by “the presence... of a critical mass of easily influenced people, each of whom adopts... after being exposed to a single adopting neighbor” (Watts 2007, pp. 22-23). In the case of the tulip bubble, the overall connectedness of the social network made it unnecessary for people to be so naïve that exposure to just a single buyer drove their decisions. As Golub and Jackson have shown more formally, a small number of “prominent” agents in a social network can distort an entire network’s beliefs about a value, even if they have no greater knowledge about that value and everyone else in the network knows this (Golub and Jackson 2010, pp. 112-149). Moreover, sequential sales can give rise to a context in which it becomes optimal for buyers to imitate previous buyers rather than act on their own private information (Welch 1992, pp. 695-732, cf. Lee 1998, pp. 741-759).

An analogy to art auctions serves to illustrate the process.<sup>16</sup> An art dealer who has been active for many years will know most of the other active art dealers — especially the local ones — and will have come to trust their knowledge and judgment. Imagine that a piece outside her area of expertise has caught her eye. She would like to acquire it, but does not wish to pay more than the work is worth. Three possible strategies readily suggest themselves: 1) research the value of the piece, thus acquiring sufficient private knowledge to judge value; 2) see how much her colleagues have recently bid on

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explaining the emergence of bubble, not its duration. For recent work similarly highlighting the importance of social networks in explaining another historical bubble, the South Sea Bubble, see (Mays and Shea 2011, Shea 2011).

<sup>16</sup> For a more formal analysis linking auctions and bubbles, see (Bulow and Klemperer 1994, pp. 1-23).

comparable pieces; and 3) simply outbid any of her colleagues whose judgment she trusts, but stop bidding if an unknown person drives up the bid further.

No strategy can eliminate all uncertainty: no two pieces of art are exactly alike, and even art experts are not always sure how much a work of art might fetch on the open market. Hence, strategy 1 may not be worth pursuing, since it is not guaranteed to repay the considerable costs involved in acquiring sufficient knowledge, especially compared to the more modest costs associated with strategies 2 or 3. This implies that the adoption of strategies 2 or 3 may be rational, albeit riskier. The risk associated with strategy 3 is obvious: If art buyers X and Y each trust the knowledge and judgment of the other, they may end up in a bidding contest well beyond the “fundamental” value of the piece, up to a point where the price reaches a level that even the imperfect knowledge of either X or Y tells her that it is not worth that much. The risks with strategy 2 are less obvious but just as severe. The strategy will work well if bids made in the recent past on similar pieces by other dealers were based on private knowledge, i.e. on strategy 1. If not, the actions of X will simply propagate the misvaluation. The social context — art dealers who know and trust one another — makes such outcomes more likely than if nobody trusted the knowledge and judgment of her colleagues. After all, as one’s confidence in one’s fellow dealers falls, the incentive to acquire adequate private knowledge rises.

Now imagine novice art dealers X1 through Xn who, one after the other, decide to get involved in the market, attracted by the lure of easy money, or because their disposable

incomes has risen considerably in recent times.<sup>17</sup> They can begin purchasing art most easily by adopting strategies 2 and 3 exclusively. However, doing so reduces the proportion of the auction participants with private knowledge. As a result, for each successive collector/dealer that enters the market in this manner, there is a smaller likelihood that a randomly chosen auction participant has valuable private knowledge. Nevertheless, it may continue to be rational for each new entrant not to invest resources in acquiring private knowledge.

Applying this basic model to the Dutch tulip mania is relatively straightforward. Below, I first characterize the market by discussing the supply of bulbs, the nature of tulip sale contracts and the community of tulip traders. Next I apply the basic logic presented in the preceding paragraphs to the case of the tulip bubble. I show that the bubble logically emerged from a combination of two factors: an innovation in the market — bulbs sold in bulk, by combined weight — and the entry of new traders embedded alongside existing bulb lovers in a densely connected social network. A brief discussion of the aftermath of the bubble underscores the key role played by these two factors.

#### IV

The supply of bulbs was comparatively fixed; it increased through the growth of offsets, but these took several years to become full-grown bulbs capable of flowering and

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<sup>17</sup> At least one contemporary observer in fact believed that a small number of expert traders deliberately set about drawing such new entrants into the market, precisely with the aim of driving prices higher and “riding the bubble” (see Krelage 1943, pp. 26-48).

creating their own offsets. With the newest varieties often in greatest demand, growers in possession of such bulbs could be fairly certain of controlling the market for a few years. The rapid expansion of the professional and merchant class within the towns of Holland meant that demand easily kept pace with the development of new varieties. With demand growing faster than supply starting in the early 1630s, it is no surprise that prices rose, nor that a market emerged for lower-quality bulbs too. Rising prices drew new entrants into the market, and made existing bulb traders more enthusiastic (Krelage 1942a).

Eventually, however, supply was bound to outstrip demand: the bulb supply *could* grow faster than the number of wealthy burghers, and there was a limit to the number of recognizably different varieties that could be developed. Prices would, therefore inevitably fall in the medium term. This, in essence, is the story told by Garber, and it adequately explains both the rise in prices up to the summer of 1636 and the gradual decline that appears to have set in once the crash had been sorted out by the late summer of 1637. However, it cannot account for the dramatic price increases in the fall and winter of 1636-1637, nor for the crash that followed.

Most tulip sales followed a standard format. Transactions in the colleges were conducted in a ritualized fashion, with separate procedures for sales and purchases, and were confirmed with the payment of the *wijnkoop* fee.<sup>18</sup> The sales agreement provided for

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<sup>18</sup> The procedures are described in (Roman 1637c) and (Roman 1637b), respectively. Sales were open to multiple bidders and were done in an auction format, whereas purchases were conducted as bilateral negotiations in which buyers and sellers tried to find a mutually acceptable middle ground. Detailed explanations can be found in (Krelage 1942a). In addition to entering the sale in the college's ledger, both sides to a transaction often wrote out a small sales note, or entered the text in their own ledgers.

simultaneous payment and delivery at the moment a bulb was dug up, with the opportunity to verify the flower beforehand (cf. Goldgar 2007). Deals struck outside the blooming period therefore always resembled a futures transaction. Even with the norms governing the manner of buying and selling, uncertainties remained: buyers worried about the quality of the bulbs they were buying, while sellers worried about being paid in full. As a result, contracts themselves were subject to norms too.

