BUSINESS CYCLES WITHIN THE DUTCH FLORICULTURE INDUSTRY

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ABSTRACT

The Dutch floricultural industry, similar to the aggregate economy, relies on (re)exporting activities and represents the trading 'hub' within Europe. Based on this notion, the thesis examines whether business cycle(s) are detectable within the Dutch floriculture and subsequently if the structure is comparable with the Dutch business cycle. Using an autoregressive model with harmonic regressors, for both time series, business cycles are detected. The business cycles of both categories match. Interestingly, the business cycle structure clusters around the start of the Fibonacci sequence 1, 2, 3, 5 and 8 years. Finally, based on these findings, out-of-sample forecasts are generated for the Dutch floricultural industry till 2020.

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CHAPTER 1. INTRODUCTION

This chapter introduces the fundamentals of the research including the research question, its contribution, limitations followed by an outline of the thesis.

1.1 Preface

The thesis aims to examine if business cycles (or economic cycles) are detectable within the Dutch floriculture industry. The concept of business cycles is elaborated in the proceeding chapter; however it basically refers to the aggregate economy-wide fluctuations in activities such as production, GDP and sales in the long term. Since these economic cycles can be repetitive over time, policy makers can form expectations based on these cycles to devise their short and long-term strategies for businesses and governments.

The Netherlands is a global player in producing, importing and exporting flowers and plants, with companies that are directly or indirectly linked to the Dutch floriculture industry being highly clustered. The floricultural sector, like the Dutch economy can be considered as an (re)exporting industry, therefore exploring whether market sales are driven by (various) business cycles is particularly appealing. More importantly, the research is focused on whether the length of the business cycle(s) of the Dutch floriculture industry match with the Dutch economy as this can contain valuable information.

1.2 Research question

The following research question is central to this study:

"Do the floricultural industry and real Dutch GDP share the same business cycle length(s)?"

The answer to this question firstly requires identification of the business cycle length(s) of the floricultural industry. Market data of sales from the Association of Dutch Flower Auctions (VBN: Vereniging van bloemenveilingen in Nederland) and the PVS (Productschap Voor Sierteelt) for the period of 1953 till 2010 will be obtained and tested for cycle length(s) through a harmonic regression model.

The inherent diffusion property of business cycles implies that they should be visible in various sectors and businesses. Therefore, cycle(s) detected in the floricultural data raise the question of whether they are comparable with the Dutch business cycle length(s).

1.3 Contribution

Answering the research question is significant for both the academic and practical field. Academically, empirical support for business cycles as described in the next chapter will contribute to the debate regarding these cycles in various journals including discussions on alternative explanations for cyclical movements, varying length of cycles and research methodologies. Furthermore, this study contributes to the existing knowledge by focusing on the diffusion property of business cycles within a mesoeconomic environment since so far, no former business cycle study has examined the Dutch floriculture industry.

From a practical perspective, answering the research question will give participants within the floriculture markets insights into fluctuations of market sales allowing them to formulate expectations of the market for the near future. Lastly, stakeholders such as the Dutch government and capital providing institutions can perceive market characteristics and act accordingly in the medium term.

1.4 Limitations and boundaries

This section provides explanatory notes regarding the limitations and boundaries concerning this research.

Firstly, this thesis is *not* focused on the question 'what drives business cycles?' This question is still unresolved and conflicting theories have been revealed. Moreover, this study is *not* focused on the important explanatory factors of floricultural market sales, like weather conditions, diseases, consumption indices and monetary policies. Instead, this research tests for the proposed diffusion property of the Dutch business cycle.

Secondly, a comprehensive review of literature concerning the business cycle is out of the scope of this research whereby chapter 2 refers to articles and authors of significant academic findings.

Thirdly, in the statistical section it is assumed that the economy consists of a multiple cycle structure. Paragraph 3.4 clarifies this assumption in more detail.

Fourthly, in the business cycle literature there is a lack of conformity on the appropriate statistical methodology to identify cycles in data series. It is not the aim of this thesis, to contribute to this discussion.

Lastly, throughout this thesis ‘economic cycles’, ‘business cycles’, ‘cycles’, ‘wave movements’ and ‘cyclical movements’ are mentioned interchangeably.

1.5 Thesis outline

The proceeding chapter 2 explores the background of the phenomenon ‘business cycles’ and elaborates on the Dutch business cycle followed by an introduction to the Dutch floriculture industry and the hypothesized linkage with the Dutch business cycle in chapter 3. Empirical research and findings are presented in chapter 4 and the research concludes by answering the research question with chapter 5.

CHAPTER 2. BUSINESS CYCLE LITERATURE

This chapter presents a theoretical and historical background of the phenomenon business cycles beginning with a broad definition followed by a description of the historical setting surrounding the topic. The chapter proceeds further with a discussion of the literature regarding waves in the agriculture sector and finishes with a presentation of the research on the Dutch business cycle.

2.1 Defining business cycles

The section elaborates on the actuality that current literature on business cycles presents no widely accepted definition since the approach, theoretical explanation and statistical evidence has been developing over time.

For convenience[1] this paper follows two 'general' definitions cited in Bormotov (2009). The first is presented by Sullivan and Sheffrin (2006): "The term business cycle (or economic cycle) refers to economy-wide fluctuations in production or economic activity over several months or years. These fluctuations occur around a long-term growth trend, and typically involve shifts over time between periods of relatively rapid economic growth (expansion or boom), and periods of relative stagnation or decline (contraction or recession)". The second definition by Burns (1951) adds that "business cycles are not merely fluctuations in aggregate economic activity. The critical feature that distinguishes from the commercial convulsions of earlier centuries or from the seasonal and other short term variations of our own age is that the fluctuations are widely diffused over the economy – its industry its commercial dealings, and its tangles of finance".

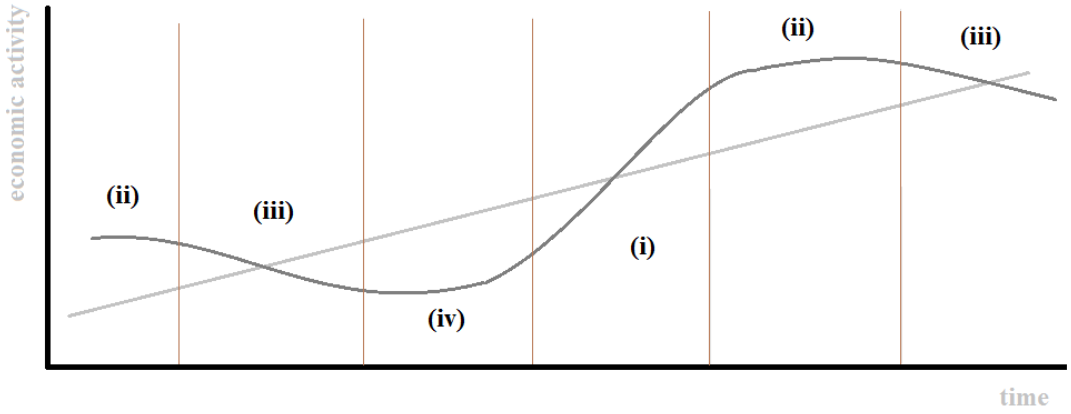
In business cycle literature, aggregate economic activity typically refers to growth or decline of gross domestic product (GDP). However, as in the adopted definition, its scope is not limited to GDP as wave movements are also visible such as in price indexes, consumption, investments, production, employment and interest rates. Furthermore, De Groot and Franses (2011) state that the main categories are prices, production, innovation and invention, capital investment, trade, real wages and working class behavior and war. Finally, cyclical movements do not pertain exclusively as an economic phenomenon but rather as an

[1] There are a variety of theoretical explanations regarding what defines a business cycle. Since the aim of the research does not require this analysis, a broad definition is adopted.

interdisciplinary research. The *Cycles Research Institute* [2] reveal the significance of cycles in other fields like astronomy, climate, geology and physics.

Schumpeter in his *Business cycles: A theoretical, historical, and statistical analysis of the capitalistic process* (1939) provided an illustrative framework for studying developments in aggregate economic activity through time by distinguishing four stages of economic status, as presented in figure 1, namely (i) prosperity phase (ii) recession phase (iii) depression phase and (iv) recovery phase. Aggregate economic activity can be categorized into these four distinct stages as follows. The prosperity phase (i) is characterized by an optimistic business environment reflected in the expansion of output, productivity, employment or profits. The recession phase (ii) leads to variations in the business environment, such as price changes that cause profits to either stagnate or slowdown and subsequently drop. The resulting state of recession is defined as two subsequent quarters of negative economic growth and is followed by the depression phase (iii) where the economic downturn continues for several periods. The final recovery phase (iv) exhibits stagnation of the negative economic growth due to the creation of new economic activities, being noticeable in higher levels of employment, positive investment climate and higher aggregate demand. It is pertinent to mention here that these indicators are neither representative of the drives nor the properties of the cycle such as the cycle length and impact.

Figure 1: Four phases within an economic cycle (visualized as a deviation cycle)



[2] The official website of the interdisciplinary Cycle Research Institute
http://www.cyclesresearchinstitute.org/index.htm

Cycles have their own depth, duration and diffusion characteristics as stated by Den Reijer (2006). Depth of a cycle refers to the magnitude, upper or lower bound, of a cycle relative to other cycles whereas duration refers to the time lag between two peaks or troughs. For example, a generally accepted cycle is the Juglar wave with 7-11 years between two peaks. However, shorter and longer cycles have been detected. According to Den Reijer (2006) "the diffusion of the cycle represents the extent to which the business cycle is visible in different business sectors and geographical areas". This last property is specifically interesting with respect to the floriculture industry and hence the thesis aims to test this property.

Detecting the presence of this diffusion property in the floriculture industry, whereby the business cycle length(s) are similar to those exhibited in the Dutch GDP, raises the question of whether these cycles run synchronal. Cycles can lead, lag or coincide with the economy. Leading economic indicators are represented by variables that change *before* the economy changes (commonly measured in growth of real GDP) whereas lagging economic indicators are those that change *after* the economy changes and coincide indicators run *simultaneously* with the aggregate economic activity in the economy. Van Duijn (1978) found that during the period 1948 to 1976, several indicators lead, lag or coincide with the Dutch business cycle and established that indicators such as changes in short-term lending and stock exchange prices *lead* the Dutch business cycle whereas wholesale prices, industrial employment and retail sales *lag* the cycle and industrial production, total exports, total imports and unfilled vacancies along with other indicators *roughly coincide* with the Dutch business cycle.

Another important subject within the business cycle literature concerns the nature of cycles. De Groot and Franses (2008) present two broad ideas regarding the nature of cycles. Firstly they propose that cycles are caused by external exogenous shocks and hence, a stochastic nature is apparent in economic life. As this chapter will highlight further, Schumpeter (1939) claims that new innovations (external shocks) that will be diffused throughout the economy are the cause of business fluctuations over time. War is another example of a possible exogenous shock affecting the economy. Secondly, De Groot and Franses (2008) suggest an economy that consists of cycles having a combination of deterministic and stochastic nature, arguing that multiple cycles and shocks are inherent in the structure of the economic system and hence are incorporated in the time series data of the past and the predicted future. They further state that: "dynamic stability in a macro economy might exist as a consequence of the existence of multiple cycles underlying the oscillations of several key economic variables".

This empirical section of this thesis assumes the second view concerning the nature of cycles, as outlined in section 3.4.

Since the beginning of the wave debate, 'what drives and pushes cycle(s)?' has been the key question. The answer to this question requires an analysis of a long timeframe to test for the influence of underlying components of the cycle(s) and cannot be obtained by evaluating only a short timeframe. Economic cycles consist of various complex interrelated drivers, which amongst others; include natural, financial, political, social, technological and economical processes through time. Owing to the inherent complexity and presence of several disciplines, a variety of interpretations (sometimes contradictory) are developed regarding the long wave movement in the economy.

For example, Lucas (1981) [3] in his book *Studies in Business-Cycle theory*, writes about cycles present in the GNP variable. "Technically, movements about trend in GNP in any country can be well described by a stochastically disturbed differential equations of very law order (…) Those regularities (…) are in the co-movements among different aggregative time series. Principle among these is the following:
(i) Output movements across broadly defined sectors move together (high conformity, high coherence)
(ii) Production or producer and consumer durables exhibit much greater amplitude then does the production of non-durables.
(iii) Production and prices of agricultural goods and natural resources have lower than average conformity.
(iv) Business profits show highly conformity and much greater amplitude than either series
(v) Prices generally are pro-cyclical; long term rates slightly so.
(vi) Monetary aggregates and velocity measures are pro-cyclical (…) Business are all alike".

Therefore, pro-cyclical (counter-cyclical) refers to a positive (negative) correlation between the cyclical movement among the macroeconomic variable and the GNP.

Presently, no uniform definition to describe economic cycle has been specified owing to the continuous evolutions in research and economic events through time which is reflected in the

[3] Cited in Bormotov (2009)

way academics have been considering the drivers of business cycles. Moreover, empirical methods and evidence have been developing over time, surfacing new insights regarding this theme and the proceeding section presents a limited overview of these evolutions.

2.2 Historical perspective

This section presents an overview of the various findings in literature regarding the business cycle where it should be noted that the aim is not a discussion of all point of views but rather to elaborate on the debate through time.

Several researchers have contributed to the studies in the business cycle field, providing evidence for various cycle lengths. Although a declaration can be made about the presence of a segregation of the lengths between longer and shorter cycles, there exists no quantification regarding this distinction. However, there is more unanimity within academics on the presence of shorter duration cycles in an aggregate economy than on longer cycles. The longer the cycle lengths, the more representative they are to the fundaments and properties of the socio-economic system. Owing to the presence of a complex coherency of natural, political, social and technological factors along with others, no converged theoretical foundation for the long-wave exists so far. Additionally, the quality and quantity of short time series is higher than that of long time series leading to less skepticism about shorter cycle length. Moreover, greater statistical evidence on shorter cycle length is present whereas the statistical methodology for identifying long-wave movements remains heavily debated.

De Groot and Franses (2011) provide an extensive historical overview of the cycle debate referring to the main authors and findings over time. Since a detailed discussion explaining all cycles is out of the scope of this thesis, following table 1, important findings of Kondratieff, Schumpeter, Kuznets and Kitchin are discussed below.

The debate regarding long wave was started by Kondratieff in 1925 with his book *The long waves in economic life*, where here states that capitalism is characterized by a multifarious cyclical mechanism rather than a linear mechanism. Kondratieff identified a cycle length between 48 and 60 years, concluding that events such as technological developments, wars and revolutions are embedded in the economic system and only the economic status of these factors determine the current point within the long wave. Reijnders (2006) clarifies that "… Kondratieff does not accept these factors as causes of the long waves. Their coincidences with

certain phases of the long wave do not indicate the causes of but rather the existence of long waves". Shortly after Kondratieff's publication, various academics expressed their critiques concerning the inadequacy of the statistical approach and evidence implying that the theoretical explanation was incomplete.

Despite the criticism, Schumpeter (1939) follows on Kondratieff's findings and introduces his research of aggregate cyclical movements within economic variables, focusing on the theoretical explanation of business cycles rather than the preceding views regarding phases within the long wave. In his theory, Schumpeter considers basic innovations as the exogenous driving factor of the long wave and innovating entrepreneurs (along with research and development departments) play a crucial role in overcoming the depression phase. He proposes the following five types of innovations: "Two types include new methods of production and new sources of supply of raw material or semi-finished goods and they are identified as process innovation. The three other types can be classified as product innovations: a new good or a new quality of a good, opening of a new market, and a new industry structure such as the creation or destruction of a monopoly position" as Dabic (2005) [4] states. Innovation paves way for new business opportunities, which combined with sufficient credit provided by the banking system strays the economy slowly towards the prosperity phase. Continuation leads to widespread diffusion and imitation of innovation causing a slowdown within the cycle and thereafter innovation gets 'exhausted'; the economy ultimately enters the recession phase and subsequently the depression phase. The cycle continues as the process repeats itself with new innovations causing new upturn.

