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Manufacturing in historical national accounts: when was Norway industrialised?

Identifying the time of the Norwegian industrialization using empirical evidence on business cycles and growth theory based on new historical GDP figures (1816-1939)

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Abstract

This thesis examines the period when Norway was industrialized using new historical GDP data from 1816 to 1939. Different historians through their research give different periods for when an industrial breakthrough took place. This has led to historians being divided into two different schools of thought for industrialization. Therefore, some historians believe that an industrial breakthrough took place before the 20th century, while others believe after that. At the same time, some also believe that industrialization in Norway took place in waves. Based on the above, it will therefore be interesting to study when Norway was industrialized based on new historical GDP data.

In this thesis, different types of literature were used with different purposes to answer the research question. First, literature from previous work was used for various historians. This is because we wanted to observe different views of different historians, but also find support for the choice of variables in the analysis chapter. Furthermore, theoretical aspects are presented with the main purpose to help us uncover an industrial breakthrough. After that, the data and the methodology chapter will be presented. This therefore gave us the opportunity to carry out an analysis, which will be discussed in more detail in another chapter.

Our results indicate that there has been several periods of expansion in Norwegian manufacturing, where various industries emerged. There were clear business cycles and growth cycles that could give an indication of industrialization. The labour statistics also shed more light on the fact that growth was largely pre-emptive before the 20th century. Although it became more stable towards the turn of the century. Exports show the same with major changes taking place around 1890. Therefore, the results of our analysis show that industrialization in Norway took place with a decisive breakthrough from 1887 to 1916. This means that the industrial breakthrough in Norway took place at the end of 1880s (before 1900).

Acknowledgements

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We would like to thank Ola Honningdal Grytten for the guidance and all the constructive feedback during the writing process. It has been a privilege to have him as our supervisor, and we are thankful for the opportunity we were given.

Finally, this thesis is part of a European research project, BALTIC100, which aims at constructing historical macro series for the Baltic states from 1920 onwards, until present times. It is our hope that the present work can serve as an example of how it is possible to utilize historical data to construct such series and use them in analytical research work.

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1. Introduction

"Industrial revolution is the process of change from an agrarian and handicraft economy to one dominated by industry and machine manufacturing" (Encyclopædia Britannica, 2022). In Norway, this process lasted from the middle of the 19th century until the first World War. The annual period for the breakthrough is two-dimensional, i.e., some historians believe that industrialization in Norway took place before the 20th century. On the other hand, some researchers believe that industrialization in Norway took place after the 20th century. (Dørum, 2021)

From the middle of the 19th century until the First World, Norway went through several phases that can be said to constitute the industrial revolution. Common to the phases are more use of machines and mechanisation of production, new technical inventions, increased investments, more productivity (greater return per NOK invested) and more people employed in industry. The breakthrough for industrialization in Norway can be divided into four phases, the 1840s and 1850s, the 1860s and 1870s, the 1880s and 1890s, and the period 1905-1920. (Dørum, 2021)

The first phase of the 1840s and 1850s was marked by the breakthrough for the textile industry and mechanical workshops in several Norwegian cities. The second phase of the 1860s and 1870s was expressed in the establishment of several Norwegian wood grinding mills powered by steam engines. The third phase in the 1880s and 1890s was reflected in new industries that produced wood pulp, cellulose, and paper, and in the strong development of the mechanical workshops. Furthermore, in the period 1875 to 1905, Norway, like the rest of the world, experienced crises, and went through economic stagnation, not least for production and exports. This is something that naturally dampened growth in Norway. The fourth phase – from 1905 to 1920 – is today considered by many Norwegian historians as the great breakthrough as waterfall power and electricity had come into general use in the industry. During that period, Norway also acquired electrometallurgical and electrotechnical industries. (Dørum, 2021)

Furthermore, in Europe, industrialization had already begun in some countries in the late 18th century. If one compares the course of industrialization between countries in Europe, one can observe that several countries had different periods of industrialization. Table 1.1 therefore gives an estimate of the period in which Germany, Great Britain, France, Sweden, and

Denmark were industrialized. We chose to compare the five mentioned countries due to various reasons. First, it is to get an insight into how long industrialization took place in the three countries that led to industrialization. Namely England, France, and Germany. Finally, we also wanted to compare the industrialization period in the neighbouring countries of Scandinavia to Norway.

Country	Industrialization period	Source
Great Britain	1760-1840	(Ashton, 1997)
France	1848	(Encyclopædia Britannica, 2022)
Germany	1830-1873	(Kiesewetter, 1989)
Sweden	1870-1914	(Jörberg, 1965)
Denmark	1870-1916	(Kristensen, 1989)

Table 1.1: Industrialization across Europe

1.1 Research question & purpose

Grytten presented in 2020 a novel set with annual gross domestic product (GDP) series by industry for the period 1816 to 2020. When choosing the topic of the thesis, we wanted to write about a topic that was related to finance, economics, and econometrics. At the same time, we also wanted to write a thesis which would contain some analysis. Grytten therefore proposed and encouraged us to study when Norway was industrialized based on his new annual GDP series. Based on the above, this thesis has three main hypotheses:

- *Was Norway industrialized before the 20th century?*
- *Was Norway industrialized in the 20th century?*
- *Was Norway industrialized in waves?*

The purpose of this thesis will therefore aim at determining when the industrial breakthrough took place in Norway. We will do this by analysing Grytten's new GDP series for various industries from 1816 to 1939. We chose the mentioned time period because it best describes industrialization in Norway.

1.2 Consideration

To answer the thesis research question, we have used GDP series for different industries. Hence, this thesis should be limited to studying GDP from selected sectors, and not total GDP, given that we want to identify an industrial breakthrough. Employment, exports, and finally a production index will also be studied. The data will be presented more thoroughly later in the thesis. Furthermore, since the data used had some imperfections, it led to limitations on the thesis. Hence, we will further explain factors related to the data in the analysis from this thesis that caused limitations.

GDP is a monetary aggregate measure of total value creation through all resident producers in an economy. In addition, GDP is the most cited macroeconomic variable that can explain economic development but is unfortunately not error-free. First, to calculate the macroeconomic variable, one must define what production is and what is not. This is something that has varied over the years when researchers constructed different series. Furthermore, GDP alone is an imperfect measure of growth and prosperity and should therefore be supplemented by other macroeconomic targets. Finally, one needs good statistics of GDP to perform reliable analysis. This is not always available, especially based on historical data sources which are often scarce and insufficient.

A limitation in the thesis therefore comes from the fact that GDP data is used in several places in the analysis and this can reduce reliability in the analysis part. This applies to data for GDP series and the production index because it is calculated with GDP figures.

Another problem that has led to limitations in the analysis is that there was a lack of data in the early 1800s. This applies to data for exports and for the production index. Which in turn means that we were not able to analyse the first industrial wave, to the same degree as the later waves. Furthermore, the data for employment were calculated based on how many people were employed in Norway up to the 1900s. From 1900 until 1939, it was calculated differently, and the number of man-hours was calculated on the number of employees in Norway. This led to challenges when comparing industrialization in the analysis before and after the 20th century. Another challenge with employment data was it was calculated every five years. This also created limitations in the analysis since the data was available only every five years.

1.3 Disposition

The thesis begins with previous work/research on when an industrial breakthrough in Norway took place. Different views of various researchers and their conclusions about the same research question as this thesis will be presented/discussed. The second part consists of theoretical grounding, where we will first explain why GDP is a good indicator of economic development. Then GDP will be defined and how it is measured with regards to the different approaches. Furthermore, we will present the different values for GDP and explain which ones have been used in this thesis. Business cycle and growth theory will also be reviewed since they have been important tools for the analysis.

The relevant previous work/research will help us to identify decisive factors that may have contributed to an industrial breakthrough. Furthermore, with the help of the theoretical ground, we will present/discuss diverse literature on how an industrial breakthrough can be uncovered.