A standard, but usually implicit, feature of sales contracts was that when a bulb turned out to be of a different variety than promised, the sale was nullified, and the seller did not have to accept it (Posthumus 1927, pp. 1-85). To reassure the seller, a system of “borgen” — guarantors of payment — emerged, in which one or two friends or relatives of the buyer would guarantee payment if the buyer could not or would not pay. In addition, buyers often explicitly pledged their assets. A sample contract listed in the second dialogue — and described as being representative of almost all such contracts — states: “in case of non-payment of the aforementioned sum, I hereby pledge all my goods, movable and immovable, placing them under the control of all the laws and courts” (Roman 1637c). Such language is hard to square with Garber’s claim that “a meaningless winter drinking game” with insufficient “internal control over the nature of contracts” produced these deals.<sup>19</sup>

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The second dialogue between Gaergoedt and Waermondts gives some examples of the latter (Roman 1637c).

<sup>19</sup> (Garber 2000) It also contradicts Thompson’s odd assertion that traders all intuited in December 1636 that the nature of tulip contracts had suddenly but fundamentally changed (Thompson 2006, pp. 99-114).

Though some trading in bulbs took place among towns and even across borders, there was virtually no systematic cultivation of bulbs for trade during the tulip mania; most growers were aficionados working in their own small gardens.<sup>20</sup> Notarized complaints make clear that the main participants regularly visited the various gardens around town in which tulips were planted, and hence were quite knowledgeable about the locally available supply of particular varieties, and even the quality of individual bulbs.<sup>21</sup> The picture that emerges is one of local markets within individual towns. Complaints still on file in the Dutch archives reinforce this impression: most recount disputes between traders from the same town, who all knew one another quite well.

In addition, the total number of active participants in the tulip market appears to have been comparatively small, ranging from several dozen in the smaller towns, such as Enkhuizen or Hoorn, to several hundred in Haarlem (Goldgar 2007). More than one merchant appears just once in the archival record, purchasing or selling just a single bulb from or for his garden, so the number of regular traders was smaller still. In fact, the first dialogue notes that new participants in the colleges attracted immediate notice (Roman

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<sup>20</sup> (Krelage 1942a). Bulb exports only began to take off in the second half of the seventeenth century, *after* the tulip mania had ended. Even then, Krelage notes, only a few growers aimed at the export market, and quantities were small — most foreign buyers were just interested in a single bulb of a particular variety (Krelage 1942a, see also Krelage 1946)

<sup>21</sup> (E.g. Posthumus 1927, pp. 1-85). One contract dispute describes how a Haarlem baker who was interested in buying a bulb from a local merchant in one college visited another college within town and received additional information about that same bulb. This indicates just how small and well-informed the market was (Posthumus 1927, pp. 1-85)

1637b). Significantly, most of those active in the tulip trade in a given town were closely connected through several different networks. Many were related by blood or by marriage, a disproportionate number were Mennonites, and more than a few appear to have engaged in mutual business transactions unrelated to the tulip trade (Goldgar 2007). These close ties further facilitated the rapid dissemination of information among traders, but they may also have given new traders an inflated sense of the expertise of their peers.

The tulip market functioned efficiently as long as two conditions were met: the traders all knew one another as fellow aficionados, and they all had ample private information about the supply and quality of individual bulbs. The first of these conditions probably applied until 1635, and the second until 1636. When novice traders entered the market, it became less stable, because this produced a drop in the average level of expertise. Once a number of new traders had entered the market, it became increasingly difficult to distinguish those with solid private knowledge from those who were simply following the crowd. The final straw was the introduction of bulk sales. As noted earlier, these constituted a new kind of trade, no longer linked to individual bulbs. This meant that the private knowledge of established bulb lovers was suddenly much less relevant.

Returning to the art auction analogy, it was as though it had become possible to buy and sell a piece of art to be named later by the seller, and even for the seller to obtain that piece from elsewhere. Pamphlets and town records alike suggest that the established tulip traders were not initially active in this new trade, implying that prices were determined almost exclusively by traders playing strategies 2 and 3 from our art auction scenario, with the latter dominant initially. The bubble that followed inevitably spread to the rare bulb trade. After all, the two trades were linked: new traders were also interested in the

rare bulbs, and rare bulb buyers were not immune to the lure of profits from the faster-rising prices of bulk sales. Moreover, a number of bulb lovers may have convinced themselves that they understood the market better than the latest entrants — that their private knowledge of individual bulbs had some value in the bulk context too.

In fact, it probably did. Prices could rise steeply as long as bulb traders — new entrants as well as established tulip lovers — continued to play strategies 2 and 3. Traders could rationalize rising prices by assuming that all new entrants in the market wanted bulbs to plant rather than merely for speculation — in other words, that “fundamental” demand had increased several times over. Moreover, (paper) profits made from trading bulk goods could be used to bid higher sums for prized individual bulbs. But there were limits to the price increases one could rationalize for either rare bulbs or bulk goods. For bulk goods, bulb traders who had been active for some years knew how long these varieties had been around, and how easily additional supplies could be found, not just in Holland, but also abroad. (At some point, rising prices in Holland would inevitably begin to attract tulips from France or Germany.)