Furthermore, Schumpeter introduces the concept of multiple business cycles whereby multiple cycles run simultaneously and fit each other's lengths. He presented a three-cycle framework, with six Juglar waves (7-11 years) and eighteen Kitchin waves (3-4 years) fit one Kondratieff wave (48-60 years). It is pertinent to mention here that this representation was purely theoretical and not supported by empirical evidence. Schumpeter (1934) states: "I am convinced now that there are at least three such movements, probably more, and that the most important problem which at present faces theorists of the cycle consists precisely in isolating them and in describing the phenomena incident to their interaction".

[4] Quoted in Dabic (2011)

De Groot and Franses (2008) further structured the arguments of Schumpeter's multiple cycle approach: "The first reason is that different innovations take varying lengths of time to be absorbed into the economy. Secondly, he [Schumpeter] states that major driving innovations do not emerge in their final form or diffuse synchronously throughout the whole economy. (…) Finally, Schumpeter recognizes that major innovations can have a far reaching influence on the economy. In order to reap the benefits enabled by these types of innovations, business and even society as a whole have to adapt step by step". In the periods following Schumpeter's publications, several researchers reviewed his ideas and despite the hefty criticism, the so called Neo-Schumpeterian elaborated on Schumpeter's innovation theory.

Kuznets (1958) research focusing on the period of 1870 to 1913 on United States statistics claimed the association between fluctuations in building activity and population development as the driver of cycles with a length of 15 to 25 years. He argues that during an economic upswing, demand for labor increases which causes an immigration of labor and a resulting population growth in the US. These 'new' citizens require basic necessities such as food, housing and transportation, reinforcing growth during the upswing period. However, a combination of excessive building activity and population movement causes a recession. This theory of Kuznets 'swing' has so far been academically acknowledged and several researchers have elaborated on the original work of Kuznets in 1930.

Kitchin (1923) found wave movements of 40 months within economic variables 'bank clearings', 'commodity prices' and 'interest rates' from data of Great Britain and the United States and claims that these fluctuations are caused by inventory shocks. During periods of recession, businesses cutback on their inventory due to falling demand in order to slim their organization. However, demand begins to rise after the recession phase and a simultaneous adjustment in inventory takes time since related trading parties are also in the process of adjustment to this new phase. Hereafter a booming period begins, affecting all chains and subsequently the whole economy and as demand outgrows supply, businesses become optimistic and increase their stock levels in order to meet the growing demand. In literature, Kitchin's inventory cycle length is widely accepted and statistically verified.

Table 1: Socio-economic cycles (adopted from De Groot and Franses (2011))

No.	Authors	Cycle period	No.	Authors	Cycle period
1.	Kitchin	3 1/3	45	Clarke	54
2	Kuczynski/van Duijn	2	46	Kondratieff	48 to 60
3	Manso	3	47	Snyder, Kondratieff	48 to 60
4	Solomou	4,5 to 4,8	48	Namenwirth	48
5	Berry/Berry, Kim and Baker	6	49	Forrester	50
6	De Groot and Franses	5	50	Kuczynski	60
7	Juglar	7 to 11	51	Haustein and Neuwirth	53
8	Kuczynski/van Duijn	8	52	Marchetti	54.55
9	Kuczynski	9	53	Beveridge (in Mager)	54
10	Haustein and Neuwirth	7	54	Goldstein	55
11	Berry	9	55	Goldstein	50 to 60
12	Solomou	8–10	56	Berry	56
13	Berry/Berry, Kim and Baker	9	57	Metz	54 to 56
14	De Groot and Franses	10	58	Berry, Kim and Kim	54
15	Forrester	14	59	Silverberg and Lehnert	40 to 80
16	Kuczynski	13	60	Berry and Kim	50 to 60
17	Haustein and Neuwirth	13	61	Modelski and Thompson	58
18	Dagaev	12 to 14	62	Dent	54
19	De Groot and Franses	13	63	Corredine	54
20	Haustein and Neuwirth	17	64	Berry/Berry, Kim and Baker	54 to 57
21	De Wolff	19 to 25	65	Modelski/Devezas and Modelski	60
22	Kuznets	22; 23	66	Devezas and Corredine	52 to 58
23	Kuznets	15 to 25	67	Thompson	40 to 50
24	Abramovitz	15–25	68	Devezas and Santos	40 to 50
25	Kuczynski/van Duijn	23	69	Ryzhenkov	58 to 63
26	Haustein and Neuwirth	20	70	De Groot and Franses	58
27	Berry	25–30	71	De Groot and Franses	61
28	Solomou	20–23	72	Strauss and Howe	90
29	Berry/Berry, Kim and Baker	18–19	73	Ageev	80
30	Berry, Kim and Baker	28	74	De Groot and Franses	92
31	Diebolt and Doliger	15 to 20	75	Namenwirth	152
32	De Groot and Franses	24	76	Modelski	101-130
33	De Groot and Franses	26	77	Wallerstein	150
34	Lösch	33	78	Goldstein	150
35	Lee	25 to 33	79	Modelski and Thompson	108
36	Haustein and Neuwirth	32	80	Modelski and Thompson	116
37	Haustein and Neuwirth	40	81	Modelski/Devezas and Modelski	120
38	Thio	32	82	Reijnders	242
39	Dent	34.5	83	Modelski/Devezas and Modelski	250
40	Weeks	27	84	Reijnders	376
41	Corredine	35	85	Ageev	400
42	Devezas and Corredine	30	86	Modelski/Devezas and Modelski	500
43	Modelski/Devezas and Modelski	30	87	Reijnders	690
44	De Groot and Franses	34	88	Modelski/Devezas and Modelski	1000;2000;4000;8000

The presence various deviating perspectives can be deduced from the prior discussion. The contributors in the cycle debate, with their conflicting and corresponding explanatory drivers can be categorized in the following so-called main school of thoughts, as identified by De Groot and Franses (2011), namely (1) the Marxist capitalist crisis school, (2) the investment school, (3) the innovation school and (4) the institutional school. Additionally, various researchers have several elements belonging to different school of thoughts within their findings. The Marxist capital crisis school views the noticeable decreasing rate of return within the economy in the long term as a downswing and exogenous shocks as the primary cause for upswing. The investment school is of the opinion that the upswing phase is caused by fundamental large investments like railways and IT-infrastructure. The innovation school maintains the view of radical basic innovation, with Schumpeter's ideas forming the basis for this school of thought. Lastly, the institutional school claims the relationship between technologic and socio-economic development as the driver of cycles, explaining that the institutional framework, political, social and economic cohesion within sectors adjust to technological developments, causing the downswing and subsequently the upswing.

Clustering of cycles

Table 1 above shows the detection of various cycle lengths throughout time, however an overarching question remains that 'to what extent do these lengths match?' De Groot and Franses (2011) collected 71 socio-economic time series data from different countries and found that these cycle periods cluster around 8, 21, 32 and 55 years.

In their paper *Stability through cycles*, De Groot and Franses (2008) introduced a new theoretical insight in the long wave debate following Schumpeter's hypothesis of multiple cycles. However they do not follow the conceptual framework of shorter cycle lengths fitting into a longer cycle but rather that each cycle within the multiple cycle environment possesses its own depth, diffusion and duration. They argue that for instance, if two shorter cycles fit into one large cycle, governments and the business environment would start behaving anti-cyclically, therefore having the same effect as that with single cycles. Moreover the presence of the property that multiple cycles do not coincide at the same time results in the event where they almost never peak or dip simultaneously causing stability within the economy and preventing anti-cyclical behavior. The empirical results of the research support these hypotheses whereby the paper incorporated time series of 33 aggregate economic variables commonly used in the business cycle field focusing on US, UK and the Netherlands. The

findings reveal 70 cycles with a varying length of 5 to 100 years with these economic cycles forming clusters around 10.3, 25.7, 57.7 and 92.0 years.

To conclude, this section elaborates the fact that currently no widely accepted theoretical and empirically justified long wave theory is present or as Zarnowitz (1992) states "(…) there is no *single* proven and accepted cause of *all* observed business cycles. Instead, there are a number of plausible and not mutually exclusive hypotheses about what cause downturns and contractions, upturns and expansions". The debate surrounding this controversial phenomenon is expected to continue bringing new insights that will contribute to this subject in the future.

2.3 Related agriculture literature

This section focuses solely on literature concerning agriculture with a discussion on the business cycles detected in agricultural prices, production and output.

Floriculture represents one of the main categories within the broader agriculture sector. Referring to 15 USCS § 431 (a) the term agricultural products means "agricultural, horticultural, viticultural, and dairy products, food products of livestock, the products of poultry and bee raising, the edible products of forestry, and any and all products raised or produced on farms and processed or manufactured products thereof, transported or intended to be transported in interstate and/or foreign commerce". The overarching agriculture sector is used in this context due to the presence of various research findings and floriculture signifies a major part within these findings.

Although the difference between, for instance, cotton or wheat and cut flowers or fruit is apparent; crude oil or wheat are greatly used as input goods for other products and within the supply chain, the distance to sales phase of the consuming good is greater than that of other products. On the other hand cut flowers, fruit or vegetables are not used as inputs for other products within the supply chain making them closely related to the end consumer. Despite this difference, similarities prevail where the harvest, in both categories, is influenced by factors such as weather conditions, technical environment and diseases leading to varying quality and quantity. A further similarity corresponds to the harvest, in both categories influencing wholesale and consumer prices.

So far, the most modern stream of linking agriculture and business cycles corresponds to the

real business cycle stream which refers to real variables like production and output that explain the aggregate economy wide movements. In agriculture this notion relates to an increase in the volume of crop which increases the demand for transport and indirectly causes trade, for instance in steel and iron, resulting in an upswing in the manufacturing of industrial products whereas a failure in crop causes a downturn in the related businesses. Andrew (1908) adds that "whether or not the farmer will be able to settle his bills with tradesmen and dealers, and whether or not he can pay for his agricultural machinery and farm improvements, will in many cases be decided by the size of the crop". Moreover, the rise in production and subsequent rise in (international) sales could cause the farmers to increase their consumption in the local economy. British economist William Stanley Jevons (1884) was amongst the first to link agricultural output movements and economy wide fluctuations with his findings that the sunspots run a 10-year cycle. His theory implied that the behavior of sunspots affected crop revenues and real income in tropical countries, causing fluctuations in demand for British industrial products. These ideas were heavily criticized, ultimately leading to the rejection of his theory.

Solomou and Wu (2003) studied the relationship between weather and agricultural prices of Germany and Britain during the period 1870 to 1913. Germany, in contrast to Britain, had a higher share of agriculture in their economy and the study revealed that the cyclical weather has sectorial and macroeconomic effects: "In the case of Germany a very different picture emerges. The relatively large effect range of weather shocks on sectoral inflation and the large weight of the agricultural sector in GDP, result in a large effect on aggregate inflation."

With the declining share of agriculture in most European countries and the US, the business cycle research relating agriculture as the driver declined simultaneously. Da-Rocha and Restuccia (2006) in their cross-country analysis describe the significance of agriculture in order to understand aggregate business cycles across countries. Their findings were as expected, that output and employment in agriculture are more volatile than in non-agriculture signifying that agricultural activity fluctuates more than the rest of the economy. The research also concluded that output and employment in agriculture are not positively correlated with output and employment in non-agriculture. The cross-country analysis established that the share agriculture holds within the economy accounts for differences between countries: "countries with a high share of employment in agriculture feature high fluctuations in aggregate output, low relative volatility of aggregate employment, and low correlation of

aggregate output and employment". Owing to the proposed relation between agriculture and different national GDP cycles, they suggest "caution in comparing business cycles across countries if the countries have different economic structures, in particular with regard to the size of agriculture in the economy."

Following the real business cycle stream is the monetary stream, mainly focused on the nineteenth century in the US and highlights the relation between cultivation, export revenues, and gold inflows. Currently the monetary stream is less prominent in literature. For this thesis, it is interesting to review the role of agriculture in the business cycle debate as various elements of findings might simply be part of a puzzle. However, the remaining research will not elaborate on the cause or driver of business cycles, being different from the objective of this thesis.

2.4 The Dutch business cycle

This section describes the Dutch Business cycle starting with an outline of the economy and followed by a discussion of business cycle research focused on the aggregate economy of the Netherland.

Dutch economy

The Dutch economy can be classified as an open international economy reliant on trading activities with a friendly business environment. The Dutch Ministry of Economic Affairs, Agriculture and Innovation (2012) reports statistics as follows. According to the World Economic Forum 2011, the Netherlands hold the 7^{th} position in competitive economies worldwide indicating an attractive business environment. Other surveys show the Netherlands playing a prominent role as producer, importer and exporter of products and services in the Europe and worldwide. The Netherlands Bureau of Economic policy analysis illustrate that nearly 30% of its national income comes from export activities of goods and services, owing to this Netherlands takes the 5^{th} position as world exporter with 4% of total global exports as ITC reports in 2011. Additionally, Netherlands is the 7^{th} largest importer with a world import share of 3.4%.

Amongst these imported and produced products and services, nearly 82% percent of the total value in Euros is exported to Europe, showing the significant role Netherlands holds as a 'distribution hub' in Europe, with Germany (24.1%) being the most important export partner,

followed by Belgium (12.1%) and France (8.9%) in 2011, according to Central Bureau of Statistics (CBS, Statistics Netherlands). Likewise in 2011, nearly 63% of the total imported products and services valued in Euros found its origin in Europe.