Thereafter, the data to be used in the analysis chapter will be presented/discussed. In this chapter we will first explain how the datasets have been developed and then describe them. This chapter concludes with a description of the background of the data. This means that regarding previous work/research, we will explain why we have chosen to analyse the selected data. After the data has been presented, we will discuss the methodology that has been used to construct the analysis chapter. The result of the analysis will then be presented/explained, followed by a chapter that will discuss the analysis and the result, before the thesis is concluded.

2. Previous work

Various authors provide different detailed descriptions of the industrialization process in Norway. It all started in the 1840s with the installation of mechanized textile factories using imported British technology. In the 1850s and 1860s, mechanical engineering followed and flourished rapidly. The "long downturn", which lasted from the second part of the 1870s until the beginning of the 1880s, was marked by both stagnation and reorganization. Industries with large forest resources shifted the focus from primary products to industrial raw materials, such as., mechanical and chemical wood pulp. (Venneslan, 2009).

Over the years, sectors in Norway that produced oils and fats, food and drink, bricks and glass also saw significant mechanization of the production processes. Matches, explosives, margarine, and cod liver oil are all examples of objects that were affected by modern chemistry. New large-scale production in the electrochemical and electrometallurgical sector emerged after the turn of the century. These progressive industries expanded rapidly due to significant use of hydropower until a severe setback occurred in the 1920s (Svendsen, Holst, & Wasberg, 1963).

Nevertheless, it turns out that several historians do not always agree on how long the industrial breakthrough in Norway took place. In the article published by Christian Vennesland (2009) it is explained that when it comes to when the breakthrough took place, there are two schools. One of them considers the events before the turn of the century (ante-school), while the other, places the events after (post-school). The different perspectives of historians therefore reflect fundamental controversies about how Norway became a modern industrial society (Sejersted, 1993). Therefore, we will further in this chapter present the research on different historians who have studied the same research question for this thesis. The main purpose will be to study Norwegian industrial development through different perspectives.

Francis Sejersted was a Norwegian historian who studied Norwegian industrial development. He believed that an industrial breakthrough took place between the 1880s. The historian linked the formation of a modern industrial system to the decline of the protracted international economic crisis and a shift in the technical paradigm (Sejersted, 1992).

The prolonged international economic crisis took over Norway at the beginning of 1873 until 1887. During this period, Norway experienced a significant reduction in the growth of the

manufacturing industry due to the air going out of a long rise. Investments, production and supply of goods and services reached a far higher level than the demand. The centralized international economy in the country seemed overheated. As a result, the export industry to Norway experienced a significant decline. Norway thus began to lag behind other countries in industrialization in terms of economic growth and technological renewal. The technology developed rapidly, and the demand for Norwegian goods fell sharply. This at that time was catastrophic with regards to the centralized international economy of Norway. Norway was unable to keep up with this process due to lack of capital and expertise. The large immigration from Norway to the USA also helped to curb economic value creation (Dørum, 2022).

At the same time, Francis Sejersted believed that the crisis led to restructuring and technological innovation that made it possible for Norway to get out of it. This is because the growth potential of traditional industries was exhausted, and the only way out of the crisis was through innovation and the establishment of new technology. Furthermore, the historian also believed that demand-driven explanations for the industrial breakthrough were rejected due to a sharp fall in prices. Thus, there was rather greater focus on the supply side of contractors, as the manufacturing industry was no longer as profitable, and it was tempting to innovate the technical potential that could be improved. This gave contractors more room to experiment with the new technology paradigm, and a result of this is that the crisis led to a serious reorganization process (Sejersted, 1992).

This reorganization process, which was run by entrepreneurs during a difficult period for Norway, was also researched by the historian Even Lange. Lange's arguments were also that the manufacturing industry became the driving force in a period marked by economic downturns. He emphasizes employment data, degree of urbanization, changes in trade with foreign countries, and that growth was no longer concentrated on one or two industries (Statistics Norway, 2008)

Furthermore, Sejersted together with Lange emphasized in their research that the wood processing industry was a good illustration of a growing sector at a time when industrialization was making its breakthrough. (Venneslan, 2009). During the 1870s and 1880s, the forementioned industry developed strong factors on the supply side, and a fundamentally new outward-looking business in mechanical wood pulp. According to historians, this process was not driven by worldwide demand pressure, but by creative and imaginative entrepreneurs who adopted new production techniques. (Sejersted, 1992). A significant reduction in production

costs in the wood processing industry also gave contractors greater opportunities. The reduction in costs came from good developments in mechanical engineering, pulp mills and turbine design (Lange, 1989).

The historian Kristine Bruland has also shown in her research that the development that reduced costs in the wood processing industry made it a more modern sector (Bruland, 1989). At the same time, she has also argued that the breakthrough came in the years before 1875. Bruland emphasizes the leading role of the textile industry in the early phase of around 1840, as well as the rapid growth in the iron and metal industry after 1860, and especially a strong display in industrial employment in the 1860s. (Statistics Norway, 2008). The period Bruland considers to be the breakthrough of industrialization is also characterized as the first industrial wave. The first industrial wave reached the major cities in Norway around the 1840s and 1850s (Dørum, 2022).

The growth in the 1840s and 1850s was driven by textile factories and mechanical workshops that gained ground. Decisive for the first industrial wave in Norway was the import of British expertise. Where British machine shops sent professionals to design, build, and operate factories in Norway with machines, and provide Norwegian workers with training. The forementioned imported expertise also greatly affected the Norwegian mechanical workshops that shot up in the wake of the textile industry. The textile industry was able to take advantage of strong demand in Norway, which followed population growth, urbanization, increased prosperity, and a specialized job market. Another important condition was that the raw cotton that was imported, not least from the United Kingdom, was cheap. Therefore, a large market opened up for the engineering industry as there was increasing demand (Dørum, 2022).

Furthermore, Bruland also mentions that the period after 1850 is considered the second phase of the industrial revolution (Statistics Norway, 2008). After 1850, the historian finds in her research a marked exponential growth over a longer period that had repercussions into the crisis years after 1880. This exponential growth was driven by various factors. Factors in question are the development of steamship routes, and eventually trains and railway tracks. Due to this, the need for iron products from Norwegian workshops also exploded. As a result, industrial employment also increased significantly. Furthermore, the liberalization of legislation against free production and free trade also drove industrialization after the 1850s. (Dørum, 2022).

Some other historians who believe that an industrial breakthrough took place before the turn of the century are Edgar Hovland and Helge W. Nordvik. Historians believe that a relevant strengthening of the manufacturing industry was evident between the 1880s and 1890s. This is due to the fact that during that period, there was a significant increase in capital holdings per worker and a steady increase in employment at larger companies. And thus scholars also support the claim that a breakthrough occurred before 1900 and laid the foundation for an expansion in the following years (Hovland & Nordvik, 1997).

In any case, this ante-school attitude towards industrialization is not shared by supporters of the "post-school" approach. In the "post-school" approach, it is also important to remember that it denies the dynamics of the supply side that the "ante-school" approach focuses on. For example, in relation to the "post-school" approach, it is considered that the wood processing industry grew due to increased demand from export markets, and not from new technological thinking from entrepreneurs (Venneslan, 2009).

Fritz Hodne and Ola Honningdal Grytten describe in their research that the wood pulp factories became a growing sector in the 1870s and 1880s (Hodne, 1981). One consequence of this was that Norway made a profit on this export business, and this increased the demand for manufacturing products. At the same time, historians argue that the size of the production of manufacturing products had modest dimensions before the turn of the century (Grytten & Hodne, 2000). Before the turn of the century, however, the scope of manufacturing activity was low. Only 80,000 arbitrators (less than 10% of the workforce) were employed in manufacturing factories (Hodne, 1981). In addition, there were most employees in the most populous cities, and during that period out in the countryside, one would rarely see any significant manufacturing activity.