Most of the rare bulbs, in contrast, were new varieties for which the supply was inelastic. All established bulb traders knew who owned those bulbs. Here, the built-in limit was the price beyond which even the wealthiest merchants would not be interested in acquiring a bulb. (That such a limit existed was clear from the beginning: even at the height of its desirability, for example, the famous *Semper Augustus* had never fetched prices that were beyond the reach of most bulb lovers — they simply did not wish to own it at all costs.) Since private knowledge was more germane here, this bubble did not expand as far. In turn, this implied that the bursting of the bubble would lead to less of a

price collapse. The limited price data we have suggest that this is exactly what happened. Prices for pound goods could rise further because there was more uncertainty both about local supplies and about the price level that would attract imports.

The bubble reached its limit first for the so-called pound goods. By the end of 1636 numerous outsiders were already predicting an imminent crash (e.g. Theunissoon van der Lust 1637). As January progressed and prices rose ever faster, traders, too, began to fear that prices might be unsustainable (Krelage 1942a). The dense social networks joining all tulip traders guaranteed that such fears were common knowledge. Things went sour in Haarlem first, on February 3<sup>rd</sup>. Members of a college decided to test market confidence by putting up for sale amongst themselves bulk quantities of common tulips — Switsers or Croonen. Just one buyer made any bids in three successive sales, and each of the sellers accepted his offer, even though the sum he offered was successively 15% below, 25% below, and finally 35% below recent prices for comparable bulbs. News of this precipitous drop in prices spread like wildfire throughout town, and the next day trading came to a complete halt, with traders simply staring at one another in stunned silence (Roman 1637b).<sup>22</sup>

Still, the bubble had not burst completely, or at least not everywhere. Two days later, on 5 February, at an auction in Alkmaar — only about 20 miles north of Haarlem — peak prices were reached for many individual bulbs, as well as for numerous varieties sold in 1000 *aas* quantities (1637b). By this point, however, news of the crash was spreading to other towns, and bulb traders everywhere were girding for the crash. The first recorded

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<sup>22</sup> The pattern of events in this crash closely resembles that modeled in (Bulow and Klemperer 1994, pp. 1-23).

evidence of a response on the part of the traders was a 7 February meeting in Utrecht to decide on delegates for a meeting of the trading colleges throughout Holland, to be held in Amsterdam on 23 February. There, representatives from 11 cities proved unable to arrive at a jointly acceptable solution. The most popular proposal was to honor all contracts signed through November 30, 1636. All those signed later, however, would be canceled if the buyer paid a buyout fee (“roucoop,” i.e. regret fee) of 10% of the agreed purchase price by March 1637. In those cases, the seller would retain ownership of the bulbs (Barckman 1637).

Local authorities, which had played no role during the bubble, did not have much of an impact on its resolution either (Goldgar 2007, Dash 1999). Some actors looked to the provincial authorities for resolution instead. These agreed to address the issue on 11 April (Posthumus 1927, pp. 1-85). On 25 April, the Court of Holland recommended that the States pursue further inquiries into the bubble and its collapse. Pending a final decision, all contracts were to remain valid, and the town authorities were to do their best to mediate and negotiate contract disputes. However, although contracts were to remain in force, the Court recommended a moratorium on any official enforcement of contracts. Two days later, the States of Holland adopted the Court’s recommendation verbatim (Posthumus 1927, pp. 1-85).

Numerous towns took this to mean that they should not allow their officers to intervene on behalf of one party or another to a dispute by issuing writs, summons, etc., and passed decrees to this effect (Posthumus 1927, pp. 1-85, Dash 1999). In the absence of government involvement, bulb traders were forced to resolve contract disputes amongst themselves. The first record of a sales contract canceled by mutual consent dates

to 10 February. The seller accepted a buy-out payment of 160 *gulden* for a contract that had been worth 1800 *gulden* (Posthumus 1927, pp. 1-85). Many contract disputes were, in fact, settled more or less amicably. Some contracts already contained buyout clauses, often specifying a penalty payment of 10% of the purchase price (Munting 1696). For those that did not, traders arrived at their own figures, which were typically lower. One notary certified that buyout rates ranged from 1-5%, with plenty of buyers in default refusing to make any payment at all (Posthumus 1927, pp. 1-85).

Many cases appear to have turned on the principle of honoring contracts, rather than on the sums involved, which were often quite modest compared to each party's assets. What appears to have disturbed those involved in complaints most was the breach of social norms implied by the refusal to abide by a contract. Here, once again, we see the importance of the social network within which the tulip traded had been embedded. The bursting of the bubble posed a threat to its strength, and since the commercial success of the Dutch merchant class relied heavily on social network ties, such a threat could have serious wider implications (cf. Goldgar 2007). While broken contracts were nothing new, they had always been the exception. In the aftermath of the tulip bubble, they briefly became the rule, and that was deeply disconcerting (Goldgar 2007, cf. Krelage 1942a).

Finally, the fact that most of the bulb trade was localized, and appears not to have spread much beyond about a dozen Dutch towns, helps explain why the end of the tulip mania had only a minor impact on the rest of the Dutch economy. Claims to the contrary in the literature are largely due to uncritical copying from Mackay's sensationalist account, which declares that "the commerce of the country suffered a severe shock, from which it was many years ere it recovered" (Mackay 1932 [1852]). In fact, though there is

some disagreement among historians about rates of growth in the Dutch economy during this period, nobody seriously suggests that the tulip mania had a sizeable impact on its fortunes (e.g. Israel 1995, de Vries and van der Woude 1997). The collapse of the tulip bubble even failed to cause much local economic dislocation. Almost all tulip traders had other careers — they were merchants, successful artisans, or professionals — and most were comparatively wealthy. A few of the poorer tulip speculators may have faced economic ruin, but most of the active bulb traders remained prosperous in the late 1630s, despite losing all of their paper profits from the bubble (Goldgar 2007).<sup>23</sup>

## V

The Dutch tulip mania of 1636-1637 clearly qualifies as a bubble, in the sense that prices were not sustained by private estimations of value; claims that market fundamentals explain the observed price patterns cannot be sustained. Nor do arguments about inadequate government regulation offer much explanatory leverage. It is true that authorities remained largely uninvolved in the bubble — although the States did consider taxing tulip profits in 1636-1637 — and they mostly refused to be drawn into the adjudication of individual cases, at least until a year later (Goldgar 2007, Posthumus 1927, pp. 1-85). However, the market was regulated by the rituals and norms that

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<sup>23</sup> Though many accounts of the bubble suggest that people from all walks of life were involved, these claims appear to derive from some hyperbole in the first dialogue between Gaergoedt and Waermond, where the latter claims that “daughters and maids, farmers and noblemen, even letter carriers... [and] chimney-sweeps” had entered the speculation (Roman 1637b).

developed around the tulip trade, as well as by the broader social connections within which it was embedded.