Figure 2: Yearly time series of Dutch export in billions of euros to main partners (CBS)

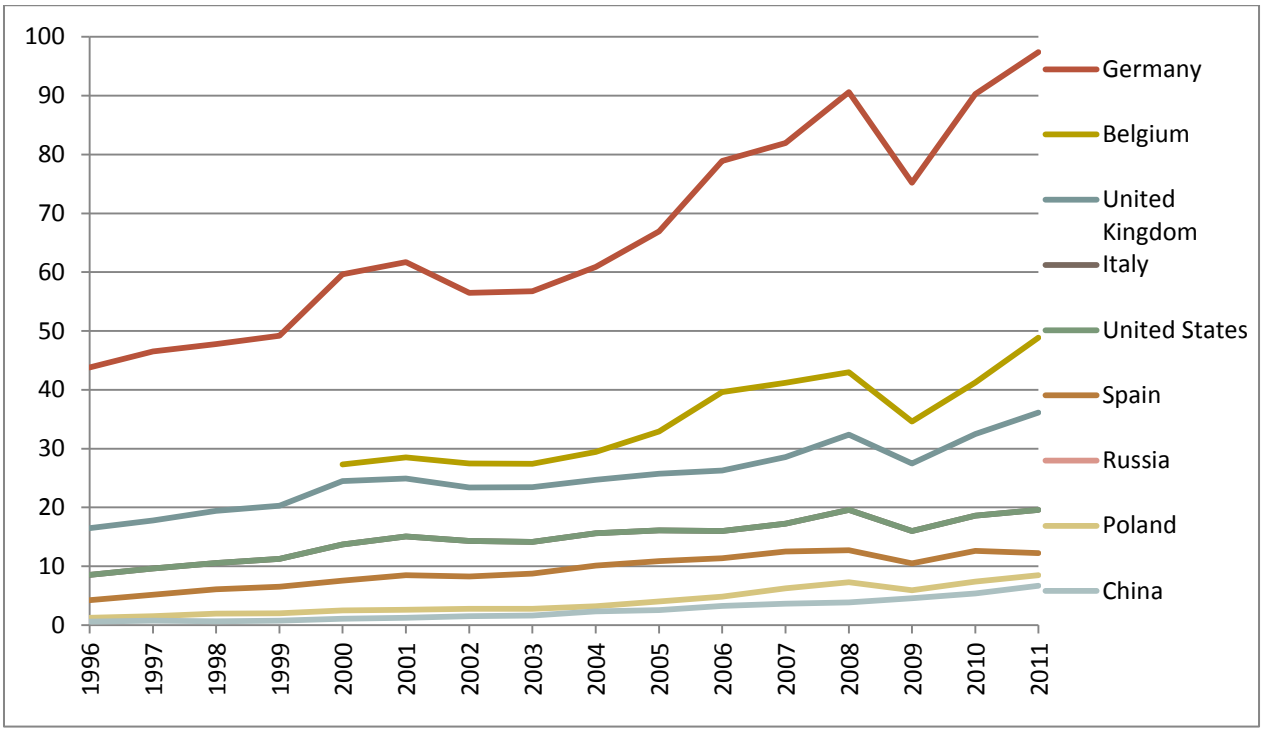
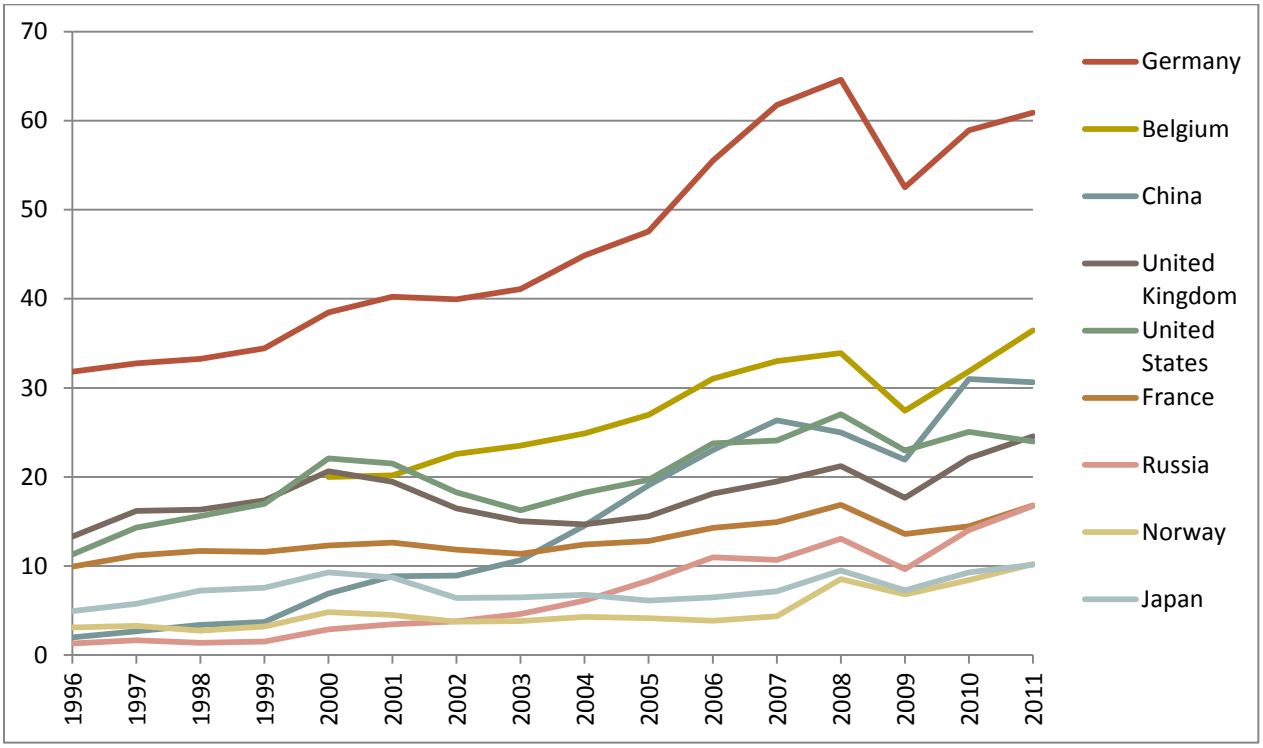


Figure 3: Yearly time series of Dutch imports in billions of euros to main partners (CBS)



With a reported negative growth in the Dutch real GDP of -3.9% was in 2009 (CBS), the prospects for the subsequent years were pessimistic. In 2011, the Dutch Minister of Economic Affairs presented a project called '*Naar de top'* (to the top) with the intention to strengthen the economic position that Netherlands holds worldwide by launching investment programs focusing on nine key sectors within the Dutch economy. These investments are focused on innovation and financed by both the business field and the government. The nine key sectors are (1) Agri-food, (2) Horticulture, (3) High-Tech Materials, (4) Energy, (5) Logistics, (6) Creative, (7) Life Sciences, (8) Chemicals, and (9) Water. It should be noted that the floriculture industry forms a part of the first two key sectors whereby it is labeled as a key sector by the Dutch government.

Research on the Dutch business cycle

Den Reijer (2006) studies the main parties involved in forecasting the Dutch economic cycle namely CPB, DNB, OECD, Rabobank and CBS. Different aggregate growth forecasts for the Netherlands are provided using several indicators in conjunction for the predictions, such as interest rates, stock indices, employment, business surveys and consumer confidence indices. Moreover various statistical techniques are used to filter the trend from macroeconomic variables through time.

Van Ruth et al. (2005) applied several filter techniques for identifying cycles in Dutch GDP and established that the length from peak-to-peak and trough-to-trough lies between 10 and 11 years. Furthermore, they concluded that the downswing length (peak-to-trough) approximates 3 years whereas the upswing length (trough-to-peak) lasts approximately 7 to 7.5 years. The model incorporated the following mix of leading, lagging and coincident variables: producer confidence, unemployed labor force, consumer confidence, jobs of employees, temporal jobs, consumer survey on large purchases of durables, exports, fixed capital formations, business surveys on orders received, GDP, total household consumption, index of industrial production, vacancies, 10-year bond yield and lastly, bankruptcies.

Applying the multiple cycle approach, De Groot and Franses (2006) found partly the same results by identifying two business cycles in Dutch GDP of roughly 5 and 10-11 years using a harmonic Poisson regression model where the second cycle length approximates the finding of Van Ruth et al. (2005). Furthermore, they observed that the Dutch GDP and Randstad's temporary staffing services share a common stochastic trend. In De Groot and Franses (2005),

staffing services are represented as a leading economic indicator since the demand for temporal labor changes with changing business environment and the staffing services of Randstad, the Dutch company, are visible in every economic sector. The model is practical for forecasting owing to the limited number of variables incorporated in it along with the fact that this indicator of the Dutch economy can provide forecasts in much shorter time lags than CBS's predictions. Den Reijer (2006) confirms that the statistical method, applied in De Groot and Franses (2005), is a gratifying research method for detecting cycles within economic activity.

Business cycle co-movement in Europe

Previously, there was great emphasis on the role of Netherlands as a 'distribution hub' within Europe; however the political European integration, including the introduction of the currency Euro, affected this role and thereby trading activities. Particular attention is drawn to the question of whether business cycles in Europe co-move and what effect does the economic and monetary integration have on the business cycles of the EU members? Existing literature consists of researchers' who have documented findings that point towards both synchronization and non-synchronization of business cycles within Europe. Kalemli-Ozcan et al (2001) argues that increasing economic integration leads to efficient capital movement whereby every country specializes in a particular production and services portfolio and this output is traded amongst European members. Since every member contributes its main portfolio of economic activity, the business cycles in Europe are less synchronized. Additionally, Krugman (1991) suggests that regional concentration of industrial activity causes sector or area specific shocks that lead to non-synchronicity. However, most research conducted suggests a synchronization of the business cycle and concludes that further European integration increases this process. For example, Concaria and Soares (2009) observed that almost all European countries have a strong correlation with the Euro-area and the Netherlands, Belgium, Germany and Austria are found to be the most synchronous. Amongst others, Frankel and Rose (1998) suggest that elimination of trade barriers will increase trade activities resulting in diffusion of shocks within Europe and with further economic integration, this synchronization of shocks will correspond to a synchronization of business cycles among European countries.

Previously, the literature connected varying perceptions of the business cycle, agricultural stream of business cycles and the Dutch and European business cycle. The literature discussed

drivers of the business cycles, amongst others innovations, inventory shocks, population and harvest. Furthermore, it was shown that the lengths of these proposed drivers of cycles seem to cluster around a series of cycle lengths. Finally, research on the Dutch business cycle was presented. The Dutch economy can be labeled as export orientated and focused on the European market. In the next chapter it will be shown that the Dutch floricultural industry shares the same property and therefore investigating if the same underlying structure of cycle is identifiable, is appealing.

2.5 Summary

This chapter introduced varying perspectives regarding the phenomenon of business cycle and presented literature focusing on the Dutch cycle lengths. Table 2 below summarizes the discussed findings that contribute to the existing knowledge.

Table 2: Overview of reviewed literature

No.	Author	Title	Result	Findings
1.	Kondratieff (1925)	The long waves in economic life	Capitalism is featured by cyclical movements and is therefore not a linear process. Cycles are internationally synchronized.	Cycles are identified in economic variables such as prices, trade and production. Cycles with duration of 48-60 years are found.
2	Schumpeter (1939)	Business Cycles: A theoretical, historical and statistical analysis of the Capitalist Process	Innovations drive the business cycle. Within the economy multiple cycles are present and overlap each other.	In a single time series, multiple cycles can be detected.
3	Kuznets (1958)	Long Swings in the Growth Population and in Related Economic Variables	Long swings in population and economic growth run the business cycle.	Cycles of 15-25 years found in the US between 1870 and 1913.
4	Kitchin (1923)	Cycles and Trends in Economic Factors	Wave movements are caused by inventory shocks.	Cycles of 3 1/3 year found in US and UK in the variables ‘commodity prices’ and ‘interest rates’.
5	De Groot and Franses (2011)	Common socio-economic cycle	The business cycle literature documents different	Business cycles documented in the literature cluster

		periods	explanations and empirical cycles and that these different cycles cluster.	around 8, 21, 31 and 55 years.
6	De Groot and Franses (2008)	Stability through cycles	Because various cycles nearly peak or through simultaneously, anti-cyclical behavior is prevented. This causes cyclical stability in the economy.	In US, UK and Netherlands, economic variables like production index, employment, consumption price indexes cycles are found that cluster around 10, 26, 58, and 92 years.
7	Jevons (1884)	Investigations in Currency and Finance	Weather fluctuations cause business cycles in agriculture intensive countries.	Sunspots cause a 10 year cycle which is diffused in economy and traded economies.
8	Solomou and Wu (2003)	Weather effects on European agricultural price inflation 1870-1913	Weather is found cyclical and has sectorial and macroeconomic effects on GDP and inflation	N/A
9	Da-Rocha and Restuccia	The role of agriculture in aggregate business cycles	Agricultural output and employment are more volatile than non-agriculture. Countries with a high share of employment in agriculture fluctuate more in harvest and have a low correlation with national aggregate output and employment	Agriculture fluctuations account for business cycle differences amongst countries. The Netherlands has a relatively low share of employment in agriculture, which suggests a high correlation of national output and employment.
10	Den Reijer (2006)	The Dutch business cycle: which indicators should we monitor?	There are 5 main parties concentrated on business cycle composition and they use different (leading) indicators.	N/A
11	Van Ruth et al (2005)	The Statistics Netherlands' Business Cycle Tracer. Methodological aspects; concept, cycle computation and indicator selection.	Various leading, lagging and coincide Dutch economic variables are incorporated to measure the Dutch Business Cycle. Numerous empirical methods are considered where in general results converge.	From peak-to-peak, cycles run between 10 and 11 years. From trough-to-peak lasts for 7 to 7.5 years, whereas from peak-to-trough lasts for approximately 3 years.

12	De Groot and Franses (2006)	Long term forecasts for the Dutch economy	A high correlation exists between Randstad temporary staffing services and the Dutch GDP. Instead of other business cycle forecasters, this paper only uses a single variable.	Cycles of roughly 5 years and 10-11 years are found in both Randstad statistics and Real GDP. It is an interesting feature For floriculture.
13	Concaria and Soares (2009)	Business Cycle synchronization across the Euro area: A wavelet analysis	Practically all EU countries are strongly correlated and countries with the euro have become more synchronized.	Through time European countries are more converged. Because the Dutch floricultural sector is almost exclusively traded in the EU, this strengthens the notion that aggregate GDP fluctuations could be detected in the floricultural data.

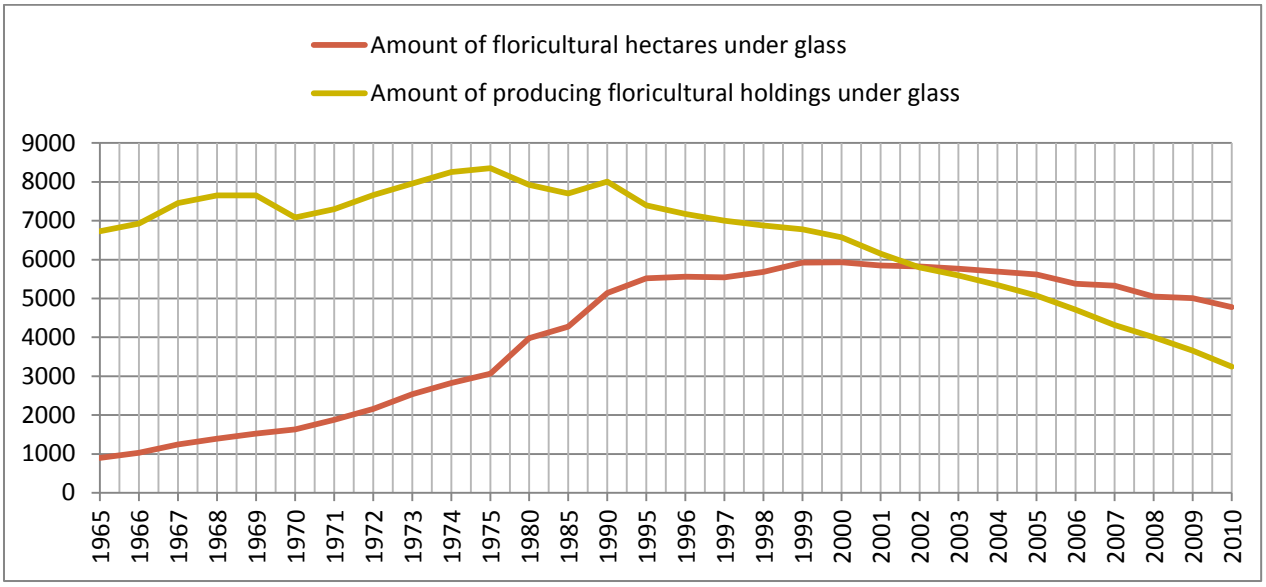
CHAPTER 3. THE DUTCH FLORICULTURE INDUSTRY

This chapter describes the development and the current status of floriculture including an explanation of the Dutch auction system and its linkage to the research question.