Therefore, Hodne and Grytten believed that industrialization gained momentum in the 1880s-1890s in most Norwegian large cities. The challenge is that the whole country could not be characterized as industrialized, but only certain parts of it. Historians therefore describe a breakthrough that took place around the 1890s, but Norway could not be characterized as industrialized until after the 20th century (Grytten & Hodne, 2000). At the same time, it is also important to mention that despite Hodne and Grytten did a lot of common research, they also had slightly different views on the breakthrough. Grytten concludes that the breakthrough took place from the end of the 1880s and onwards, when Hodne argues that it took place from 1895

and then from 1905 onwards (Grytten & Hodne, 2000). Hodne's arguments are also supported by Jan Tore Klovland, who concludes almost the same thing in his research.

Fritz Hodne's arguments were especially based on the use of how electricity was used after the 20th century (Hodne, 1981). After the 20th century, large-scale production facilities were built out of many waterfalls and river valleys using water-powered electricity in electrochemical and electrometallurgical production processes. Electricity was also very beneficial for extracting metals from rock in mining and mineral extraction. After that, several new businesses were also built around the country, especially in the north, where there was little industry before the turn of the century apart from some production of guano fertilizer (Try , 1979).

Hodne together with the supporters of the "post-school" approach therefore place the greatest emphasis on the effect of international markets and foreign capital in the companies that began to spread around the country. This is in line with the philosophy of export-led growth. Almost all of the companies' production was exported, and the companies therefore demanded a large inflow of capital. Thus, foreign players often took the initiative to invest in Norwegian companies since most Norwegian players at that time lacked capital. (Grytten & Hodne, 2002).

Two other important historians who are supporters of "post-school" are the historians Per Fulum and Gunnar Nerheim. A common denominator that historians have in their research is that they place great emphasis on electric motor power and its transforming influence on manufacturing production. The researchers explained that the properties of electricity were unusually different. After the 20th century, the new type of energy source was used in several industries, and not just in heavy industry. Electricity therefore enabled progress across a wide range of different industries (Landes, 2003). Furthermore, we shall present the research on the three mentioned historians. Venneslan also agrees with Fulum and Nerheim but emphasises an industrial breakthrough from the mid-1890s.

In the research of Per Fuglum at the University of Trondheim, he says that the development of the electrochemical and electro-metallurgical industry (based on the use of hydropower) were the leading sectors that made an industrial breakthrough take place. This is because the mentioned sectors helped to increase the demand for other products, for their own needs and the purchasing power they created (Fuglum, 1978).

Furthermore, Venneslan compiled annual estimates for employment, productivity, and value creation in the period 1896-1920. As a result, the manufacturing sector was too small to make a breakthrough before 1900. He argues that it was not until electricity and electric motors had a major impact that the economy was truly industrialized. At the same time, the historian believes that the breakthrough took place in the mid-1890s, but the whole country could not be characterized as industrialized (Statistics Norway, 2008).

Finally, the historian Gunnar Nerheim also emphasizes in his work the importance of electricity in Norwegian industrial development. In the work of the historian, it is explained that Norwegian industrial development in the first decades of the 20th century was strongly dependent on the flexibility and transferability of the new energy source (electricity). This is because the emergence of the modern manufacturing system should be linked to the utilization of large waterfalls and electric power. Thus, Nerheim believes that the transmission of electricity had the most lasting impact on the structure of the Norwegian manufacturing industry (Nerheim, 1980).

Furthermore, Nerheim emphasized the far-reaching implications of incorporating electricity into conventional production, in addition to launching a rapid expansion in electrochemical and electromechanical businesses. Electric motors expanded production flexibility and reorganized the work process in fundamentally new ways by replacing and supplementing the centrally driven shaft and belt system of steam and water drive motors. This had the consequence of not only making energy consumption more efficient, but also that industry could increase productivity and set new production records (Nerheim, 1980).

Finally, in this chapter, we will also refer to Pål Thonstad Sandvik's research. Compared to historians from the "pre-school" and the "post-school", Sandvik has not located industrialization according two different schools. If we observe the study of the historian, we can see that he had a different goal and concept for industrialization. This means that he did not choose to concentrate just on the innovations of the industrial revolution. More precisely, Sandvik was not concerned with a specific time when various production processes revolutionized the industries in Norway (Sandvik, 2018).

On the other hand, according to Sandvik, the development of manufacturing was considered to take place in stages until a total breakthrough took place. By this, the historian believed that industrialization took place by means of various breakthroughs throughout the period, and

during the last total breakthrough, Norway became industrialized. The various breakthroughs that Sandvik refers to have already been discussed in this chapter and are the breakthroughs that we have reviewed in the two different approaches. At the same time, Sandvik describes that the characteristics of the recent breakthrough were that the development in several industries was significantly greater, and that the workforce in the secondary industry grew.

After the recent breakthrough, this growth was maintained, and Norway could therefore be characterized as industrialized. The time for the last total breakthrough is considered by Sandvik to have started around the beginning of the 1890s (Sandvik, 2018).

3. Theoretical aspects

In the above discussed chapter, we have reviewed different relevant work/research that has studied the same research questions as this thesis. We did so, to first and foremost be able to map variables that will be analysed later in the thesis. At the same time, it will also help us to lay the foundations for a theoretical basis that can identify an industrial breakthrough.

The theoretical basis for the thesis will first present/discuss why GDP can function as an indicator to explain Norwegian industrial development. Furthermore, we will show the different approaches to GDP, and the difference between GDP in nominal- and real form. A subchapter will also be presented that explains business cycle theory. Mentioned theories are taken from Grytten and Arngrim Hunnes *"Crashes and Crises in historical perspective"* (Grytten & Hunnes, 2016). Then we will also present a subchapter that includes traditional growth theory by Steigum's book *"Moderne Makroøkonomi"* (2004). This means that we will present the classic Solow-model. Then another illustration of the Solow model will be presented that is obtained from the article *"Generational links between entrepreneurship, management and puritanism"* (2019) by Grytten and Kjell Bjørn Minde. This is because it takes growth into account and will therefore be more suitable for this thesis.

3.1 Gross domestic product as an indicator

In several economic contexts, gross domestic product (GDP) is used as an indicator to describe the state and development of a national economy. We have used GDP as an indicator to be able to explain the industrial development in Norway. Other indicators are also used to describe the state and development of a national economy. According to E.J. Fløttum (Grytten & Hunnes, 2016, p. 54) there are five reasons why GDP is calculated as the most important indicator of all macroeconomic variables:

1. GDP describes the overall value creation in society.
2. Economic growth is usually measured by the development in GDP at constant prices.
3. Comparisons of the level of prosperity between countries are often based on GDP.
4. Several variables are related to the country's GDP as an international basis for comparison (for example, taxes and government deficits as a share of GDP).

5. The level of GDP in current prices is used as an equalization basis for the size of the country's contribution to the EU budget and similar schemes.

Real GDP is also often used as an indicator and considers the second point above on fixed prices. The advantage of this is that you adjust for inflation since it is largely removed.

3.2 Gross domestic product

Gross domestic product (GDP) is a monetary aggregate measure that reflects the market value of the total unsupported value creation through all resident producers in an economy (OECD, 2002). As described in the above subchapter, economic growth in a country will usually be measured as the development of GDP in real terms. Something that will be discussed more thoroughly later in the thesis. Often one also uses real GDP per capita or in shares so that it becomes possible to compare different economies regardless of size. (Grytten & Hunnes, 2016)

There are three main approaches to how GDP is defined and measured: the production approach, the expenditure approach, and the income approach. The approaches will be discussed in the next three subchapters. The equations in the subchapters are reproduced from the framework by Grytten (2015).