The social network that made the bubble possible also helped facilitate amicable resolutions. Contemporary observers often blamed the problems on a few speculators in pound goods. While such speculators clearly existed, what made them influential was that socially they were almost indistinguishable from “true” bulb lovers, despite what the epigram at the start of this paper suggests. In the end, it was the very strength of the social network connecting bulb traders, new and old alike, that made the bubble possible. All this implies that the tulip mania deserves to retain its position as a classic financial bubble. However, it also suggests that the lessons to be drawn from the bubble are less about a spectacular rise in prices followed by a collapse than about the social structures within which the market is embedded.

These lessons are far from irrelevant today. Consider, for example, Bernard Madoff’s ability to fool many investors for many years because they knew him socially and hence did not feel a need to practice due diligence (Schweitzer and Shell 2009). Similarly, in the subprime mortgage crisis, where people appear to have trusted Moody’s ratings not because of its proven expertise in that area, but because its judgment had proven reliable in other fields (Lewis 2008). Although investors can always convince themselves that “this time is different” (Reinhart and Rogoff 2008), the underappreciated aspects of the tulip bubble highlighted here demonstrate how little has changed over the course of nearly four centuries in “the madness of small groups,” not of crowds.

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## Appendix

Date	Variety	Type	Weight (azen)	Price (guldens)	Price/aas	Source
1611	Caers op de Candelaer	bulb	n.a.	20		5
1611	Caers op de Candelaer	bulb	n.a.	24		5
1623	Semper Augustus	bulb	n.a.	1000		7
6/18/25	Admiraal	bulb	n.a.	60		6
5/17/33	Paragon Schilder	bulb	n.a.	50		6
5/17/33	Paragon Schilder	bulb	n.a.	41		6
			200			
3/1/34	Semper Augustus	bulb	(est.)	2000		3
12/1/34	Admiraal van der Eyck	bulb	19	66	3.47	5
12/1/34	Admiraal van der Eyck	bulb	80	80	1.00	5
12/1/34	Gouda	bulb	30	45	1.50	5
12/1/34	Slechte Juriae	bulb	n.a.	3		9
7/1/35	Saeyblom	bulb	n.a.	118		9
9/17/35	Generael Gouda	bulb	n.a.	650		9
11/1/35	Latour	bud	16	27	1.69	5
11/1/35	Saeyblom van Coningh	bud	7.5	30	4.00	5
			3			
1/1/36	Gouda	bud	offsets		2.10	5
5/15/36	Gouda	bud	2nd off.		3.75	5
			largest			
5/31/36	Admiraal van Enghelandt	bud	offset		3.00	5
6/1/36	Admiraal Liefkens	bud	offset		6.60	5
7/1/36	Vice Roy	bulb	510	900	1.76	2
7/21/36	Admiraal van der Eyck	bud	offset		2.50	5
	Purper ende Wit van					
10/1/36	Quaeckel	bulb	large	750		5
10/31/36	Gouda	bud	7	100	14.29	5
early Nov. 1636	Admiraal de Man	bulb	130	15	0.12	1
early Nov. 1636	Generalissimo	bulb	10	95	9.50	1
	Gheel ende Root van					
early Nov. 1636	Leyden	bulb	515	46	0.09	1
early Nov. 1636	Gouda	bulb	4	20	5.00	1
Nov. 1636	Admiraal Hazes	bulb	n.a.	1000		9
11/12/36	Gemarmerde de Goyer	bulb	357	70	0.20	2
11/25/36	Gouda	bulb	66	446	6.76	5
	Gheel ende Root van					
12/9/36	Leyden	bulb	578	260	0.45	2
12/12/36	Gouda	bulb	48	520	10.83	2
12/28/36	Gepluymaseerde (Groote)	quantity	2000	140		9
12/28/36	Blijenburger (Late)	bulb	104	120	1.15	5
12/28/36	Blijenburger (Late)	bulb	n.a.	150		9
12/31/36	Gepluymaseerde (Groote)	bulb	n.a.	110		9
	Gheel ende Root van					
12/31/36	Leyden	bulb	n.a.	40		9