3.1 Development of Dutch horticulture

The Dutch floriculture industry originated centuries ago when humans started horticultural enterprises in the Netherlands due to its humid and gentle climate. Nowadays, floriculture remains an important industry for the country with Netherlands being represented as a world player in this industry, as observed in statistical data of production, imports and (re-)exports.

Figure 4: Time series on floriculture under glass in hectares and the amount of holdings in units (LEI and CBS)

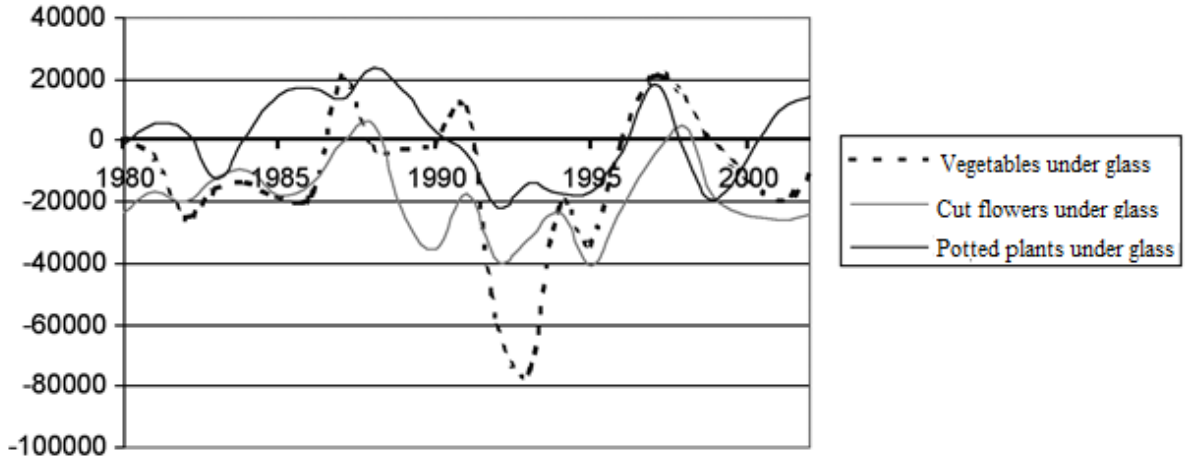


Benseddik and Bijl (2004) describe the development of horticulture in the Netherlands, primarily focusing on Westland, the Netherlands' largest horticultural production area.

In the second half of the 19th century, the cultivation of vegetables and fruit rose owing to increasing demand as the population grew and prosperity surfaced in West-Europe due to industrialization. Immediately after the First World War, the export of horticulture products recovered slowly as the Dutch currency was too strong relative to other trading countries. The export of horticultural products increased significantly during the years 1924 to 1929. The financial Wall-Street crash of 1929 in the US subsequently affected the horticulture industry and led to a rigorous end to the booming periods.

After the Second World War, the economies in West-Europe had to be reconstructed leading to a rapid, comprehensive and prolonged growth period of prosperity in Europe. Furthermore, the growth in wealth led to an income increase in every layer of the population, which for the Dutch floriculture caused an intensive international demand for its crops. Former EU policies further strengthened the exporting possibilities due to liberalization of international trade between EU member countries during that time. Production expanded to fulfill demand and investments in greenhouses increased along with development of new innovative technologies for more intensive and efficient production due to the relatively small country size of the Netherlands comprising a small horticultural area. Figure 4 elaborates the amount of floricultural hectares through time and shows a significant increase in greenhouses after the Second World War, which stagnated in the 90s. Additionally, the average hectares per producing floricultural holding under glass increased. Subsequently, Benseddik and Bijl (2004) document the production efficiency growth in the floricultural sector. For example the amount of roses per square meter increased from 166 to 218 units during 1980 to 1999 whereas cut flower 'gerbera' increased during the same time line from 103 to 269 units.

Figure 5: Average net profit in euros of different horticultural groups under glass (CBS, adopted from Benseddik and Bijl (2004))



Horticulture (including floriculture) is a highly volatile industry reliant on the harvest and other factors. Figure 5 visualizes the average net operating profit of various horticultural businesses and highlights the financial difficulties facing the horticultural companies, both in the past and future. From an optimistic view, the continuous focus on cost reduction in horticultural farms made the floriculture an innovative sector along with the banking system and the Dutch government playing an important role in the development of the volatile and

capital intensive horticultural businesses in the Netherlands. After the Second World War the government, in collaboration with the banking system, stimulated the start of new horticultural businesses by creating a special financial lending platform. Along with the rising international demand, this can be classified as an important condition for becoming the current leader in Floriculture trade to date.

Figure 6: EU exports of ornamental horticultural products (excluding seeds) in million euros to all countries worldwide (AIPH / Union Fleurs: International Statistics Flowers and Plants)

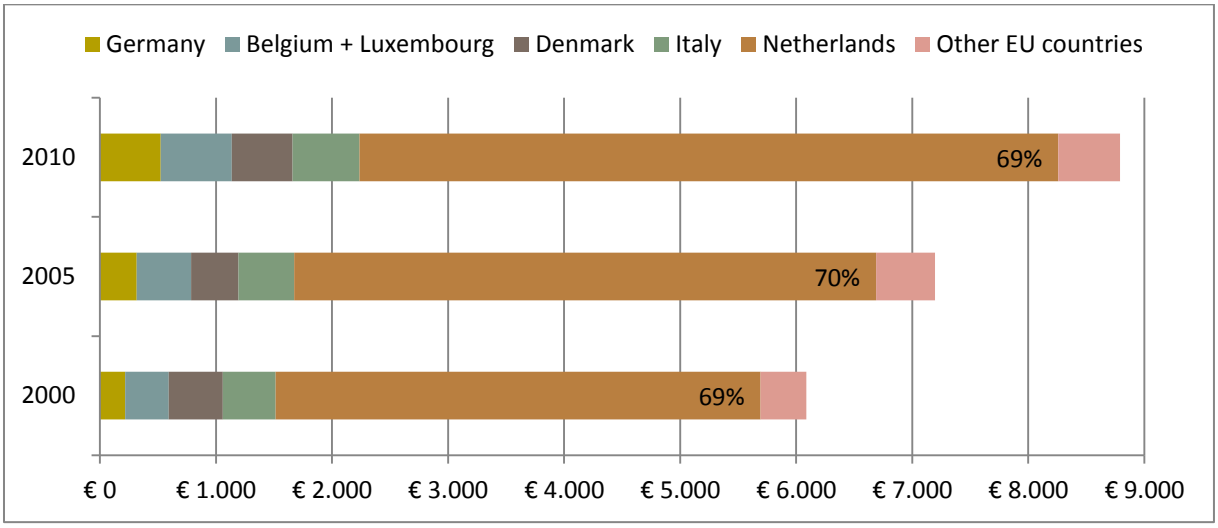
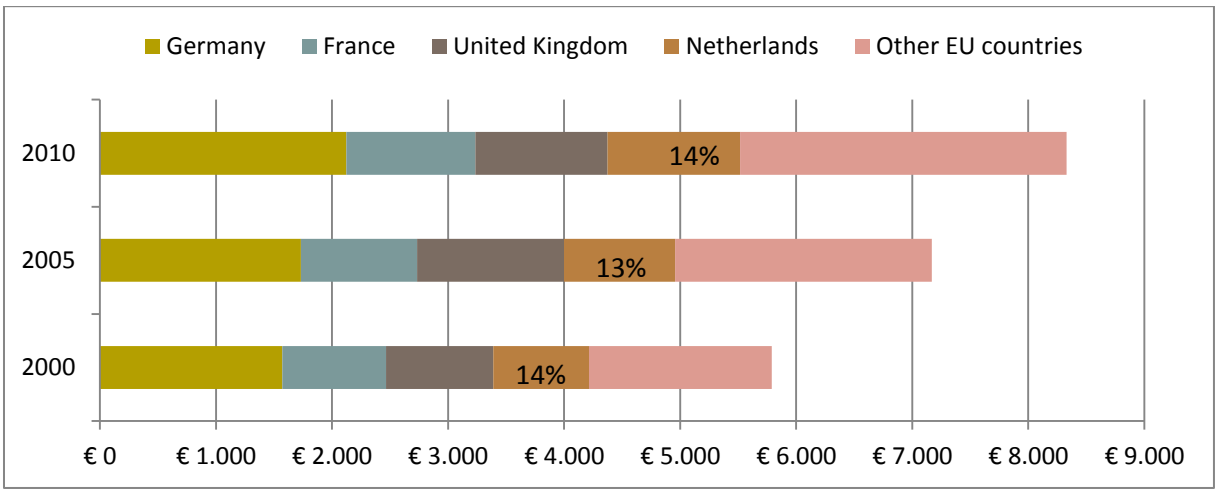


Figure 7: EU imports of ornamental horticultural products (excluding seeds) in million euros from all countries worldwide (AIPH / Union Fleurs: International Statistics Flowers and Plants)

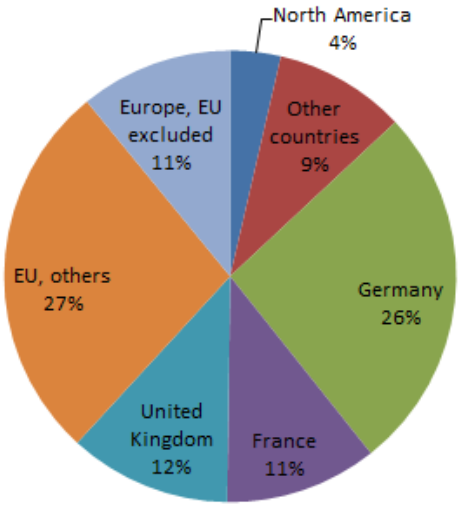


The significant role the Netherlands holds in the floricultural sector can be observed in production, import and re-export statistics. According to AIPH, International Statistics Flowers and Plants (2011), the production value of flowers and plants in the Netherlands in

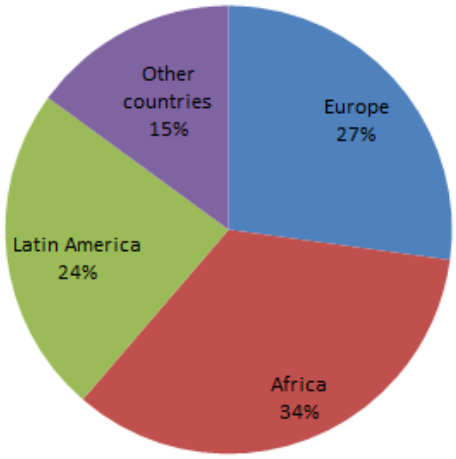
2010 was 3,780 million euros, holding a 14.4% share worldwide a 34.8% share in Europe. A comparison of figure 6 and figure 7 highlights the fact that production is mainly export oriented. Furthermore, figure 6shows that the Netherlands accounts for almost 70% percent of the total exports of EU countries, having exported nearly 2,440 million euros of cut flowers and 1,853 million euros of potted plants, representing 46% of the total exports in cut flowers worldwide and 58% of the total export in potted plants in Europe, as documented in AIPH (2011). Figure 8a presents the main countries Dutch floricultural businesses exported to in 2010 and the most significant conclusion that can be drawn is the fact that 87% of total Dutch exports remains in Europe whereas 76% within EU countries. Moreover, AIPH (2011) document that from the worldwide import of ornamental horticultural products, excluding seeds by the EU countries, 60.5% originates from the Netherlands. It can be concluded from these findings that the 'distribution hub' of the Dutch floricultural market retains within Europe.

In the past decades, Dutch floricultural businesses increased their imports of cut flowers and \ plants from lower cost countries like Kenya. In 2010, the Netherlands was responsible for 10.6% of world imports of cut flowers and 10.6% of European imports for potted plants.
Figure 8b highlights the significant import share Africa holds within Dutch floricultural imports and that 32% of Dutch imports originate from European countries.

Figure 8a: Origin of Dutch exported ornamental horticultural products (excluding seeds) in 2010 (AIPH / Union Fleurs: International Statistics Flowers and Plants)
Figure 8b: Origin of Dutch imported ornamental horticultural products (excluding seeds) in 2010 (AIPH / Union Fleurs: International Statistics Flowers and Plants)



(a) export



(b) import

The Netherlands is still considered one of the most important leaders in the floricultural sector despite the declining area for floricultural production and the continuously tensions with factors such as spatial pressure and volatile profitability. Thereby the question arises regarding the forces that determine the future of floriculture within the Netherlands.

The cooperative bank, Rabobank (2012) in their report about the future of horticulture in the Netherlands defined *seven driving forces* in the world that will determine the role of horticulture in the near future, depending on the direction these forces move. The first power is the 'demographic and labor force' based on the expectation that the world population will grow slightly, however the population in West-Europe will stagnate and that in East-Europe will shrink, having an influence on the export position of Dutch floriculture. The second driving force is 'geopolitics' taking into account that currently economic growth is mainly visible in the BRIC countries (Brazil, Russia, India and China). How will this affect the role of Europe in the near future? Moreover, with the Dutch floricultural sector highly reliant on free trade policies, how will the European integration develop? Undoubtedly this will affect the role of Dutch horticulture. The third driving force is 'social conditions' based on cooperation or individualism on a societal and business level since the cooperative character within the horticultural sector is considered a significant factor for success. However, the question remains whether entities will still cooperate in the future and what will be the role of the floricultural auctions? The fourth and fifth driving forces are closely related, namely 'scarcity of fossil fuels' and '(technological) innovations' respectively. Scarcity can cause political tensions and impact access to important sources, influencing geopolitical movements in the future. On the other hand, development and application of technical innovations can cause efficient use of fossil fuels in Europe and other energetic innovations can stimulate cleaner resources. Next to these technical innovations, diffusion of ICT innovations to the floricultural business for production and trade can have a major influence in trading activities. Currently, the amount of online trade transactions is increasing which can have far reaching effects for the Dutch auctions. The development of the fifth driving force 'sustainability' refers to the quality of production of consumers intensively label products where the question focuses on whether the Dutch floriculture will lead with sustainable practices and will this have an impact to convince the consumer? The final driving force called the 'financial funding' is of key importance as previously, the financial platform stimulated by the government in the post-war period developed the floricultural sector and allowed it to mature to a world player today. With the credit crunch and the current instability of European

prospects, there exists an increasing tension to provide capital to floricultural businesses in the Netherlands. Looking objectively, floriculture has been selected by the government as one of the top sectors in the Netherlands providing them an incentive to participate in the future of this industry.

This section focused on the development of horticulture, including floriculture, in the Netherlands. The proceeding section describes two important factors providing a competitive advantage to the Dutch floricultural sector.

3.2 Dutch auction systems and clustering

The Dutch auction system plays an important role in the development of floriculture within the Netherlands. In the early 20th century in different regions, farmers of floricultural products started cooperatives to sell their products where the aim of this cooperation between producers was to combine their powers against the purchasers of their products and collectively pursue them to obtain better prices and higher private income. Individually this influence was insignificant and hence members of the cooperatives included provisions on their sold product to induce market wide investments for the creation of a better marketplace. These market wide investments include (i) the development of sales platforms that auction clocks and direct mediating services; and (ii) buckets and trailers and other logistic resources for a uniform selling and distribution process. Another significant advantage, observed in financially insecure times of today, is the payment security. Members of the cooperation are provided with the guarantee that they will receive the payment within a week, from the time of sale of their products. This agreement has been made in collaboration with the Dutch banking sector whereby the purchaser's account is automatically debited. This form of agreement is of great importance in capital intensive industries like the floriculture industry, especially in financially insecure times.