3.2.1 The production approach

This thesis places the greatest emphasis on the production approach because we want to study industrialization, as this approach considers the research question. The production approach can conceivably describe the supply side of an economy since it looks at goods and services produced for end use. GDP is found by summing the production, or value creation, in each industry. For each industry, one finds value creation by taking output and subtracting input. This gives us the next equation where (j) indicates production units, (y) is gross value creation, (e) indicates gross value of output in period t, and (h) is gross value of input in period t. (Grytten, 2020).

$$\sum y_{j,t} = \sum \left(e_{j,t} - h_{j,t}\right) \tag{3.1}$$

3.2.2 The expenditure approach

This approach describes GDP (Y) from the demand side of the economy when it looks at consumption in the various aggregate macro units of an economy. For period t, (C) means private consumption, (I) is gross investment, (G) is government expenditure, (X) is export and (M) is import. (Grytten, 2020)

$$Y_t = C_t + I_t + G_t + (X_t - M_t) \tag{3.2}$$

3.2.3 The income approach

In this approach, GDP is measured as income from the use of labour and capital in the production of goods and services, plus the difference between taxes and product subsidies. For period t, (W) means salaries for employees and (S) is gross operating profit. Furthermore, (T) denotes taxes and (S) subsidies on (Q) production and (M) imports. (Grytten, 2020)

$$Y_t = W_t + S_t + \left(T_t^Q - S_t^q\right) + (T_t^M - S_t^M) \tag{3.3}$$

3.3 Nominal and real values

Series of GDP are often presented in both nominal and real values. The problem with nominal series is that changes can occur over several periods due to changes in prices. In other words, nominal series include the effect of price changes. This will be problematic if one is to compare GDP from different periods. Thus, if one is to decide whether an industry is doing better or worse when comparing different time periods, it is necessary to adjust for inflation. This problem can be eliminated by turning nominal GDP series into real GDP series. By keeping prices from previous periods constant, one can consider changes in quantity between subsequent periods. In other words, by considering changes in price levels and the use of an inflation-adjusted target, there are more accurate figures on economic growth.

In this thesis, we have therefore used real series to address the mentioned problem. Nominal series are only used when we look at GDP in an industry as a percentage share of total GDP. This is because we only observe at a certain period.

3.4 Business cycles

Burns and Mitchell (1946) describe business cycles as a type of fluctuation that is observed in aggregate economic activity. The business cycle itself starts with an expansion in several aggregate economic variables which after a while turn into a recession before the economy picks up in a new expansion phase. This cycle is recurring, but not periodic. This means that the economy will always be in a phase of this cycle. Recession means that the country's economy has had a negative GDP development for a certain period of time. The authorities in most cases have decided that the fall in production will be six months before they officially call the decline a recession. This also depends on the country in question. The authorities can mitigate the effects of the recession with an appropriate economic policy. (Grytten & Hunnes, 2016, pp. 55-56).

Figure 3.1 shows a business cycle, and the discrepancy between the underlying trend and fluctuations in real GDP depicts the business cycle. The orange line in the figure represents the underlying trend. That is, the economy makes full use of the input factors (full employment). The fluctuations in real GDP are represented by the blue line in the figure. The discrepancies also represent what is called the output gap. If the discrepancy between the variables is positive, the situation is described as a boom and if the discrepancy is negative, the situation is described as a recession. This can also be observed in Figure 3.1, where a positive and negative deviation can be seen. A positive deviation (boom) tells us that the economy is in a boom and the country is producing more than the possible output gap, which means pressure on wages and other prices. If the deviation is negative (recession), the country produces less than the potential, and there is a slack in production, which means that parts of the production equipment and input factors are not used. Typically, the country will also experience higher unemployment rates. (Grytten & Hunnes, 2016, p. 57)

Furthermore, if one observes the growth of fluctuations in real GDP and compares it with the growth in the underlying trend, one uses the terms downturn and upturn. If the growth in real GDP fluctuations is greater than the growth in the underlying trend, we have an upturn. This means that the economy is in an expansion phase. Conversely, if the growth in actual GDP is lower than the growth in the trend, we have a downturn (Grytten & Hunnes, 2016, p. 56). This means that the economy is in a contraction phase. If we observe Figure 3.1, we can observe an upturn after the point «Trough», and a downturn after the point «peak».

The figure also describes the top and bottom points in a business cycle, but it is important to distinguish between classic cycles and growth cycles. The figure that we constructed mainly considers classic cycles, and that is due to simplicity. The classic cycle addresses the fluctuations in real GDP and has its turning points in local maximum and minimum points where $\frac{dy}{dt} = 0$. In Figure 3.1, the maximum point is represented by point «peak», and the minimum point is represented by point «trough». Growth cycles have their turning points where the curve of fluctuations in real GDP has the same growth rate (a) as the underlying trend. This is something that suggests that $\frac{dy}{dt} = a$. The turning points of the growth cycle are marked as gray triangles in Figure 3.1. Finally, it is also important to note that not all peaks and bottoms are defined as turning points as there are requirements for such a duration, depth, spread, and speed of the cycles that must be considered. (Grytten & Hunnes, 2016).

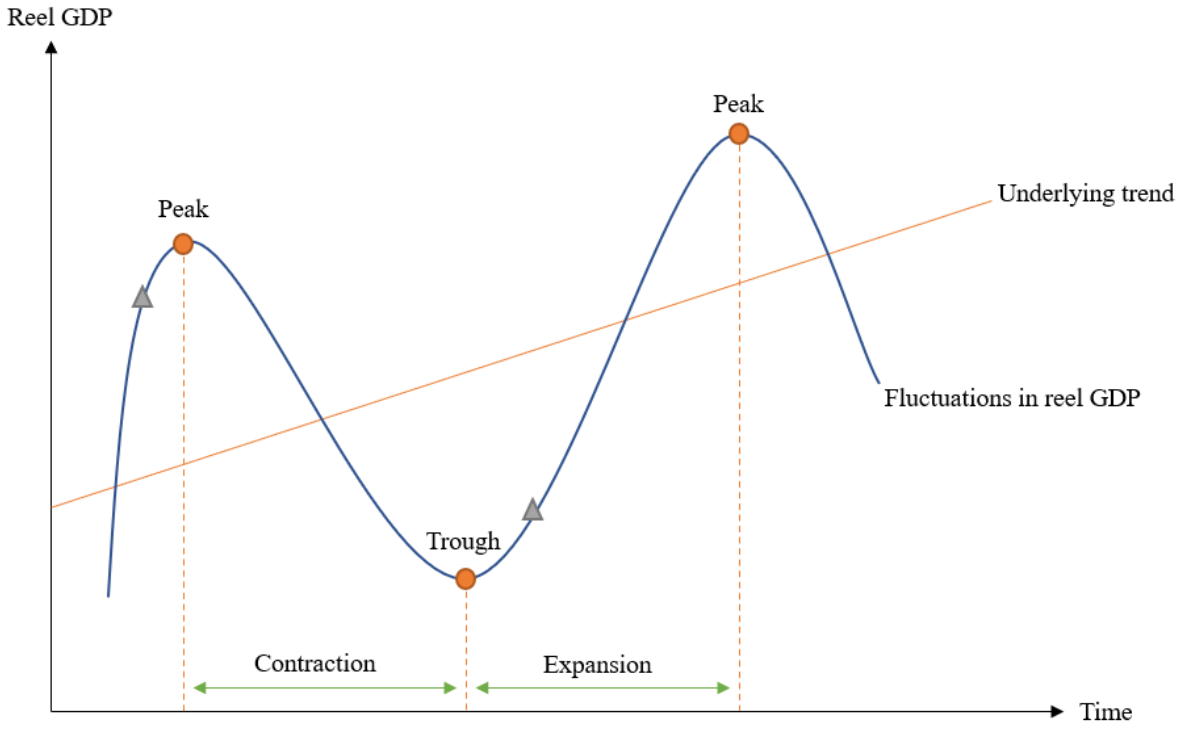

Figure 3.1: Classic business cycle

Therefore it is relevant/important to analyse the economic conditions in our thesis in order to shed light on why and when industrialization in Norway took place. It will therefore be useful to observe when the fluctuations in real GDP grew faster than the underlying trend over different time periods. If this can be a sign of industrialization. Another important function of the business cycle theory in this thesis will also be that it is used to observe if industrialization

took place in waves. In this thesis, we will use the Hodrick-Prescott Filter (HP-filter) to discover business cycles in the analysis chapter, and it will be reviewed later.