12/31/36	Ian Symonsz	bulb	n.a.	35		9
12/31/36	Lieffkens	bulb	n.a.	130		9
12/31/36	Lion	bulb	n.a.	70		9
12/31/36	Paragon Lieffkens	bulb	n.a.	130		9
12/31/36	Switser	quantity	9728	125	0.01	9
late Dec. 1636	Admiraal de Man	quantity	1000	90	0.09	1
late Dec. 1636	Audenaerde	quantity	1000	70	0.07	1
late Dec. 1636	Cent	quantity	1000	40	0.04	1
late Dec. 1636	Coorenaert	quantity	1000	60	0.06	1
late Dec. 1636	Croon (Gheelee)	quantity	9728	22	0.00	1
late Dec. 1636	Croon (Witte)	quantity	9728	125	0.01	1
	Gheel ende Root van					
late Dec. 1636	Leyden	quantity	1000	100	0.10	1
late Dec. 1636	Scipio	quantity	1000	800	0.80	1
late Dec. 1636	Switser	quantity	9728	60	0.01	1
late Dec. 1636	Vice Roy	quantity	1000	3000	3.00	1
Pre-peak	Switser	quantity	19456	1200	0.06	3
	Hollantschen Admiraal & Petter	2 bulbs	n.a.	1250		9
1/3/37	Nieu-Burger	bulb	425	125	0.29	5
1/6/37	Nieu-Burger	bulb	n.a.	145		9
1/9/37	Gouda	bulb	400	600	1.50	5
1/12/37	Gepluymaseerde (Groote)	quantity	2000	300	0.15	5
1/12/37	Scipio	quantity	1000	1500	1.50	5
1/15/37	Cent	bulb	530	72	0.14	9
1/15/37	Legrand	bulb	122	90	0.74	8
mid Jan. 1637	Switser	quantity	9728	110	0.01	5
1/18/37	Admiraal van der Eyck	bulb	n.a.	1250		9
1/22/37	Croon (Geel en Root)	quantity	20480	385	0.02	5
1/22/37	Coorenaert (Gevleugelde)	quantity	1000	220	0.22	5
1/22/37	Audenaerde	quantity	5120	1430	0.28	5
1/22/37	Cent	quantity	3000	380	0.13	5
1/22/37	Gevlamde Nieulant	bulb	410	54	0.13	5
1/22/37	Kistemaecker	bulb	70	12	0.17	5
1/22/37	Legrand	quantity	1000	480	0.48	5
1/22/37	Switser	quantity	10240	280	0.03	5
1/24/37	Brandenburger	bulb	306	28	0.09	5
1/24/37	Haghenaer	bulb	400	12	0.03	5
1/24/37	Legrand	bulb	185	21	0.11	5
1/28/37	Croon (Witte)	quantity	1438	325	0.23	9
1/30/37	Coorenaert	quantity	5791	2200	0.38	9
2/1/37	Switser	quantity	9728	1450	0.15	5
2/3/37	Golinx	quantity	10240	775	0.08	5
2/3/37	Haghenaer	quantity	2000	4000	2.00	5
2/3/37	Porsemaeckers	quantity	1000	250	0.25	5
2/3/37	Switser	quantity	40960	6000	0.15	5
2/5/37	Admiraal Katelijn	bulb	181	225	1.24	4
2/5/37	Admiraal Liefkens	bulb	59	1015	17.20	4
2/5/37	Admiraal van der Eyck	bulb	92	710	7.72	4
2/5/37	Admiraal van der Eyck	bulb	214	1045	4.88	4

2/5/37	Admiraal van der Eyck	bulb	446	1620	3.63	4
		bulb + small				
2/5/37	Admiraal van Enckhuysen	off-set		5200		4
2/5/37	Anvers (ghemeene)	quantity	1000	930	0.93	4
2/5/37	Anvers	quantity	1000	900	0.90	4
2/5/37	Anvers	quantity	1000	905	0.91	4
2/5/37	Anvers Vestus	bulb	52	510	9.81	4
2/5/37	Audenaerde	quantity	1000	530	0.53	4
2/5/37	Audenaerde	quantity	1000	510	0.51	4
2/5/37	Bellaart	bulb	399	1520	3.81	4
2/5/37	Blijenburger (Late)	quantity	1000	570	0.57	4
2/5/37	Blijenburger (Vroeghe)	bulb	171	900	5.26	4
2/5/37	Blijenburger (Vroeghe)	bulb	443	1300	2.93	4
2/5/37	Botterman (schoon)	bulb	246	250	1.02	4
2/5/37	Botterman (veranderde)	bulb	563	263	0.47	4
2/5/37	Botterman	bulb	400	405	1.01	4
2/5/37	Brabanson	bulb	346	835	2.41	4
2/5/37	Brabanson	bulb	542	1010	1.86	4
2/5/37	Brabanson	2 bulbs		3800		4
2/5/37	Brabanson Bol	bulb	524	975	1.86	4
2/5/37	Bruyne Blaeuwe Purper van Kouper	bulb	790	220	0.28	4
2/5/37	Bruyne Lack vander Meer	bulb	365	215	0.59	4
2/5/37	Bruyne Purper	bulb	320	2025	6.33	4
2/5/37	Cenekourt	quantity	1000	105	0.11	4
2/5/37	Duc de Winckel	quantity	1000	210	0.21	4
2/5/37	Fama	bulb	104	440	4.23	4
2/5/37	Fama	bulb	130	605	4.65	4
2/5/37	Fama	bulb	158	700	4.43	4
2/5/37	Gepluymaseerde (Groote)	quantity	1000	280	0.28	4
2/5/37	Gevlamde Branson de Nonville	quantity	500	130	0.26	4
2/5/37	Ghevlamde Iacot	bulb	100	94	0.94	4
2/5/37	Gouda	bulb	63	635	10.08	4
2/5/37	Gouda	bulb	82	765	9.33	4
2/5/37	Gouda	bulb	125	1015	8.12	4
2/5/37	Gouda	bulb	156	1165	7.47	4
2/5/37	Gouda	bulb	160	1165	7.28	4
2/5/37	Gouda	bulb	187	1330	7.11	4
2/5/37	Gouda	bulb	244	1500	6.15	4
2/5/37	Grebber	bulb	95	615	6.47	4
2/5/37	Grebber	bulb	523	1485	2.84	4
2/5/37	Haghenaer	quantity	1000	300	0.30	4
2/5/37	Haghenaer	quantity	1000	300	0.30	4
2/5/37	Ian Gerritsz (Swymende)	bulb	80	51	0.64	4
2/5/37	Ian Gerritsz (Swymende)	bulb	925	210	0.23	4
2/5/37	Ian Gerritsz	bulb	263	210	0.80	4
2/5/37	Ian Symonsz	quantity	500	70	0.14	4
2/5/37	Ian Symonsz	quantity	1000	140	0.14	4