The centralization of marketplace is advantageous for the purchaser as well since they can buy from a diverse range of products within a centralized place rather than going through the process of visiting and comparing different suppliers and products. Moreover, the quality standardization and categorization provided by the cooperative encourages trading between suppliers and purchasers. Additionally, centralization accelerates the transit of sold goods to the consumer since the collective sale of products in the market eliminates the burden of transportation for the buyers. This is essential for cut flowers since they are rapidly perishable

goods. Over the past decades, various regional auction markets have merged into one cooperative organization, FloraHolland with their market and distribution centers located in Aalsmeer, Naaldwijk, Rijnsburg, Bleiswijk and Eelde.

Another contributory factor for the market competiveness of the Dutch floriculture is the clustering of businesses in the horticulture chain. OECD (2005) explain that: "Clustering refers to local concentration of horizontally or vertically linked firms that specialize in related lines of business together with supporting organizations, though definitions as to what exactly constitutes a cluster vary greatly (…). By clustering together, firms can achieve economies of scale and scope and lower their transaction costs due to geographical proximity and increased interaction often based on trust". The horticultural cluster infrastructure consists of flower and plant breeding units, production companies, flower auctions, transporters, logistics, wholesale companies, retail companies, financial and research institutions. They are horizontally or vertically linked in the floriculture value chain making companies dependent on each other. Deterioration of one section within the cluster affects the total cluster although extensive cooperation brings competitive advantage for the complete cluster, as explained in OECD (2005).

Michael Porter, one of the initiators of the cluster theory, stated in FloraHolland Magazine (2011) the importance of the Dutch floricultural cluster, claiming that it has proven its value. Hogervorst, branch manager of FloraHolland Rijnsburg, declares it theoretically illogical it that this cluster evolved in the Netherlands, since the country is considered small and expensive. Despite this claim, Hogervorst explains the strength of this cluster: "We [the Netherlands] are closely located to important [export] markets. Our product range and logistics are solid. We are international orientated, have relative decent regulations and little trade barriers". Lastly, Hogervorst refers to Porter, who highlights one of the strengths of the Dutch floricultural cluster as its ability to bind to 'sub-clusters', such as the production of roses in Kenya. Questions like 'how did the clustering started?' and 'how did it develop?' are of particular interest. Porter (2003) distinguishes regional competiveness of clusters between resource-dependent, local and traded industry. The development of floriculture in the Netherlands points towards the resource-dependent industry since centuries ago humans started horticultural entities owing to the humid and gentle climate, as Beneddik and Bijl (2004) documents. However, literature doesn't provide a uniform answer, although the physical floricultural auctions undoubtedly play an important role in clustering.

3.3 Factors influencing floricultural trades

Similar to cycles in Dutch GDP that consists of natural, financial, political, economic, social and sectorial processes, the floricultural industry consists of factors influencing trade and market turnover. While listing the factors is particularly challenging, modeling them is more difficult. Although it is not the aim of this business cycle and empirical research, it is important to mention the factors influencing floricultural trade in an attempt to increase the reader's view of the sensitivity of the sector.

The following list highlights the factors influencing trade activities in the Dutch floriculture sector. It is pertinent to mention here that the list is not conclusive and only the most important factors are described.

- *Weather conditions*. Weather conditions primarily influence harvest affecting the quality and amount of products sold, thereby impacting the supply side. On the other hand, warm summer weather corresponds to consumers buying fewer flowers (whereas in this instance the growth of floricultural products is faster).
- *Consumption (rates) of flowers and plants*. Different countries correspond to differing willingness to pay on part of the consumers for the consumption of floricultural products; thus marketing plays an important role.
- *(Product) innovations*. ICT is an important example of innovation, where an increasing number of transactions are closed online in the floricultural sector. These e-trade activities enhance the possibilities in matching international demand and supply.
- *Employment.* Trade activities are influenced by the amount of people willingness to work in floricultural businesses along with the possibility of finding well educated people and successors of production companies.
- *Political factors.* On a national level the stimulation to import, export or produce floricultural products by the government influences international trades. However, on an international level the European integration affects Dutch business activities, including floricultural trade.
- *Spread of public holidays* Due to national public holidays, on various days there will not be traded or harvested which can cause an oversupply in the first trading day after these public holidays. In turn this can negatively influence the price in the proceeding period.

- *International supply and demand.* A match or mismatch of international supply and demand can require adjustment to fluctuations by the Dutch floriculture.
- *Currency conditions.* A strong or weak currency can have influence on the import or export of floricultural products. However, it doesn't have a big impact on the Dutch floriculture as nearly all export is in euros, with the exceptions of countries such as the United Kingdom.

3.4 The Dutch business cycle and the Dutch floriculture cycle

In section 2.1, the term business cycle was defined as economy-wide fluctuations in economic variables over a long period. Furthermore, from a national economic perspective the diffusion property of business cycle implies that they are observable in different business sectors and geographic regions. This thesis tests for this property using the floricultural industry.

Section 2.4 classifies the Dutch economy as an open exporting economy with a friendly business environment and a logistic 'hub' for international trade. De Groot and Franses (2006) identified two cycle lengths in Dutch GDP over the period 1967 to 2010, being the 5 year and 10-11 year cycles. Chapter 3 introduced the Dutch floricultural industry as a worldwide market leader in (re)exporting flowers and potted plants and it was stated that the future of floriculture relies less on production and more on extending and commercialization of the knowledge (innovative concepts) and the binding of international floricultural trade flows and related services.

Both the aggregate Dutch economy and Dutch floricultural sector are (re)export orientated and reliant on European demand, making it interesting from a business cycle perspective. Therefore, the following **research question** is drawn up: 'Do the floricultural industry and the Dutch GDP share the same business cycle length(s)?'

The proceeding chapter attempts to answer the research question(s) by identifying the Dutch floricultural cycle and comparing it with the Dutch business cycle with the underlying assumption that the empirical methodology for identification of cycle length(s) by De Groot and Franses (2006) leads to the Dutch business cycle lengths. Moreover, their methodology assumes that the economy is a combination of deterministic and stochastic nature, however there is no consensus on this subject in business cycle literature. Various schools of thought have claimed the existence of a multiple cycle structure but with a different explanation of the

drivers as that mentioned in Chapter 2. Additionally, with over 150 years of research, no theory has rejected the existence of business cycles implying that business cycles are an integral part of the economic system. It should be mentioned here that the aim of this research is to contribute to this discussion, as highlighted in section 1.4.

CHAPTER 4. EMPIRICAL RESEARCH

This chapter presents the empirical research starting with the data description, followed by an outline of the empirical methodology and ends with a discussion of the results and forecasts.

4.1 Data description

For effective comparison of the cycles within the floricultural industry and the Dutch business cycle, two categories of time series are incorporated in the empirical research, namely, the floricultural industry and real Dutch GDP.

Floricultural industry

Regarding this first category, the thesis assumes the market value of transactions traded at the auction markets (as explained in section 3.2) to describe the Dutch floricultural industry. The rationale for this assumption is twofold. Firstly, almost all Dutch produced cut flowers, plants and floricultural imports are sold by Dutch suppliers through the Dutch auction markets allowing it to retain a monopolistic position, implying that the data is a reliable indicator of the Dutch floricultural industry. Secondly, the primary focus of this thesis is on the trading position of the Netherlands and using the floricultural auctions as the indicator for the floricultural industry incorporates both supply and demand forces, which is reflected in the price and quantity components (output) of market turnover via the floricultural auctions. This elaborates the importance of these trading components and is hence included in the empirical analysis, making it functional for cyclical identification and comparison with the aggregate economy.

The various Dutch floricultural auction organizations are affiliated through the overarching organization called *Vereniging van Bloemenveilingen (VBN)* or the Association of Dutch Flower Auctions. One of the main responsibilities of the VBN (www.vbn.nl) is to provide statistical market information including the market turnover, market supply, quantities sold and average market prices of all Dutch floricultural auctions jointly and of different products or product groups. Prior to 1986, the *Productschap Siergewassen (PVS)*, now defunct, provided information regarding the floricultural market. These two sources were utilized in the data selection for this research.

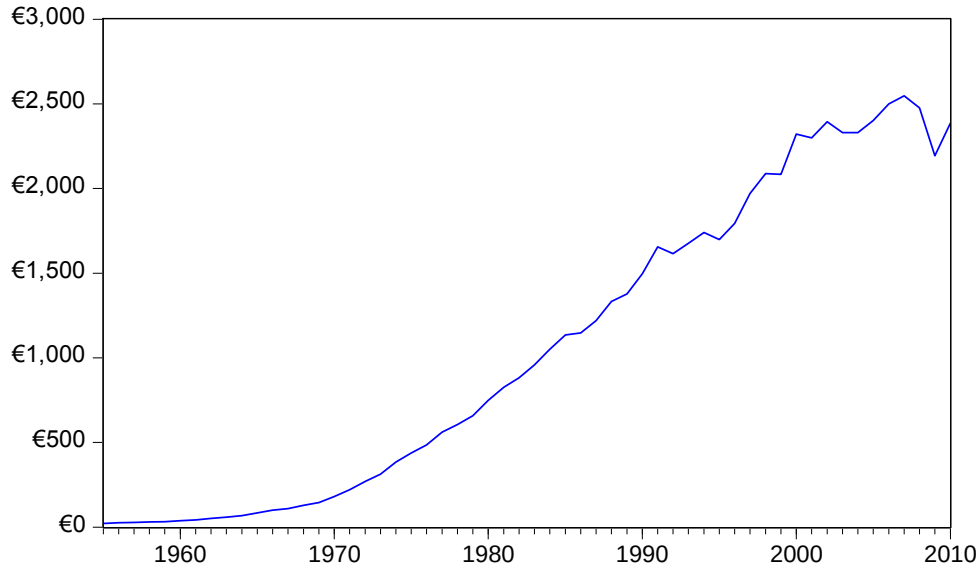
The following data was retrieved and collected from the archive of Wageningen University library (www.wur.nl/UK/) during the periods of April, May and June 2012. With regards to

the proceeding data specification, the details of the direct internet URLs and accessed archives is provided in the footnotes.

The data consists of two time series, namely (1) yearly data from 1953 to 2010 and (2) quarterly data from 1986 to 2010. From the period of 1953 to 1985, the volume of annual report [5] of *Productschap Siergewassen (PVS)* provides yearly data on market turnover. Following on, from the period of 1986 to 2010, the yearly volume of statistical book of the Association of Dutch Flower Auctions, *Vereniging van Bloemenveilingen (VBN)* [6] provides weekly data on market sales. Figure 9 below visualizes the yearly market turnover of cut flowers and figure 10 shows the quarterly sales of (1) cut flowers, (2) potted and garden plants and (3) summation of both.

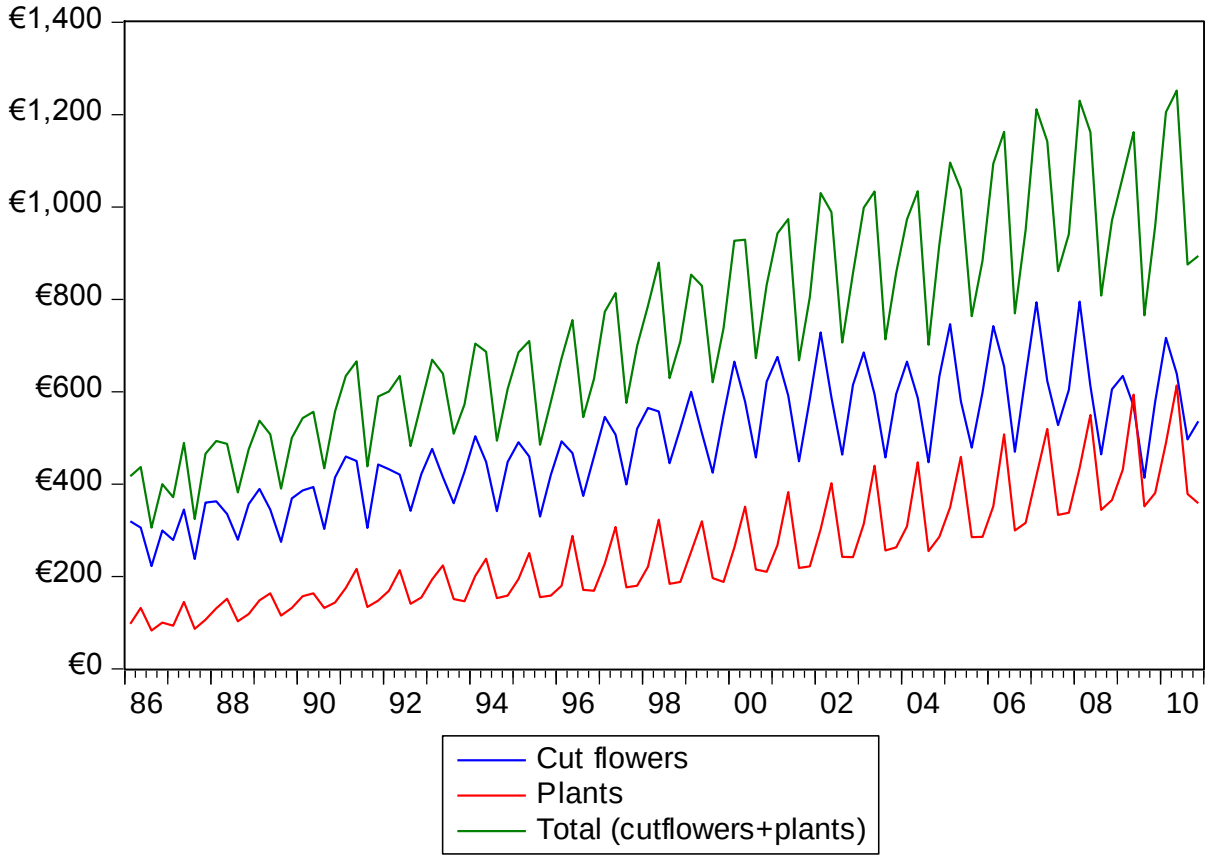
Some facts need to be highlighted regarding the chosen data. Firstly, the second time series fits the first time series by totaling the four quarters per year in the period 1986 to 2010. Secondly, the pre-euro real market turnover in Dutch currency 'gulden' is converted to euros. Thirdly, after 2010 the VBN stopped public publicizing of weekly market turnover. Only by being a member and paying a significant fee, the data can be obtained. Fourthly, the quarterly data is calculated from weekly data and lastly, no yearly time series on potted and garden plants is available owing to an inconsistent database.

Figure 9: Yearly time series on market revenues of cut flowers (x € 1,000,000)



[5] http://library.wur.nl/WebQuery/clc/68156
[6] http://library.wur.nl/WebQuery/clc/94584

Figure 10: Quarterly time series on market sales of cut flowers and plants (x € 1,000,000)



There are two limitations to the data that can have a possible impact on the research. Firstly, the lack of reliable data prior to 1953 complicates the identification of longer cycles in the data. However, the data during the years 1967 to 2004 is used for identification of the Dutch business cycle. Since the thesis compares the two cycles, floriculture and aggregate real GDP, the same limitations hold for both and hence they can be compared. Secondly, there is no quarterly data available prior to 1986 although the yearly data is sufficient for identification of cycles in floricultural data. Moreover, the quarterly data should illustrate similar results, thereby strengthening the findings for the period prior to 1986.

Real Dutch GDP

For identification of cycles, the second category data is collected from the Central Bureau of Statistics (CBS, Statistics Netherlands). Referring to section 2.4, the Dutch business cycle lengths identified were of approximately 5 and 10-11 years, forming the basis for comparison with the Dutch business cycle for this thesis. Since CBS continuously revises the statistics, it is necessary to identify cycles by utilizing the latest revised dataset.