3.5 Traditional economic growth theory

Economic growth is a term for the increase in the value of goods and services that are produced in one economy (GDP) from one period to another. Therefore, economic growth is in many cases calculated using changes in a country's GDP. The background for the study of traditional growth theory is that economic growth over a longer period can explain an industrial breakthrough.

Within traditional growth theory, the level of production depends on the level of input of capital and labour, as well as the technological level. A central model in traditional growth theory was developed by the American Robert Solow in 1956 and was called the Solow-model. Steigum (2004) describes a simplified version of the classic Solow-model based on the following five assumptions:

1) Saving equals investing
2) No foreign sector
3) No public sector
4) Decreasing marginal productivity
5) Constant scale yield

Furthermore, the model is formulated so that production is dependent on the effort of capital and labour. This means that economic growth can be increased through investments in real capital if one considers the production per worker with a given technology. The profitability of increased investments in this model is declining, and this means that growth in production will gradually flatten out (Steigum, 2004). More precisely, this means that increased investments in the long term will not increase profitability since the model does not take productivity improvements into account. Consequently, production will also flatten out in the long term since no more capital is invested due to poor profitability. This results in no growth effect in the long run.

As explained at the beginning of the subchapter, we want to study economic growth over a longer period to shed more light on an industrial breakthrough. Hence, we will use an extended Solow-model that considers technological productivity improvements. This is because if

technological productivity improvements are introduced in the model, economic growth will still be able to continue. This is because they provide economic growth, but at the same time also improve the profitability of investments.

3.5.1 Solow growth model

Economic growth is divided into two components by growth accounting (Grytten & Minde, 2019). The first part is due to production variables such as labour and capital, as well as natural resources. The second component is multifactor productivity (MFP), which includes qualitative elements including technology, institutions, frameworks, input composition, and production organization. In each period (t), production can be expressed as a function of capital (C), labour (L), and MFP (A):

$$Y_t = A_t F(C_t, L_t) \tag{3.4}$$

Furthermore, after Grytten and Minde (2019) equation (3.5) can be used to express the contribution of input components to production:

$$= A_t + \alpha C_t + (1 - \alpha) L_t \tag{3.5}$$

Denison (1967) defines economic growth as growth in (Y) because of growth in capital (C), labour (L), and MFP (A), which represents the share of input contribution to production. This is expressed arithmetically by the following equation:

$$\frac{\Delta Y_t}{Y_t} = \frac{\Delta A_t}{A_t} + \alpha \frac{\Delta C_t}{C_t} + (1 - \alpha) \frac{\Delta L_t}{L_t}_t \tag{3.6}$$

As a result, an increase in production capacity explains long-term economic growth. The production capability frontier is determined by the ability to produce (Solow, 1956). MFP is the most crucial component for growth, according to empirical studies. In other words, the most important growth factor is the efficiency of capital and labour composition and usage (Abramowitz, 1956).

4. Data sources and historiography

When it comes to the question of when Norway became industrialized, we have seen from previous research in chapter 2.0. that there are divided opinions. Some researchers believe that Norway was industrialized before the 20th century. On the other hand, some researchers believe that Norway was industrialized after the 20th century. Based on that, to address this issue, we have used various analyses to examine various factors that may have led to an industrial breakthrough in Norway.

Therefore, in this chapter, the data used for the analysis part will be presented. The purpose of this will be to explain how the data has been constructed, but also to describe it. The article *"two centuries of economic growth Norwegian GDP 1816-2020"* will first be presented by Professor Grytten (2020). Furthermore, the data from the book *"Historical statistics"* by Statistisk sentralbyrå (Statistics Norway) will be described. After that, we will also refer to the data from the article *"Measuring trends and cycles in industrial production in Norway 1896-1848"* by Jan Klovland. Finally, a subchapter will be presented where we summarize the data and explain its background.

4.1 Two centuries of economic growth Norwegian GDP 1816-2020

This article has been produced by Grytten (2020) at the Norges Handelshøyskole (NHH). The article reports GDP for 17 industries and 78 sub-industries in Norway. The purpose of the article was to construct a data set for GDP in Norway from 1816 to 2020. The author follows the principle of the national accounting system (SNA2010) and calculates annual series of inputs and outputs and uses double deflation technique, when possible, to obtain real prices. This is a new approach in historical national accounts, as data usually limits one to using simple deflation. For the period from 1816 to 1930, the article gives new estimates, for 1930-1946 revised figures, then the author splices with an updated series of Statistics Norway.

The dataset contained information on disaggregated GDP values for the various industries. The problem was that the GDP values were wrong. The changes we made were therefore, among other things, to calculate new GDP values for our thesis. The way we solved this was by using weighting in each industry and multiplying it together with aggregate GDP values for each industry. This gave us a more accurate answer since the weighting was correct.

Furthermore, we put together the series of the different industries so that it was aggregated. Figure 4.1 illustrates the annual GDP series for Norway from 1816 to 1939. This is presented in the current basic values calculated according to the production side approach on the Y-axis, and the number of years on the X-axis. The graph reflects industrial development as we know it. (Grytten, 2020)

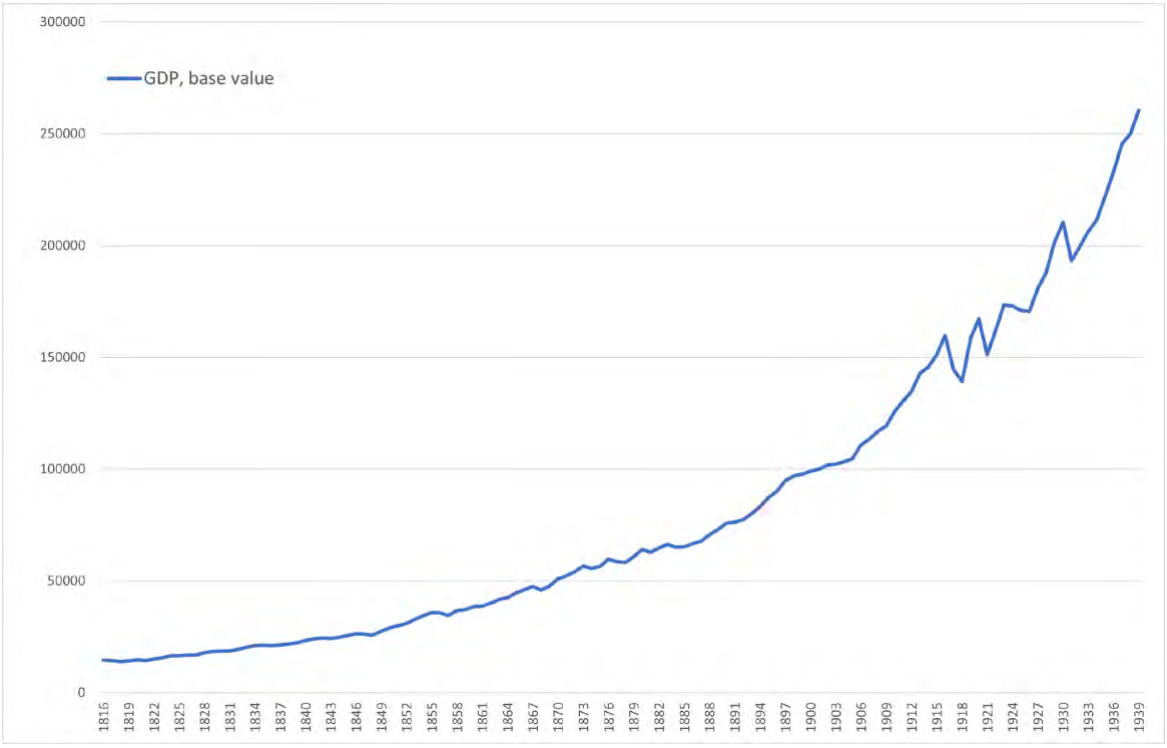

Figure 4.1: Real Total GDP 1816-1939 (Grytten, 2020)

Furthermore, in the next subchapters, we will present/discuss the data of selected industries that are part of the aggregate GDP illustrated in Figure 4.1. This is because the selected industries best explain production in Norway at that time.