2/5/37	Iulius Ceser	bulb	82	650	7.93	4
2/5/37	Lack van Rijn	quantity	500	160	0.32	4
2/5/37	Lantmeter	bulb	71	175	2.46	4
2/5/37	Lantmeter	bulb	277	365	1.32	4
2/5/37	Laroy	bulb	306	510	1.67	4
2/5/37	Legrand	quantity	1000	780	0.78	4
2/5/37	Lion	quantity	1000	500	0.50	4
2/5/37	Monassier	bulb	510	830	1.63	4
2/5/37	Monassier	bulb	542	920	1.70	4
2/5/37	Nieu-Burger	quantity	500	235	0.47	4
2/5/37	Nieu-Burger	quantity	1000	430	0.43	4
2/5/37	Paragon Lieffkens	bulb	200	500	2.50	4
2/5/37	Paragon Lieffkens	bulb	300	705	2.35	4
2/5/37	Paragon Lieffkens	bulb	348	730	2.10	4
2/5/37	Parragon de Man	bulb	148	260	1.76	4
2/5/37	Parragon Kasteleyn	bulb	100	450	4.50	4
2/5/37	Parragon Schilder	bulb	106	1615	15.24	4
2/5/37	Parragon van Delft of Mols-wijck	bulb	123	500	4.07	4
2/5/37	Parragon van Delft of Mols-wijck	bulb	294	650	2.21	4
2/5/37	Parragon van Delft of Mols-wijck	bulb	354	605	1.71	4
2/5/37	Petter	quantity	1000	730	0.73	4
2/5/37	Petter	quantity	1000	705	0.71	4
2/5/37	Rector	quantity	1000	310	0.31	4
2/5/37	Saeyblom (ghemeene)	quantity	1000	495	0.50	4
2/5/37	Saeyblom Casteleyn best	quantity	1000	1000	1.00	4
2/5/37	Schapesteyn	bulb	95	235	2.47	4
2/5/37	Schapesteyn	bulb	246	375	1.52	4
2/5/37	Scipio	bulb	82	400	4.88	4
2/5/37	Sjery Katelijn (beste)	bulb	619	2610	4.22	4
2/5/37	Sjery Katelijn	of-zet	206	1280	6.21	4
2/5/37	Sjery na by	bulb	129	755	5.85	4
2/5/37	Somer-Schoon	bulb	368	1010	2.74	4
2/5/37	Tournay Casteleyn	quantity	1000	705	0.71	4
2/5/37	Tournay Rijckers	quantity	1000	345	0.35	4
2/5/37	Troyaen	bulb	165	400	2.42	4
2/5/37	Troyaen	bulb	252	500	1.98	4
2/5/37	Troyaen	bulb	470	720	1.53	4
2/5/37	Tulpa Kos	bulb	117	205	1.75	4
2/5/37	Tulpa Kos	bulb	477	300	0.63	4
2/5/37	Tulpa Kos	bulb	485	305	0.63	4
2/5/37	Vice Roy	bulb	410	3000	7.32	4
2/5/37	Vice Roy	bulb	658	4200	6.38	4
2/5/37	Violet gevlamt Rotgans	quantity	500	375	0.75	4
2/5/37	Violet gevlamt Rotgans	quantity	1000	805	0.81	4
2/5/37	Violet gevlamt Rotgans	quantity	1000	725	0.73	4
2/5/37	Vytroep	quantity	1000	705	0.71	4
2/5/37	Vytroep	quantity	1000	725	0.73	4

2/5/37	Wit Purper Ieroen	bulb	148	475	3.21	4
2/5/37	Wit-Purper van Buscher	bulb	134	110	0.82	4
2/5/37	Wit-Purper van Buscher	bulb	315	245	0.78	4
2/5/37	Wit-Purper van Buscher	bulb	481	295	0.61	4
2/6/37	Switser	quantity	10240	1065	0.10	6
2/6/37	Switser	quantity	10240	1100	0.11	9
peak	Admiraal de Man	bulb	130	175	1.35	1
peak	Admiraal de Man	quantity	1000	800	0.80	1
peak	Audenaerde	quantity	1000	600	0.60	1
peak	Cent	quantity	1000	350	0.35	1
peak	Coorenaert (Ghebiesde)	quantity	9728	250	0.03	1
peak	Coorenaert (Ghebiesde)	quantity	9728	250	0.03	1
peak	Coorenaert	quantity	1000	450	0.45	1
peak	Croon (Gheele)	quantity	9728	1200	0.12	1
peak	Croon (Witte)	quantity	9728	3600	0.37	1
peak	Generalissimo	bulb	10	900	90.00	1
peak	Gheel ende Root van Leyden	bulb	515	550	1.07	1
peak	Gheel ende Root van Leyden	quantity	1000	750	0.75	1
peak	Goliat	quantity	9728	700	0.07	1
peak	Gouda	bulb	4	225	56.25	1
peak	Rattebeet	quantity	9728	300	0.03	1
peak	Rijswijcker	quantity	9728	800	0.08	1
peak	Scipio	quantity	1000	2200	2.20	1
peak	Switser	quantity	9728	1800	0.19	1
peak	Vice Roy	quantity	1000	6700	6.70	1
peak	Vice Roy	bulb	510	3400	6.67	2
peak	Admiraal de France	bulb	180	60	0.33	3
peak	Admiraal de Man	bulb	175	250	1.43	3
peak	Admiraal Krijntjes	bulb	130	300	2.31	3
peak	Admiraal Liefkens	bulb	400	4400	11.00	3
peak	Admiraal van Enckhuysen	bulb	8	900	112.50	3
peak	Admiraal van Enckhuysen	bulb	215	5400	25.12	3
peak	Admiraal van Enghelandt	bulb	25	700	28.00	3
peak	Admiraal van Ghelder	bulb	700	155	0.22	3
peak	Admiraal van Hoorn	bulb	440	200	0.45	3
peak	Admiraal van Hoorn	quantity	1000	230	0.23	3
peak	Agaet Rubijn	bulb	56	100	1.79	3
peak	Anvers (ghemeene)	bulb	387	405	1.05	3
peak	Anvers	quantity	1000	1000	1.00	3
peak	Anvers Vestus	bulb	52	510	9.81	3
peak	Audenaerde	bulb	450	370	0.82	3
peak	Audenaerde	quantity	9728	5700	0.59	3
peak	Beschuyt Backer	bulb	105	250	2.38	3
peak	Blijenburger (Late)	bulb	495	570	1.15	3
peak	Blijenburger (Vroeghe)	quantity	1000	700	0.70	3
peak	Bode	bulb	280	300	1.07	3
peak	Brabanson Spoor	bulb	430	1500	3.49	3
peak	Branson, Nette	bulb	300	54	0.18	3