The dataset consists of two time series, namely (1) yearly data from 1988 to 2010 and (2) quarterly data from 1988 to 2010. There are two reasons for choosing the data up to 2010. Firstly due to the comparison with the Dutch floricultural data and secondly owing to CBS continuously revising the latest quarterly real GDP calculations, meaning that after 2010 the chance that revisions have impact on the results in this thesis, is more significant. The main limitation of the dataset is the inconsistency prior to 1988 leading to a lack of reliable data. The figures below visualize the time series data, both presented in euro's.

Figure 11: Yearly time series on real Dutch GDP (x € 1,000,000)

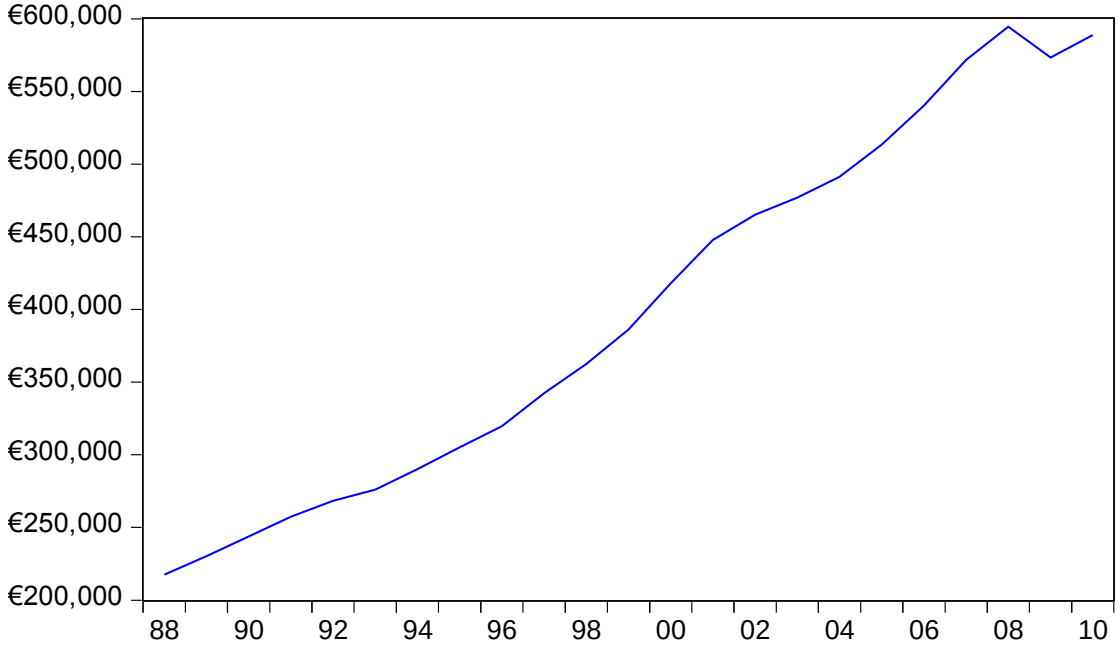
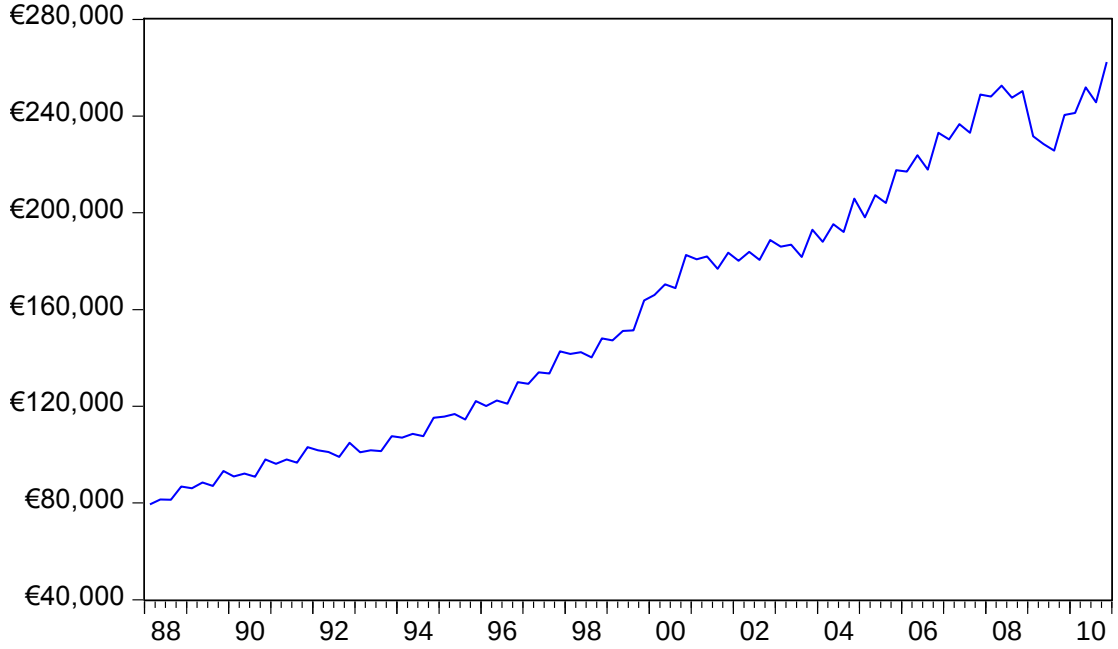


Figure 12: Quarterly time series on Dutch GDP (x € 1,000,000)



Comparing the two categories of time series at first glance, provides a first intuitive impression. Both the real Dutch GDP and real market turnover of floricultural products clearly show an upward trend and cyclical movements. The quarterly time series of real Dutch GDP and market turnover of cut flowers seems to be affected by the credit crises and its aftermath, although a significant downturn was already visible in the statistics of Dutch traded market turnover of cut flowers during the second quarter of 2008 whereas the substantial downturn was noticible in real Dutch GDP in the fourth quarter. Furthermore, figure 10 indicates intuitively that the market turnover of plants is rather linear, instead of cyclical and is insenstive to the negative growth noticed in the other time series.

The table below outlines the time series included in the empirical analysis. The proceeding section elaborates on the statistical methodology used in this research.

Table 3: Time series included in the empirical research

Time series (visualized in figure #)	Quality	Time frame	# Obs
I. Dutch GDP (figure 11)	per year	1988 – 2010	23
II. Market turnover of cut flowers in Netherlands (figure 9)	per year	1955 – 2010	56
III. Market turnover of cut flowers in Netherlands (figure 10)	per quarter	1986Q1 – 2010Q4	100
IV. Dutch GDP (figure 12)	per quarter	1986Q1 – 2010Q4	92
V. Market turnover of plants in Netherlands (figure 10)	per quarter	1986Q1 – 2010Q4	100
VI. Market turnover of plants & flowers in Netherlands (figure 10)	per quarter	1986Q1 – 2010Q4	100

4.2 Methodology

In order to identify cycle(s) within the Dutch floricultural and GDP data, an autoregressive (AR) model with harmonic regressors is fitted for both categories. The model implies that cycles in data are not fully stochastic (caused by external shocks) but partly deterministic.
Following on, methodology similar to that of the identification of the Dutch business cycle by De Groot and Franses (2006) is applied. Den Reijer (2006) outlined various business cycle indicators, concluding the aforementioned methodology as most suitable for identifying cyclical movements. Therefore, this thesis employs the methodology of De Groot and Franses (2006) which would also allow documentation of the impact of revision of the real Dutch GDP by the CBS.

The statistical analysis is undertaken with Eviews 7.0 (student version). Following on, the section outlines the statistical methodology, with the time series reported in table 3 forming the basis for this statistical part. The results will be presented in section 4.3.

Firstly, the observations Y_t are considered in their stationary form meaning that the natural logarithm is taken.

For each time series, the following regression is considered:

$$Y_t = \mu + \varepsilon_t \tag{1}$$

The regression above leads to a best fitting autoregressive model per time series. For the yearly time series the explanatory basis t_{-1}, for quarterly time series this is t_{-4}.

Secondly, harmonic regressors are added to the identified AR model to test for significant cycles in the data. Equation 2 shows the harmonic regressors sinus and cosines, whereby ε_t has a mean and variance σ^2 of zero.

$$\mu = \alpha_o + \sum_{i=1}^{C}\left[\beta_{1,i}\sin\left(\frac{2\pi t}{C_i}\right) + \beta_{2,i}\cos\left(\frac{2\pi t}{C_i}\right)\right] \tag{2}$$

This harmonic regression model implies that both variables contain cycle length(s) of C_1, C_2 … C_i . Various cycle lengths are added to the AR model and subsequently tested for significant parameters using a trial-and-error method. Collectively, this leads to an autoregressive model with significant harmonic regressors. Herewith, the R^2 should be sufficiently large to label the model as suitable and sufficient to render forecasts. This methodology is employed to identify cycles in the floricultural industry and assisting in answering the research questions.

Finally, business cycle theorists suggest that cycles are incorporated in economic activity, where the empirical foundation has been discussed in the second chapter. For the purpose of this research, assuming that the economy consists of multiple cycles allows generation of out-of-sample forecasts, which will be presented in the last paragraph of this chapter.

4.3 Results

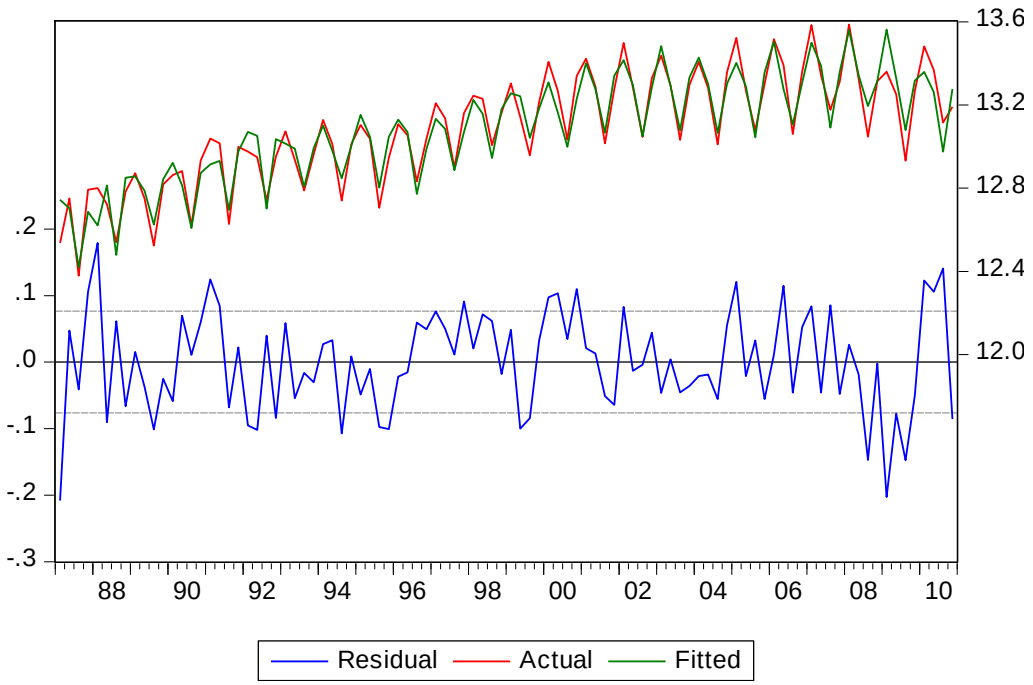
This section outlines the results of the empirical research and aims to answer the research question of whether business cycles are detectable within the Dutch floricultural industry and subsequently their relation to the Dutch business cycle.

As outlined above, firstly for each time series, an AR model is fitted where the results are shown below in table 4. Recall that for the yearly time series the explanatory basis is t_{-1}, and for the quarterly time series t_{-4}.

Table 4: Fitting AR-models

Dataset	Quality	R^2
I. Dutch GDP	per year	0.989
II. Market turnover of cut flowers in Netherlands	per year	0.955
I. Market turnover of cut flowers in Netherlands	per quarter	0.915
II. Dutch GDP	per quarter	0.975
III. Market turnover of plants in Netherlands	per quarter	0.978
IV. Market turnover of plants & flowers in Netherlands	per quarter	0.957

Figure 13: AR model fit of time series on market turnover of cut flowers in Netherlands (in natural logarithms)



Using the AR model per time series as a basis, cycle lengths are added to test if they are significantly present in the data.

Following is an explanation of the procedure of adding cycle lengths. First, a maximum for the cycle length is set, whereby a distinction is made between the yearly and quarterly time series dependent on table 3. For the yearly time series, a maximum adding cycle length of 20 observations (years) is retained whereas for the quarterly time series the maximum is set at 50 observations (quarters). Additionally, a minimum requirement of 2 peaks or troughs is set to account for a possible business cycle per time series. Second, the Wald-test is performed for each added length. Referring to equation 2, the hypothesis ($H_{0)}$ per added cycle length indicate that the betas (β) are equal to zero. If H_0 is rejected, meaning that the betas (β) are different from zero, the added business cycle length(s) c_i in $\sin\left(\frac{2\pi t}{c_i}\right)$ and $\cos\left(\frac{2\pi t}{c_i}\right)$ is found to be significant. Consequently, via this procedure significant business cycle lengths are detected.

Essentially, the second step concerns the identification of significant business cycles within a given time frame (in years or quarters) via a trial-and-error method. The procedure starts by adding the maximum selected cycle length (20 years or 50 quarters) and continuously performing the Wald-test until the cycle length is zero, thus working backwards. The resulting chi-squared probabilities are stored and visualized per time series, as shown in figure 15a to 15d.

Therefore, significant and insignificant cycles are detected using the aforementioned procedure and the table below summarizes the identified cycles.