4.1.1 Manufacturing

The manufacturing data in Grytten's article (2020) have been constructed using previous data for various researchers. From 1816 to 1896, the data for the manufacturing industries were constructed using both Professor Anton Martin Schweigaard (1840) and M. Braun Tvethe (1848) data. The article explains that both researchers provide reliable estimates of inputs and outputs in the manufacturing industry. In addition, ten-year reference years from (Bjerke, 1966) have also been used. (Grytten, 2020)

Furthermore, a time series is constructed where it is possible to obtain fairly valid and reliable accounts up to 1896. After that, accounts for the industry calculated by Venneslan (2007) are used. The data for Venneslan were constructed based on informative data registered by Statistics Norway. Mentioned data has also been revised by Klovland (2015) with 45 manufacturing industries. The article Grytten (2020) uses this data for the manufacturing industry until 1939. (Grytten, 2020)

After that, the article uses the revised series from Statistics Norway according to the SNA2010 standard. All in all, Grytten's article (2020) concludes with 37 new estimates in the manufacturing industry covering different periods from 1816 to 2019. (Grytten, 2020)

4.1.2 Agriculture and forestry

The data for constructing the series for agriculture and forestry have been taken from previous work by Grytten (2004). The series has been constructed based on decades of agricultural censuses. The article uses production reports from counties, farm accounts, exports and import statistics to interpolate. A problem during the construction of this series was that for some years, there was a lack of data. Therefore, Grytten (2020) designed demand and production functions to estimate volumes. Price data is taken from Grytten and Hodne (1998) and the Wedervang Archive. (Grytten, 2020)

The article has also created two other series for agriculture and forestry using Camilla Brautaset (2002) and Statistics Norway (1949). Brautaset (2002) offers a detailed series of forestry exports from 1830 to 1865. In Grytten's article (2020), series have been made by making similar calculations as in Brautaset (2002). This is based on registrations from foreign trade accounts, tax records and production records from Statistics Norway. Furthermore, Statistics Norway (1949) has since 1901 reported an annual series of variables in the cultivation of private forests. To construct the latest time series, Grytten (2020) turns the series of Statistics Norway (1949) into value series. This with the help of users of the price series from Brautaset (2002) and the Wedervang Archive. (Grytten, 2020)

4.1.3 Mining and quarrying

The article retrieves series representing mining and quarries from accurate records provided by Statistics Norway (1949). The data is accurate because this industry was under strict public regulation. The data presents mining and quarries in both price and volume form. The data

was developed until 1930 using foreign trade statistics where annual production and input were interpolated between decades with reference years. After 1930, the data were spliced together with the estimates of the Sonja L. Dean (2018) and the series of Statistics Norway (Skoglund, 2009) (Grytten, 2020).

4.1.4 Construction

The construction data has also been constructed using various series. The input figures are taken from Hodne (1983) and show the size of Norwegian infrastructure. From 1914, Grytten (2020) uses relevant series in public budgets and accounts from both the state and municipalities. Furthermore, the article also uses estimates of construction in the work of Schwigaard (1840) and Tvethe (1848). In addition, reference year calculations by (Bjerke, 1966) are also used. This was to establish a ten-year reference year for the construction year. After that, audited and refined accounts from 1930 onwards are used, but before that Grytten (2020) interpolates by using years on public and private buildings. (Grytten 2020)

4.1.5 Electricity, gas, water and sanitary services

The latest series that we will use from Grytten's research (2020) contains data that represent estimates of value creation for electricity. The data includes pre-electricity products, such as kerosene and other fuels. This data has also been developed with the help of Statistics Norway and the Wedervang archive. Where industrial censuses kept by Statistics Norway, together with farm and institutional accounts kept at the Wedervang archive, provide necessary information about value creation in the reference years. These are interpolated by data that is basically taken from industry censuses, trade statistics and county reports. In addition, the series was also developed using power figures for power supply from Minde (2015). Finally, a series from Statistics Norway for electricity from the 1930s that has been revised by Dean (2018) is also used. (Grytten 2020)

4.2 Historical statistics

"Historical statistics" is a book that has been published by Statistics Norway and deals with Norwegian historical statistics dating back to the 19th century. The book is part of the project "Digitization of older Norwegian statistics". Statistics Norway has previously published historical statistical series for all the areas covered by the agency's statistics. The first of this

type of book was published in 1914 as an anniversary marking 100 years of Norway's independence. At Statistics Norway's 50th anniversary, a new 1926 edition was published. Then, the third edition was published in 1948, and an additional edition in 1958. Finally, we have the edition from 1968 which was for the first time called "Historical statistics" (1969). This was followed up by Historical Statistics 1978 and 1994 (NOS 1978, 1994). To construct this thesis, we have obtained data from the 1978 edition which gives us statistics for employment in the manufacturing industry from 1850-1900. Due to lack of data after 1900, we have used statistics on employment and hours in the manufacturing industry from 1900-1939. Finally, export statistics were also obtained from Historical Statistics 1968 in the period 1866 to 1939.

4.2.1 Statistics

The employment statistics for factories used in the book by Statistics Norway (1978) describes workers in mining, manufacturing, and power supply. Statistics Norway developed these statistics using various sources. The data illustrates the number of employees in various industries in the production sector from 1850 to 1900 at 5-year intervals. In this thesis, we have chosen to sum up the number of employees in the various production industries. This is because we want to study the total employees in the industry, and not parts of it. After 1900, employment in the manufacturing industry was no longer studied, but there was a greater focus on the number of hours worked in the industry. Hence, we have used the number of hours in the production industry after the 20th century in this thesis. Figure 4.2 illustrates this connection.

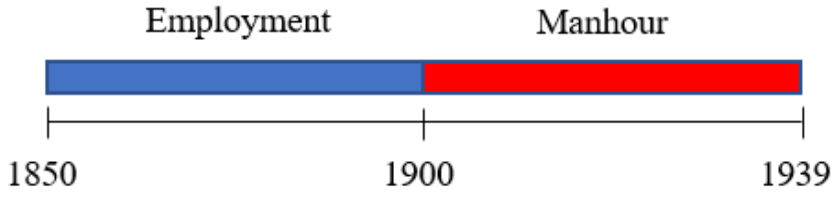

Figure 4.2: Labour statistics

Man-hour in the production industry consists of 13 different sectors, and the book has taken the statistics from the National Insurance Institution. These statistics also describe workers in mining, industry, and power supply. Man-hour in the manufacturing industry describes the number of hours all employees work during a year (NOS, 1978). The figures for 1900-1920

are given in man-years, but after that the figures were changed to man-hours from the 1978 edition of Statistics Norway.

4.2.2 Exports

The export statistics are taken from the book "Historical statistics 1968" (NOS, 1969) and is a data set that stretches from 1866 to 1939. The data set provides an insight into the goods' value in thousands of NOK that were exported from Norway in the mentioned period. From 1866 to 1922, the value of exports is not calculated as the actual value of the commodity, but it was calculated as the average price in those years.