peak	Bruyd van Enchuysen	bulb	32	275	8.59	3
peak	Bruyd van Haerlem	bulb	15	200	13.33	3
peak	Bruyne Purper	bulb	50	1100	22.00	3
peak	Bruyne Purper	bulb	60	1300	21.67	3
peak	Camelot Kromhout	bulb	170	150	0.88	3
peak	Cenekourt	bulb	85	75	0.88	3
peak	Cenekourt	quantity	1000	140	0.14	3
peak	Cent	bulb	550	375	0.68	3
peak	Cent	quantity	1000	400	0.40	3
peak	Cent	quantity	9728	4300	0.44	3
peak	Cent	quantity	9728	1800	0.19	3
	Columbijn Wit, Root ende					
peak	Arghentijn	bulb	205	80	0.39	3
peak	Coorenaert (Ghebiesde)	quantity	9728	250	0.03	3
peak	Coorenaert	bulb	448	400	0.89	3
peak	Coorenaert	quantity	1000	550	0.55	3
peak	Coorenaert	quantity	9728	4800	0.49	3
peak	Croon (Gheelee)	quantity	9728	800	0.08	3
peak	Croon (Gheelee)	quantity	48640	2025	0.04	3
peak	Croon (Gheelee)	bulb	800	75	0.09	3
peak	Croon (Verkeerde)	quantity	9728	300	0.03	3
peak	Croon (Witte)	4 bulbs	2432	525	0.22	3
peak	Croon (Witte)	quantity	9728	3200	0.33	3
peak	Croon (Witte)	quantity	1000	300	0.30	3
peak	Croon (Witte)	bulb	300	80	0.27	3
peak	Dobbele Coleuren (Late)	quantity	9728	60	0.01	3
	Dobbele Coleuren					
peak	(Vroeghe)	quantity	9728	150	0.02	3
peak	Dolabella	bulb	400	200	0.50	3
peak	Don Frederico	bulb	325	440	1.35	3
peak	Donville	bulb	70	62	0.89	3
peak	Dr. Balten	bulb	215	330	1.53	3
peak	Duc de Winckel	bulb	700	300	0.43	3
peak	Duc Flori	bulb	300	70	0.23	3
peak	Egmondte ofte Rechter Oog	bulb	50	330	6.60	3
peak	Elsevier	bulb	450	500	1.11	3
peak	Fabri	bulb	600	240	0.40	3
peak	Fabri	bulb	510	180	0.35	3
peak	Gemarmerde de Goyer	bulb	429	120	0.28	3
peak	Gemarmerde de Goyer	quantity	1000	250	0.25	3
peak	Gemarmerde van Kaer	bulb	300	106	0.35	3
peak	Generael de Man	bulb	200	330	1.65	3
peak	Gepluymaseerde (Groote)	bulb	400	300	0.75	3
peak	Gepluymaseerde (Groote)	quantity	1000	300	0.30	3
	Gevlamde Branson de					
peak	Nonville	quantity	1000	300	0.30	3
	Gevlamde Branson de					
peak	Nonville	bulb	300	140	0.47	3
peak	Gheblutste	bulb	130	80	0.62	3
peak	Gheel ende Root van	bulb	240	235	0.98	3

	Leyden					
peak	Gheel ende Root van Leyden	bulb	400	140	0.35	3
peak	Gheel ende Root van Leyden	quantity	1000	700	0.70	3
peak	Ghenerael Nieuw'lander	bulb	107	60	0.56	3
peak	Gideon	bulb	350	170	0.49	3
peak	Gouda	quantity	1000	3600	3.60	3
peak	Groote Standaert	bulb	700	150	0.21	3
peak	Haghenaer	bulb	400	300	0.75	3
peak	Haghenaer	bulb	700	390	0.56	3
peak	Helena	bulb	250	150	0.60	3
peak	Hoe langher hoe liever	bulb	300	250	0.83	3
peak	Ian Gerritsz	quantity	1000	734	0.73	3
peak	Ian Symonsz	bulb	480	180	0.38	3
peak	Ian Symonsz	bulb	150	100	0.67	3
peak	Ian Symonsz	quantity	1000	180	0.18	3
peak	Incarnadijn Branson	bulb	500	80	0.16	3
peak	Incarnadijn ghevlamt van Quaeckel	bulb	300	350	1.17	3
peak	Ioffrouw	bulb	440	200	0.45	3
peak	Ioncker	bulb	700	150	0.21	3
peak	Lack de Hooghe	bulb	250	60	0.24	3
peak	Lack Paspoort	bulb	440	250	0.57	3
peak	Lack Pieter Christiaensz	bulb	500	150	0.30	3
peak	Lack van Rijn	quantity	1000	430	0.43	3
peak	Lack van Rijn	bulb	500	175	0.35	3
peak	Lack van Rijn	bulb	300	200	0.67	3
peak	Lantmeter	bulb	171	173	1.01	3
peak	Latour	bulb	450	390	0.87	3
peak	Legrand	bulb	350	500	1.43	3
peak	Leydse Wapen	bulb	612	100	0.16	3
peak	Lion	bulb	400	475	1.19	3
peak	Lion	quantity	1000	550	0.55	3
peak	Mantel-blom	bulb	400	94	0.24	3
peak	Mercurius	bulb	300	400	1.33	3
peak	Marveilje van Ceelen	bulb	400	300	0.75	3
peak	Meterman	bulb	500	70	0.14	3
peak	Molswijck	bulb	234	650	2.78	3
peak	Moytjes Moy	bulb	350	205	0.59	3
peak	Nieu-Burger	bulb	495	390	0.79	3
peak	Nieu-Burger	bulb	270	180	0.67	3
peak	Nieu-Burger	quantity	1000	500	0.50	3
peak	Nieuw'lander	bulb	500	95	0.19	3
peak	Nons Wit (Late)	bulb	275	65	0.24	3
peak	Nons Wit (Vroeghe)	bulb	300	90	0.30	3
peak	Olinda	bulb	125	400	3.20	3
peak	Otter de Man	bulb	156	300	1.92	3
peak	Parssemacker	bulb	245	180	0.73	3
peak	Perel	bulb	300	500	1.67	3