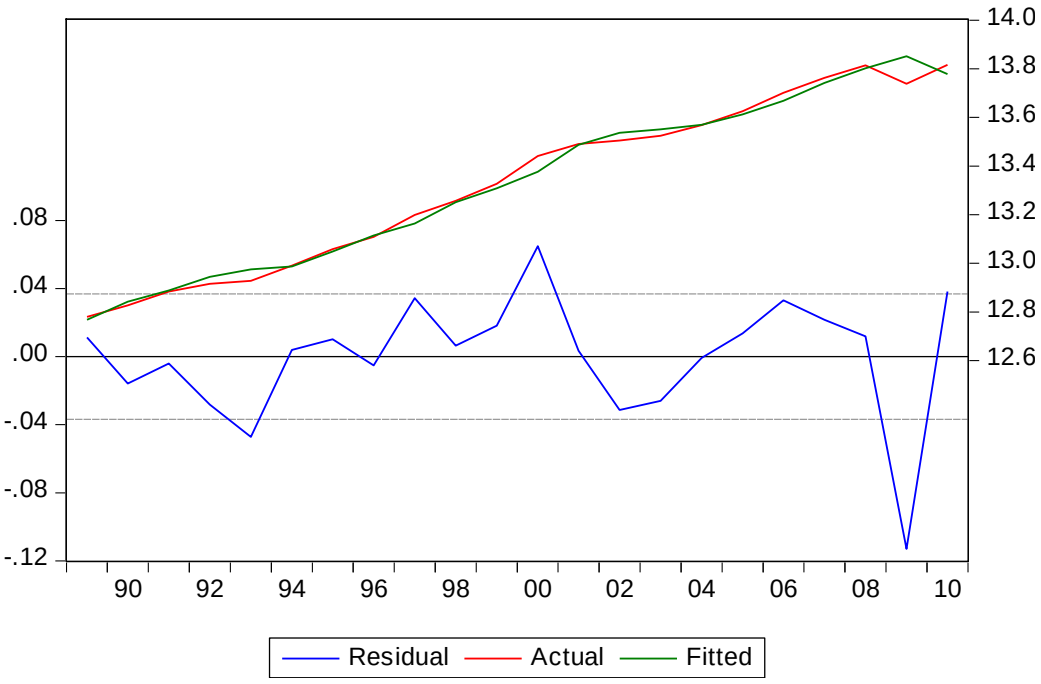
Table 5: Identified cycles

Dataset	**Quality**	**Detected cycles**
I. Dutch GDP	per year	5.5
II. Market turnover of cut flowers in Netherlands	per year	-
III. Market turnover of cut flowers in Netherlands	per quarter	27.4 ; 18.8 ; 12.5 ; 9.9 ; 7.9 ; 4.0
IV. Real Dutch GDP	per quarter	40.5 ; 30.8 ; 25.6 ; 22.0 ; 14.7 13.5 ; 12.4 ; 11.0 ; 8.4 ; 7.6 ; 4.0
V. Market turnover of plants in Netherlands	per quarter	36.6 ; 11.0 ; 8.3 ; 4.0
VI. Market turnover of plants & flowers in Netherlands	per quarter	35.9 ; 18.8 ; 12.3 ; 11.1 ; 9.8 9.8 ; 7.6 ; 4.0

I. Real Dutch GDP per year

In the yearly time series of real Dutch GDP the cycle length of 5.5 year is identified. This finding is comparable to the finding by De Groot and Franses (2006). An intuitive reason for not identifying the 10-11 year cycle is the limited amount of observations, as the time series contains only 23 observations. Adding a longer timeframe, could provide an answer to this question. In the quarterly time series of real Dutch GDP, that contain more observations, other cycle lengths are identified that hint more towards the findings of De Groot and Franses (2006).

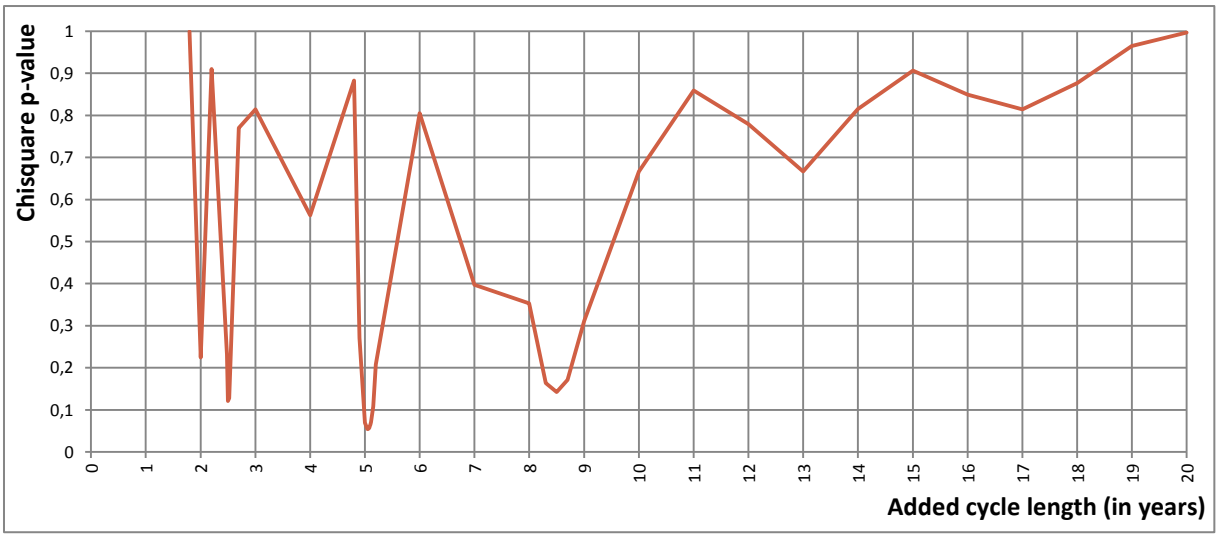
Figure 14a: AR model fit of time series I. Real Dutch GDP per year



II. Market turnover of cut flowers in Netherlands per year

It has been documented that no significant cycle is detected. However, the graph below illustrates that the length of 5 years is extremely close to being significant and especially a cycle length of 5.053 years shares a p-value of 0.0545. Within the 0.10 confidence level it is significant. Labeling the identified cycle as significant, implies that the Dutch floricultural industry and real Dutch GDP share the same business cycle of approximately 5 years, showing the interrelation between the two economic variables. As will become clear in next sections is that with a higher quality of dataset, the business cycles show even more convergence.

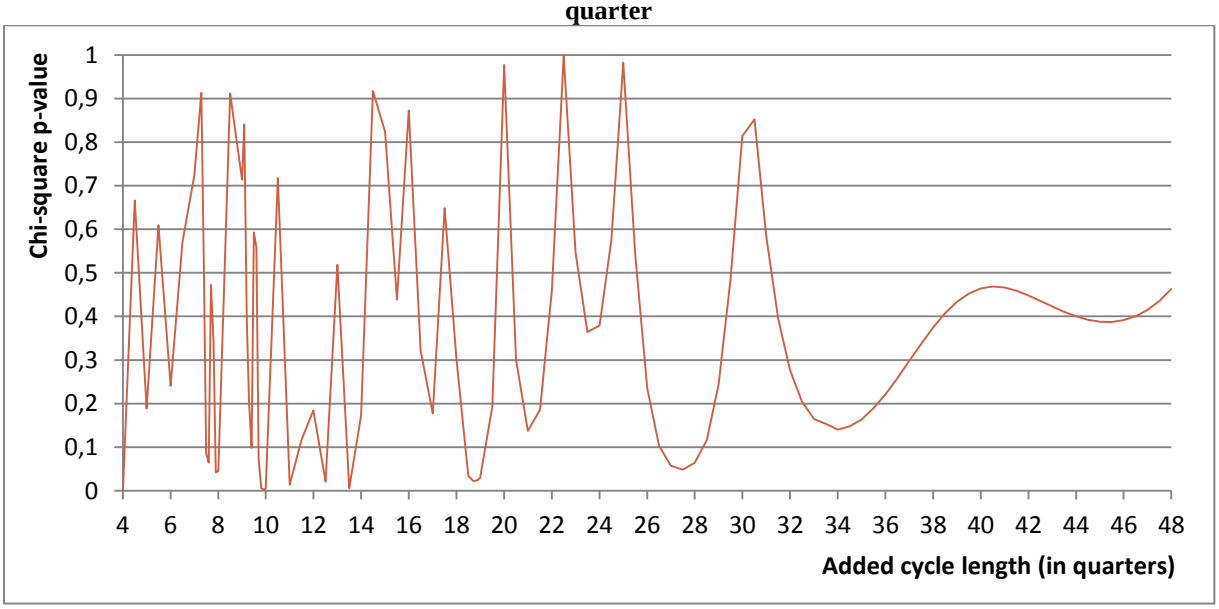
Figure 14b: Detected cycles within time series II. Market turnover of cut flowers in Netherlands per year



III. Market turnover of cut flowers in Netherlands per quarter

As documented in table 5, various significant business cycles are identified within the quarterly time series of Dutch cut flowers market turnover. Figure 14c visualizes these business cycle lengths, namely 27.4 quarters (6.9 years); 18.8 quarters (4.7 years); 12.5 (3.1 years); 9.9 quarters (2.5 years) and 4 quarters (1 year). In accordance with the finding in the yearly time series, the finding of 4.7 years approximates the identified cycle length of 5 within the Dutch market turnover of cut flowers through time. Furthermore, the identified cycle lengths in years are close to the Fibonacci sequence (1,2,3,5,8). The relation between the Fibonacci sequence and business cycles is previously raised by De Groot and Franses (2008).

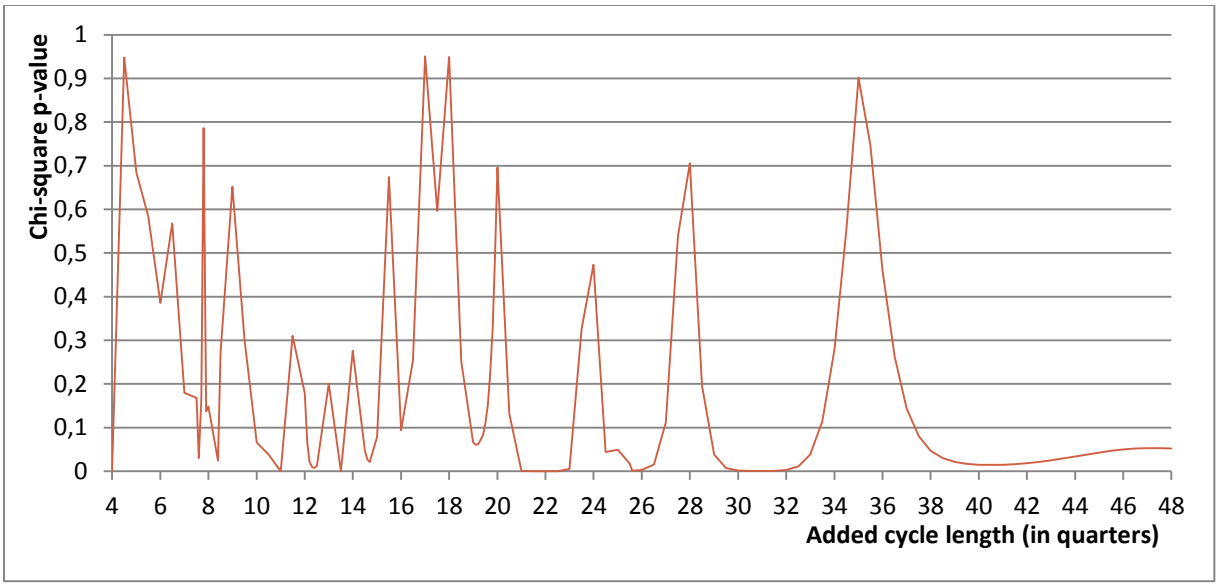
Figure 14c: Detected cycles within time series III. Market turnover of cut flowers in Netherlands per quarter



IV. Real Dutch GDP per quarter

As expected, the cycle lengths identified by De Groot and Franses (2006) have been detected in current empirical research as well. More specific, the lengths identified in this study are 40.5 quarters (10 years) and 22 quarters (5.5 years). More interesting is the sequence of the significant cycles within real Dutch GDP. The business cycles seems to be clustered around the Fibonacci sequence: 1 year (4 quarters), 2 years (7.6 and 8.4 quarters), 3 years (11, 12.4, 13.5 and 14.7 quarters), 5 years (22 and 25.6 quarters) and 8 years (30.8 quarters). Like the Dutch market of cut flowers, real Dutch GDP seems to share the same business cycle structure.

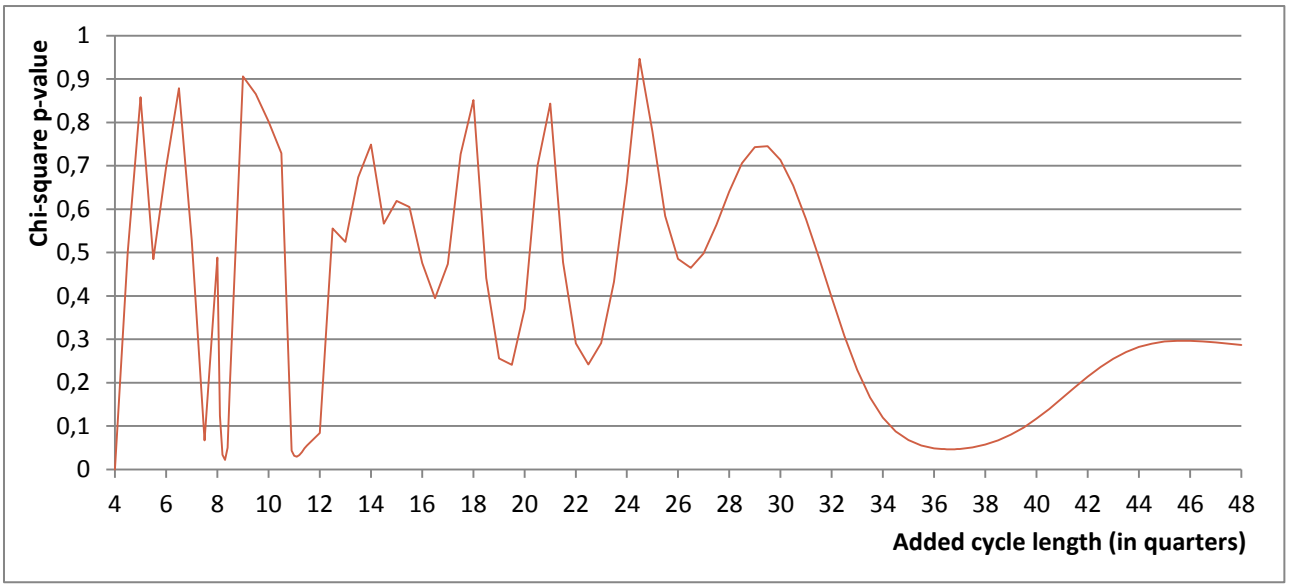
Figure 14d: Detected cycles within time series IV. Dutch GDP per quarter



V. Market turnover of plants in Netherlands per quarter

Within the Dutch market turnover of plants, 4 business cycles have been identified, namely 36.6 quarters, 11 quarters, 8.3 quarters and 4 quarters, as can be obtained from figure 14d. Like the quarterly data of Real Dutch GDP and Dutch market turnover of cut flowers, the first 3 business cycle lengths correspond. However, the 5 year cycle is not identified. The identification of business cycle besides the yearly seasonal cycle was not expected as figure 10 rather showed a trend line without strong fluctuations. Noticeably, figure 10 highlights that the market of plants was insensitive to the credit crisis whereas the Dutch market of cut flowers was undoubtedly affected.