After 1922, a value declaration was made for the exports, and this means that one must declare various information about the item, such as price and weight. This led to better data after 1922 since they had more accurate information about exports. Furthermore, the export statistics are systematically divided into 25 different main groups with further division within each of the groups. Except for a narrow change in 1939, of which the grouping remained largely the same throughout the period from 1866 to 1938 (NOS, 1978).

4.3 Measuring trends and cycles in industrial production in Norway 1896-1848

This research article (Klovland 2015) was published by Jan Klovland in 2015 and illustrates data for the production index in Norway. More precisely, the article presents new annual time series on real production in 45 industries within production and mining from 1896 to 1948. Klovland developed the data series in this article by performing new calculations on previous work for Statistics Norway and other researchers. The main purpose of the article is to measure trend and cycle output as accurately as possible. Actual production figures for individual goods have been used to fulfil this purpose where available. When data was not available, Klovland calculated new production figures. Furthermore, Klovland wanted to increase the statistical basis in the research article to identify the time and amplitude of business cycles. Thus, he derived monthly production estimates for each of the 45 industries. Monthly production estimates are calculated using a set of monthly interpolators that are relevant to each industry using annual production figures as a benchmark (Klovland, 2015). In the next subchapters, we will present in more detail how Klovland estimated the various industry indices.

4.3.1 Calculation of gross output

Klovland used gross output to calculate the production index. From 1927 and onwards, the amount of data available for gross output is detailed information on quantities and nominal values of output and intermediate inputs in the various industries, thus giving figures for nominal gross output as well as value added (Klovland, 2015).

To estimate the gross output before 1927 Klovland (2015) had to use the nominal output values in 1909, 1916 and 1927 as a starting point. He then had to apply a deflator to derive an estimate of real gross output $Y_t = \left(\frac{z}{p}\right)_t$. Afterwards, he calculated the productivity $Q_t = \left(\frac{Y}{L}\right)_t$ using annual data on man-hours (L_t). He then computed the mean growth rate of productivity between the years 1916 and 1927 as

$$g = \left(\frac{1}{11}\right) * [lnQ_{1927} - lnQ_{1916}] \tag{4.1}$$

Using the growth rate of productivity and annual industry specific series on man-hours, Klovland was able to derive an annual output series between the period 1916 and 1927 (J = 1 to 11) as

$$Y_{1916+J} = Y_{1916} * [exp(g)]^J * L_{1916+J} \tag{4.2}$$

Klovland uses the same method for the period 1909 to 1916, but he does have to take an assumption that productivity develops smoothly between the benchmark years. Extending the output series from 1909 and backwards requires yet another assumption, which is that the later productivity growths apply to the earlier years as well, which is doubtful. Since the direct gross output is absent, then there is no other way to solve it; similar methods have been extensively used by Statistics Norway and Vennesland (2007) (Klovland, 2015).

4.3.2 The weighting procedure

When it comes to aggregating the production series of specific industries to wider aggregates, there is a historical tradition of utilizing nominal value added as weights. To assess the output of key groups and overall manufacturing output, Klovland combines the indices of gross physical production for individual industries, with value added as the weight. The article from Klovland (2015) explains this process as such: *"The aggregation procedure followed here*

weighs together the annual output (Y) relatives in each industry $b_{it} = \frac{Y_{it}}{Y_{i,t-1}}$*, by nominal value-added shares* $V_{i,t-1}$*, to calculate an aggregate quantity relative for year t".*

$$b_t = \sum_{i=1}^{n} b_{it} V_{i,t-1} \tag{4.3}$$

"The index value in period t, X_t*, is then chained to the previous period's value by calculating"*

$$X_t = b_t * X_{t-1} \tag{4.4}$$

"And rebasing the index sequence to equal 100 in a base year. The choice of base year is in a sense arbitrary; here, 1929 is chosen, which is a year of relatively high-capacity utilization, without too many distortions caused by disputes" (Klovland, 2015).

4.4 Data background

In this subchapter, we will present the background that is the basis for the selected data using table 4.1 below. The first column of the table presents the data that we have reviewed in the previous subchapter. The second column represents the background to why we have chosen to analyse the data we have reviewed. The background of the selected data has been taken with regards to previous work/research from chapter 2.0. The purpose was that we wanted to analyse data that could explain an industrial breakthrough in Norway. Furthermore, the third column illustrates the source of the data, and the fourth column shows the period of the data.

Data	**Background**	**Source**	**Time period**
Manufacturing	The reason for analysing the manufacturing data is due to a strong development in various manufacturing industries in Norway during the industrialization period. This strong development can be interpreted as an industrial breakthrough. The industries	Two centuries of economic growth Norwegian GDP 1816-2020	(1816-1939)

	that go under manufacturing are the following: - Textile industry - Mechanical industry - Metal and canning industry - Electrochemical industry - Aluminium and nickel industry - Paper industry		
Mining and quarrying	In this case, we also want to analyse mining and quarrying data because of a strong development in two industries under the industrialization period. The industries that go under mining and quarrying are the following: - Iron industry - Metal industry	Two centuries of economic growth Norwegian GDP 1816-2020	(1816-1939)
Agriculture and forestry	It will be interesting to analyse agriculture and forestry data since Norway experienced a strong demand for planned cargo and wood pulp during the industrialization period. In addition, developments in the paper industry were also a decisive factor in industrialization.	Two centuries of economic growth Norwegian GDP 1816-2020	(1816-1939)
Construction	During industrialization, the Norwegian government began to develop steamship routes, trains, railway tracks, factories, and the power-intensive industry.	Two centuries of economic growth Norwegian	(1816-1939)

	Therefore, it is also crucial to analyse the construction data for Norway during the industrialization.	GDP 1816-2020	
Electricity, gas, water, and sanitary services	Electricity and electric motors made a huge leap after the 20th century, and many historians believe that it was an important cause of an industrial breakthrough. Hence, we want to use electricity, gas, water, and sanitary services data to analyse it.	Two centuries of economic growth Norwegian GDP 1816-2020	(1816-1939)
Labour statistics	A crucial consequence of industrialization is that it created more jobs in Norway. Hence, labour statistics will be a decisive factor to analyse.	Historical statistics (Statistics Norway)	(1850-1948)
Exports	The increased exports were a decisive factor in Norwegian industrialization because during this period, Norway began exporting industrial goods around the world.	Historical statistics (Statistics Norway)	(1896-1948)
Production index	The production index is a quantity index that shows the changes in production. This is useful to analyse since it may explain an industrial breakthrough, as this index also explains renewals of production processes through mechanisation of production, and technological development.	Measuring trends and cycles in industrial production in Norway 1896-1948	(1896-1948)

Table 4.1 Data background

5. Methodology

In this chapter, the methodology which was used to construct the analysis will be presented/discussed with the associated theory and method. To develop the analysis part of this thesis, we have primarily used the HP-filter as it is a suitable economic method that can shed light on when an industrial breakthrough in Norway took place. It also helps us to construct and analyse business cycles using different types of data. With the help of the HP-filter, we can shed light on when the fluctuations in real GDP grow faster than the underlying trend. As discussed earlier, it may be a sign of industrialization. Furthermore, we will also derive methodology on GDP in terms of growth and percentages.

To summarize, we will therefore in the next subchapters present the methodology for the analysis and apply it in chapter 6.0. The execution of all analyses in this thesis has been performed using Microsoft Office Excel.

5.1 Hodrick-Prescott Filter

The Hodrick-Prescott Filter (HP-filter) is a widely used method in mathematics and econometrics to measure business cycles (Grytten & Hunnes, 2016, p. 60). The filter was developed by Robert J. Hodrick and Edward C. Prescott (1997) and is a tool for discovering trend and cyclical components of a timeseries. By using the filter, one can discover deviations from the underlying trend, a positive deviation indicates a positive business cycle, while a negative deviation indicates a negative business cycle. The business cycles are often caused by disturbances in the supply and demand side of an economy.