peak	Petter	bulb	800	900	1.13	3
peak	Pio Palto	bulb	440	180	0.41	3
peak	Plomp sonder arch	quantity	9728	350	0.04	3
peak	Present Liefkens	bulb	500	490	0.98	3
peak	Present Liefkens	quantity	1000	600	0.60	3
peak	Proncker	bulb	320	118	0.37	3
peak	Provenier	bulb	270	380	1.41	3
peak	Rattebeet	quantity	9728	400	0.04	3
peak	Rattebeet	bulb	500	30	0.06	3
peak	Rector	bulb	260	207	0.80	3
peak	Rector	quantity	1000	325	0.33	3
peak	Rijswijcker	bulb	800	75	0.09	3
peak	Roosjen	bulb	300	600	2.00	3
peak	Roosjen	bulb	130	250	1.92	3
peak	Root ende Gheel verwint	bulb	300	80	0.27	3
peak	Root ende Wit verwint	bulb	220	65	0.30	3
peak	Saeyblom (ghemeene)	bulb	438	280	0.64	3
peak	Saeyblom (ghemeene)	quantity	1000	650	0.65	3
peak	Saeyblom Casteleyn best	bulb	250	350	1.40	3
peak	Saeyblom van Bol	bulb	300	250	0.83	3
peak	Saeyblom van Coningh	bulb	220	320	1.45	3
peak	Schilder	bulb	130	40	0.31	3
peak	Schilder	quantity	1000	218	0.22	3
peak	Schrijnwercker	bulb	265	90	0.34	3
peak	Scipio	bulb	10	100	10.00	3
peak	Scipio	quantity	1000	2250	2.25	3
peak	Semper Majoor	bulb	573	78	0.14	3
peak	Seyl-straet	bulb	700	190	0.27	3
peak	Sorij Liefkens	bulb	340	200	0.59	3
peak	Spinnekop (verbeterde)	bulb	315	1330	4.22	3
peak	Spinnekop	bulb	400	900	2.25	3
peak	Spits Lack van Quaeckel	bulb	300	70	0.23	3
peak	Switser	quantity	19456	2600	0.13	3
peak	Tourlongh	bulb	240	200	0.83	3
peak	Tourlongh	bulb	80	90	1.13	3
peak	Tournay Casteleyn	bulb	150	355	2.37	3
peak	Tournay Casteleyn	quantity	1000	800	0.80	3
peak	Tournay de Nonville	bulb	370	340	0.92	3
peak	Tournay Rijckers	bulb	525	315	0.60	3
peak	Troys Couleur de Nonville	bulb	150	75	0.50	3
peak	Tulpa Bitter	bulb	900	70	0.08	3
peak	Tulpa Ghelder	bulb	130	27	0.21	3
peak	Tulpa Heemskerck	bulb	400	300	0.75	3
peak	Tulpa Reynout	bulb	330	180	0.55	3
peak	Vice Roy	bulb	295	2700	9.15	3
peak	Violet gevlamt Rotgans	bulb	250	450	1.80	3
peak	Violet gevlamt Rotgans	bulb	570	712	1.25	3
peak	Violet gevlamt Rotgans	bulb	300	375	1.25	3
peak	Vytroep	bulb	440	700	1.59	3

peak	Vytroep	bulb	230	300	1.30	3
peak	Vytroep	quantity	1000	730	0.73	3
peak	Weeskint	bulb	180	400	2.22	3
peak	Wit met Roo Tippen	bulb	400	170	0.43	3
peak	Witte ende Roode	quantity	9728	12	0.00	3
peak	Woekenaer	bulb	330	230	0.70	3
	1 Gheel ende Root van Leyden, 1 Cent, 1 Switser, 1 Witte Kroon, 1 Ghee Kroon, 1 Audenaerde, 1 Coorenaer	bulbs		22.05		3
post-crash	Blijenburger (late)	bulb	n.a.	87.5		5
6/10/37	Audenaerde	quantity	10240	600	0.06	5
7/3/38	Monassier	bulb	n.a.	710		5
1/24/39	Croon (Ghee)	quantity	9728	800	0.08	5
1/24/39	Switser	quantity	9728	1300	0.13	5

Table A1. List of bulb transactions. Variant spellings changed so that varieties have just one spelling. Approximate dates deduced from descriptions when precise dates not available.

Sources: 1 – (Roman 1637b); 2 – (Roman 1637c); 3 – (Roman 1637a); 4 – (1637b); 5 – (Posthumus 1927, pp. 1-85); 6 – (Posthumus 1929, pp. 434-455); 7 – (Solms-Laubach 1899); 8 – (Dash 1999); 9 – (Goldgar 2007).