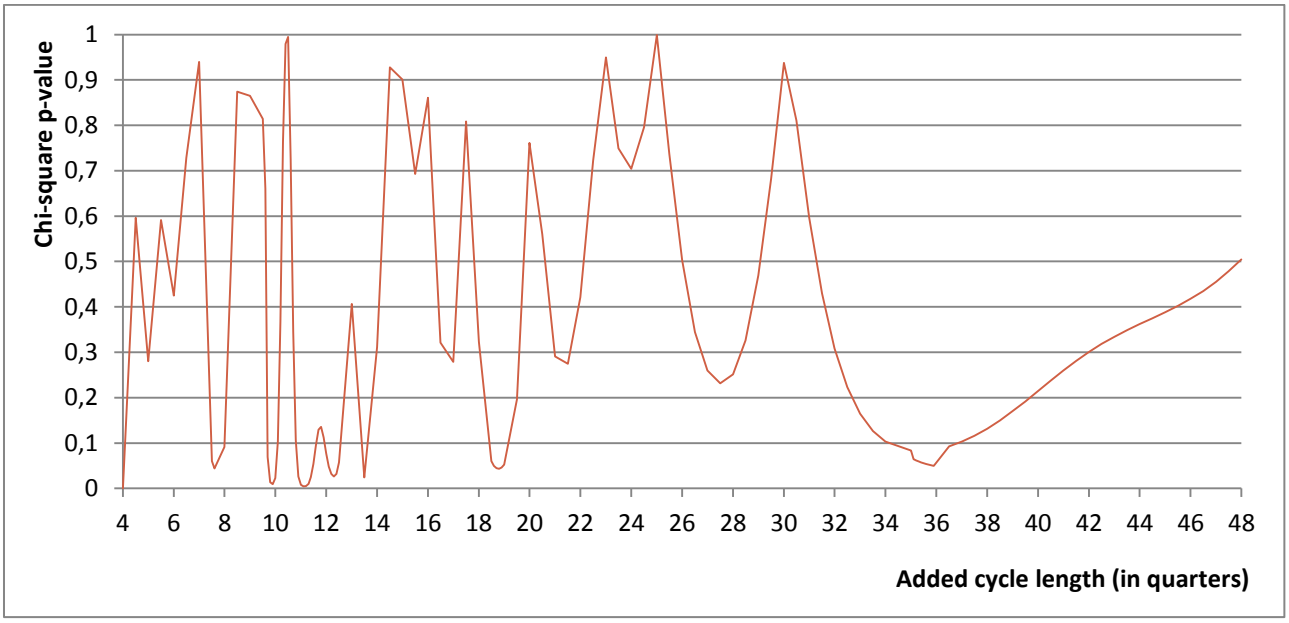
Figure 14d: Detected cycles within time series V. Market turnover of plants in Netherlands per quarter



VI. Market turnover of plants & flowers in Netherlands per quarter

Lastly, figure 14e reflects the detected cycles within the entire Dutch floricultural industry turnover, including cut flowers and plants. Again, the business cycle structure corresponds to the business cycle structure within real Dutch GDP and in turn with the Fibonacci sequence. Only the observed 9 years business cycle deviates from the Fibonacci sequence (1,2,3,5 and 8…).

Figure 14e: Detected cycles within time series VI. Market turnover of plants & flowers in Netherlands per quarter



In conclusion to this, it is apparent that within the Dutch floriculture industry, both cut flowers and plants show cyclical movements. Most importantly, the Dutch floricultural industry and real Dutch GDP seems to share the same business cycle structure. Especially the Dutch cut flowers market seems to share the same business cycle structure. However, as the market turnover of cut flowers and plants are correlated, this thesis proceeds with the summed indicator for the Dutch floricultural industry.

Labeling the identified cycle lengths to theoretical findings is seemingly attractive. For example, relating the 3 year business cycles to the Kitchin waves is reasonable. However, as described in chapter 2, the theoretical explanations for the drivers of business cycles diverge widely. Therefore, the researcher has chosen not to relate the empirical findings to theoretical prescription as the business cycle literature have not agreed on the theoretical foundation for business cycles. The result that the business cycle structure between real Dutch GDP and the Dutch floriculture correspond, is an interesting finding itself. It is shown that the business cycles detected in the Dutch economy (measure in GDP) are diffused over the floricultural sector, showing the interrelation between both economic variables.

4.4 Forecasts

In section 4.3, business cycles were detected within the floricultural industry. Furthermore, the structure matches with the cycle structure within the aggregate Dutch economy (measured in real GDP). In this section out-of-sample forecasts are presented, based on the business cycle structure.

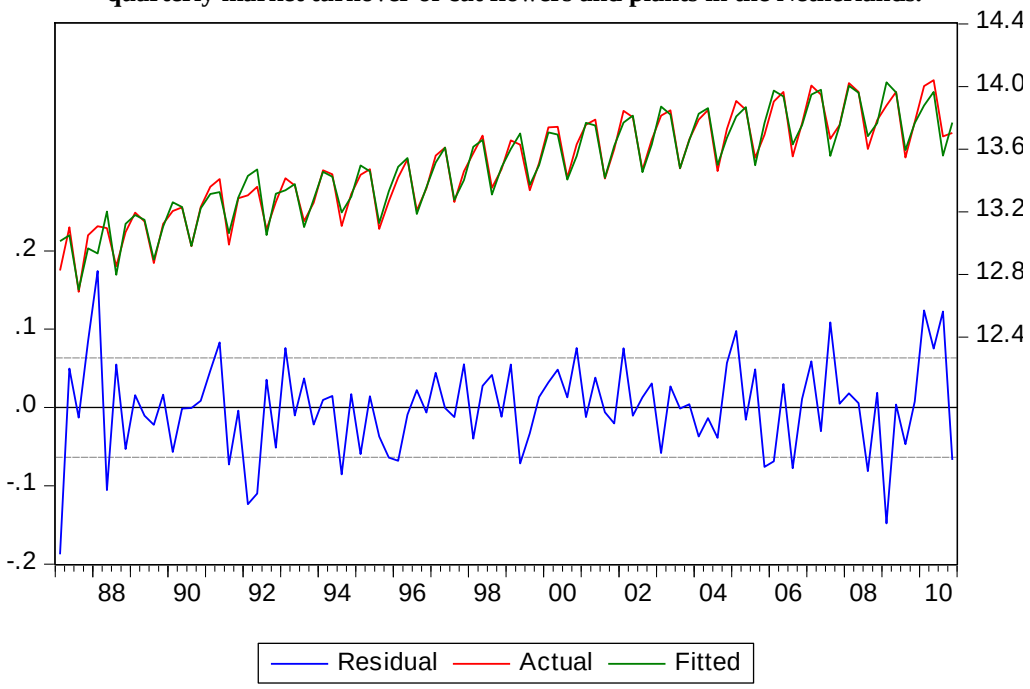
As this thesis describes, business cycles are detected within historical economic variables. Various business cycle theorists (chapter 2), supported with empirical evidence, claimed that cycles are incorporated within economic variables, implying that they are part of the underlying structure of economic variables. In this thesis, this is noticeable in the assumed partly deterministic economic environment. On the basis of this argument, business cycles should not only be present in historical time series but also in the economic future. Based on this notion, out-of-sample forecasts are generated for the floricultural industry.

Our basis for prediction is the start of Fibonacci sequence, namely 1,2,3,5 and 8 years [7]. In both the aggregate economy and the diffused indicator, the Dutch floriculture, this structure is manifested in the identified sequence of business cycles. Furthermore, findings in De Groot and Franses (2008) and De Groot and Franses (2009) document that within *international* and *historical* time series, business cycles cluster around the Fibonacci sequence. This strengthens the selection for using the Fibonacci sequence to predict the future.

The following univariate model (equation 3) predicts the market turnover within the Dutch floricultural sector. Hereby γ_t is denoted as DFI_t (Dutch Floricultural Industry) and the estimated standard errors are displayed between the parentheses.

$$\begin{aligned}\log DFI_t = {} & 0.9536 + 0.9322 * \log DFI_{t-4} + 0.0110 * \sin\left(\frac{2\pi t}{4.0}\right) - 0.010 \cos\left(\frac{2\pi t}{4.0}\right) \\ & (0.3094)\ (0.0230) \qquad (0.0093) \qquad (0.0098) \\ & + 0.011 * \sin\left(\frac{2\pi t}{8.0}\right) - 0.011 * \cos\left(\frac{2\pi t}{8.0}\right) - 0.017 * \sin\left(\frac{2\pi t}{12.0}\right) + 0.007 * \cos\left(\frac{2\pi t}{12.0}\right) \\ & (0.0092) \qquad (0.0092) \qquad (0.0092) \qquad (0.0093) \\ & + 0.012 * \sin\left(\frac{2\pi t}{20.0}\right) + 0.008 * \cos\left(\frac{2\pi t}{20.0}\right) - 0.004 * \sin\left(\frac{2\pi t}{32.0}\right) - 0.016 * \cos\left(\frac{2\pi t}{32.0}\right) \\ & (0.0093) \qquad (0.0093) \qquad (0.0095) \qquad (0.0095)\end{aligned} \tag{3}$$

Figure 15: Actual, fitted and residual graph of the AR model with harmonic regressors for forecasting quarterly market turnover of cut flowers and plants in the Netherlands.



[7] Note that not the entire Fibonacci sequence is identified, due to the limited amount of observations.

Figure 15 shows that the model fits the data well, following a R^2 of 0.96. Using extrapolation, the out-of-sample forecasts are generated, as shown in table 6. The model predicts that in 2013 the cumulative growth is negative in relation with the previous year. The following years, 2014, 2015 and 2016, the model predicts as relative growth in relation to the previous year. The market turnover within the Dutch floriculture industry will stagnate within 2017 according to the predictions and in 2020 the market is expected to grow, based on equation 3.

Table 6: Floricultural industry quarterly forecasts based on Equation 3

Quarter	Forecasted Growth	Quarter	Forecasted Growth	Quarter	Forecasted Growth
2012 Q1	+ 0.33 %	2015 Q1	+ 0.26 %	2018 Q1	+ 0.05 %
2012 Q2	+ 0.42 %	2015 Q2	+ 0.19 %	2018 Q2	+ 0.11 %
2012 Q3	+ 0.43 %	2015 Q3	+ 0.15 %	2018 Q3	+ 0.10 %
2012 Q4	+ 0.30 %	2015 Q4	+ 0.11 %	2018 Q4	- 0.01 %
2013 Q1	+ 0.14 %	2016 Q1	+ 0.14 %	2019 Q1	- 0.14 %
2013 Q2	- 0.03 %	2016 Q2	+ 0.14 %	2019 Q2	- 0.27 %
2013 Q3	- 0.11 %	2016 Q3	+ 0.12 %	2019 Q3	- 0.31 %
2013 Q4	- 0.12 %	2016 Q4	+ 0.04 %	2019 Q4	- 0.25 %
2014 Q1	+ 0.01 %	2017 Q1	- 0.04 %	2020 Q1	- 0.07 %
2014 Q2	+ 0.14 %	2017 Q2	- 0.11 %	2020 Q2	+ 0.12 %
2014 Q3	+ 0.26 %	2017 Q3	- 0.11 %	2020 Q3	+ 0.29 %
2014 Q4	+ 0.28 %	2017 Q4	- 0.06 %	2020 Q4	+ 0.36 %

CHAPTER 5. CONCLUSION

The aim of this study was to examine if business cycle(s) are detectable within the Dutch floriculture industry and subsequently if they are comparable to the business cycle(s) identified in real Dutch GDP.

The term 'business cycles', as adopted in this thesis, refers to the structured wave movements in economic variables along a trend line, generally using the economic indicator national GDP. Burns (1951) prescribed that business cycle(s) should be broadly diffused over the economy implying that they should be visible in significant national sectors. The objective of this thesis was is to test whether the Dutch business cycle(s) is diffused over the Dutch floricultural industry.

As discussed in Chapter 2 and 3, both the aggregate Dutch economy and Dutch floricultural industry are reliant on (re)export activities in Europe representing a logistic 'hub' within Europe. This idea suggests the interrelation between both economic variables and proposes a similar underlying structure. Therefore if the same cycle lengths are identified, the Dutch floriculture is considered as a good indicator for the diffusion property of the Dutch aggregate economy, commonly linked to the real GDP growth. Irrespective of the question 'what drives these cycles', the research question would provide valuable information for both the academic and practical field.

Focusing on the preceding discussion, the following research question is drawn up: "Do the Dutch floricultural industry and the Dutch GDP share the same business cycle length(s)?" To answer this question, business cycles in both categories are identified using autoregressive models and assuming a partly deterministic economic environment.

Table 5: Identified cycles

Dataset	Quality	Detected cycles
I. Dutch GDP	per year	5.5
II. Market turnover of cut flowers in Netherlands	per year	-
III. Market turnover of cut flowers in Netherlands	per quarter	27.4 ; 18.8 ; 12.5 ; 9.9 ; 7.9 ; 4.0
IV. Real Dutch GDP	per quarter	40.5 ; 30.8 ; 25.6 ; 22.0 ; 14.7 13.5 ; 12.4 ; 11.0 ; 8.4 ; 7.6 ; 4.0
V. Market turnover of plants in Netherlands	per quarter	36.6 ; 11.0 ; 8.3 ; 4.0
VI. Market turnover of plants & flowers in Netherlands	per quarter	35.9 ; 18.8 ; 12.3 ; 11.1 ; 9.8 9.8 ; 7.6 ; 4.0

The conclusion of this thesis is that the floricultural industry and real Dutch GDP share the same business cycle lengths. Both the Dutch market turnover for plants and for cut flowers show cyclical movements. Especially together, and accounting for correlation, the business cycle structure converge the Dutch business cycle structure. It is shown that the business cycles detected in the Dutch economy (measure in GDP) are diffused over the floricultural sector, showing the interrelation between both economic variables.

Another interesting finding is that the business cycle structure of both the Dutch floricultural industry and the aggregate economy, indicates the Fibonacci sequence. For example the Dutch business cycle(s) seems to be clustered around the Fibonacci sequence: 1 year (4 quarters), 2 years (7.6 and 8.4 quarters), 3 years (11, 12.4, 13.5 and 14.7 quarters), 5 years (22 and 25.6 quarters) and 8 years (30.8 quarters). This finding is valuable for the academic field, because De Groot and Franses (2008) and De Groot and Franses (2009) document that within *international* and *historical* time series, business cycles cluster around the Fibonacci sequence. The finding in this thesis fits this academic finding. Furthermore, it strengthens the selection for using the Fibonacci sequence to predict the future.

Based on the assumption that business cycles are partly deterministic, an out-of-sample forecast is generated for the Dutch floricultural industry based on the Fibonacci sequence. Section 4.4 elaborates this concept and presents out-of-sample forecasts for the Dutch floricultural industry. The model predicts that in 2013 the market will decline, but 2014 to 2016 the market will slightly grow relative to each previous year. The market turnover within the Dutch floriculture industry will stagnate within 2017 according to the predictions and finally in 2020 the market is forecasted to grow.

Connected with the outcome of this thesis, are the limitations of this study. The main limitation is the lengths of both categories of time series. The quarterly time series of both categories cover approximately 24 years or 96 quarters. If there was a more lengthier dataset available, more value could be added to the outcomes. Furthermore, longer business cycles could be detected which are now excluded from the research. However, due to dataset inconsistency beyond the timeframe, the researcher has chosen for consistency over quantity. The second main limitation concerns the tangibility of the detected business cycles. As shown in this thesis, several business cycles are detected. However, the explanation or factors,

determining the driver of these cycles is especially inexplicit. Chapter 2 discussed several theories. However, associating them to the findings in this thesis is reasonably precarious.

From an academic perspective, this thesis shows that the proposed diffusion property of business cycle is apparent within the Dutch business cycle. Thus, the Dutch floricultural industry can be labeled as a sector where the Dutch business cycle can be detected. Furthermore, the same Dutch business cycles are identified as in De Groot and Franses (2006) and Van Ruth et al. (2005). Finally, the identified Fibonacci sequence [8] within business cycle structure can be labeled as a contribution as well, as previous academics proposed the connection between business cycles and the Fibonacci sequence. From a practical perspective, this thesis shows the interrelation between the Dutch floricultural industry and the aggregate economy. Furthermore, predictions for the growth rates for the Dutch floricultural industry up to 2020 are provided, based on an autoregressive model with added Fibonacci sequence business cycles.

Finally, following the results of this thesis, there is an interesting question for future research: "Does the Dutch floricultural cycle (structure), leads, lags, or coincide the Dutch business cycle?". This attracts particular interest with respect to the practical field since if the floriculture cycle leads the Dutch business cycle, wave movements in the floriculture predicts wave movements in the Dutch business cycle in the coming future, depending on the leading time. Similarly, if the floriculture cycle lags the Dutch business cycle, wave movements in Dutch GDP could predict wave movements in the floriculture market. This question remains of particular interest to various stakeholders of floricultural businesses, including the Dutch government and investors.

[8] Note that not the entire Fibonacci sequence is identified, due to the limited amount of observations.

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