5.1.1 Theoretical presentation

To map out the deviation from trend, we estimate cycles in a time series using polynomial trends, which are smoothened versions of the original series. We employ structural time series analysis to accomplish this. This method separates an observed time series (x_t) into different trend components (g_t), cycle components (c_t), seasonal components (s_t), and irregular components (i_t) (Grytten & Koilo, 2019).

$$x_t = f(g_t, c_t, s_t, i_t) \tag{5.1}$$

An arithmetic relationship is obtained by using an arithmetic approach to equation (5.1)

$$x_t = g_t + c_t + s_t + i_t \tag{5.2}$$

The seasonal component (s_t) and the irregular component (i_t) can be seen as a part of the cycle component (c_t). Hence, equation (5.2) can be reduced to:

$$x_t = g_t + c_t \tag{5.3}$$

We are then left with an observed time series (x_t), a trend component (g_t), and a cycle component (c_t). Using a HP-filter, we can estimate these components. This is done by estimating the trend component (g_t) by minimizing the equation:

$$\min_{g_t} \sum_{t=1}^{T} (x_t - g_t)^2 + \lambda \sum_{t=2}^{T-1} [(g_{t+1} - g_t) - (g_t - g_{t-1})]^2 \tag{5.4}$$

T is the number of observations. The first term represents the squared cyclical component, and the second term is a smoothing parameter which decides how smooth the estimated line should be. The higher the λ (Lambda), the smoother the trend series will be (Grytten & Hunnes, 2016, p. 66). Both terms are squared such as the positive and negative values will be weighted equally.

The solution to the minimization problem (5.4) is given as follow:

$$g = (I_n - \lambda\, F)^{-1} x, \tag{5.5}$$

Where I_n is an $n * n$ identity matrix, and F is the penta-diagonal $n * n$ matrix, shown in (5.6) (theoretically and with numerical example):

$$F = \begin{pmatrix} f & 0 & 0 & & 0 & 0 & 0 \\ 0 & f & 0 & \cdots & 0 & 0 & 0 \\ 0 & 0 & f & & 0 & 0 & 0 \\ & \vdots & & \ddots & & \vdots & \\ 0 & 0 & 0 & & f & 0 & 0 \\ 0 & 0 & 0 & \cdots & 0 & f & 0 \\ 0 & 0 & 0 & & 0 & 0 & f \end{pmatrix},$$

$$F = \begin{pmatrix} 1 & -2 & 1 & & 0 & 0 & 0 \\ -2 & 5 & 5 & \cdots & 0 & 0 & 0 \\ 1 & -4 & 6 & & 0 & 0 & 0 \\ & \vdots & & \ddots & & \vdots & \\ 0 & 0 & 0 & & 6 & -4 & 1 \\ 0 & 0 & 0 & \cdots & 4 & 5 & -2 \\ 0 & 0 & 0 & & 1 & -2 & 1 \end{pmatrix} \tag{5.6}$$

The cyclical component will be estimated by the actual deviations in which the actual observations deviate from the polynomial trend, as such:

$$c_t = x_t - g_t \tag{5.7}$$

Because this analysis is interested in relative changes rather than absolute values, logarithmic values of the observed time series are utilized. The cyclical component can be calculated using the equation below.

$$\ln c_t = \ln x_t - \ln g_t \tag{5.8}$$

In the filtration process, the trend component g_t will be estimated by minimizing the following equation:

$$\min_{g_t} \sum_{t=1}^{T} (x_t - g_t)^2 = x_t + \lambda \sum_{t=2}^{T-1} [(g_{t+1} - g_t) - (g_t - g_{t-1})]^2 \tag{5.9}$$

The estimated cycle component will then be:

$$\min_{g_t} \sum_{t-1}^{T} (x_t - g_t)^2, \tag{5.10}$$

Which is the residual. When this is applied to equation (5.9), one gets relative deviations from the polynomial trend, or relative cycles.

$$\ln(c_t) = \ln(x_t) - \ln\left(\lambda \sum_{t=2}^{T-1} [(g_{t+1} - g_t) - (g_t - g_{t-1})]^2\right) \tag{5.11}$$

The smoothing parameter will decide how smooth the estimated trend series will become, and hence why the choice of lambda is the deciding factor in what results we will get. If the value of lambda is zero, then the equation will be minimized and equal to the timeseries. If the lambda value is set at unlimited, then the trend series will become linear, and the cycle estimate will become significantly higher in value. Choice of lambda will also be affected depending on if the time series is yearly, quarterly, or monthly. In literature, there has been an established standard for lambda = 100 for yearly data, lambda = 1600 for quarterly data and 14 400 for monthly data (Grytten & Koila, 2019).

There are different opinions on whether the established lambda values are the actual best value for certain estimates. When analysing Norwegian economic data, some have argued for using a lambda value that is 25 times higher than the annual international standard (Grytten, 2011). The effect of such a value will be a smoother trend line which will make it easier to illustrate the business cycles. In this thesis, we will use a lambda value of $100 * 25 = 2500$ to test the yearly Norwegian GDP time series.

5.1.2 Criticism of the Hodrick-Prescott Filter

The first problem in using the HP-filter is that there is no theoretical foundation and is mostly based on instrumental assumptions (Grytten & Hunnes, 2016). There is an assumption that when the economy experiences a disturbance, it will move away from what is normal, into a positive or negative business cycle. The economy will then return to equilibrium, then the trend will represent equilibrium. Therefore it can be hard to say if the actual trend has been estimated.

The second problem for the HP-filter is that in the beginning and towards the end of the timeseries, it is difficult to estimate the trend value. The filter does not have the necessary requirement, because observations from t-1 and t+1 are missing. This is what's called the endpoint problem. To calculate the trend value, the HP-filter uses a two-filter process to extract the trend value from the input data; which means that the filter uses past and future observation when calculating the trend value. It also means that towards the end of a time series it will only make use of past values and not future values (Bjørnland, Brybakke, & Jore, 2004, p. 201).

The third problem can be connected with how the lambda value should be chosen and what the correct value is. The choice can vary based on different factors such as the number of observations and the volatility of the timeseries. The international practice of the lambda values is set at 100 for yearly, 1600 for quarterly and 14 400 for monthly data, but research on this is from studies of the US economy. As mentioned, using the HP-filter on Norwegian data; the lambda multiplied by 25 can also give a reasonable estimate. Therefore, setting the "correct" lambda value is challenging and will have a great effect on the given results (Bjørnland, Brybakke, & Jore, 2004, p. 201). The lambda value needs to be set on a case-to-case basis and multiple values need to be tested to find the right value based on the current time series.

The fourth problem with the HP-filter occurs during large breaks in the trend. Significant changes in a timeseries can occur in certain years. Such a change will not be reflected in the trend because it will only gradually increase when a significant change happens.

The last problem is based around the long-lasting business cycles. The HP-filter can interpret the business cycle as a change in the underlying trend. This is a problem for variables where there is a long period of growth, which is something the HP-filter can interpret as a fundamental change in trend. The deviation from trend can therefore be misinterpreted.

5.2 Growth

There are different methods for calculating growth. In this thesis, we have used a method called compound annual growth rate. It is a measure of an investment or a time series annual growth rate over time.

$$Compound\ annual\ growth\ rate = \left[\left(\frac{EV}{BV}\right)^{\frac{1}{n}} - 1\right] * 100 \quad (5.12)$$

(Bea, 2008)

It requires an ending value and a starting value and the number of years in the period for a timeseries. It gives an annual growth rate for a specified period, and it is often used in business and investing. One negative side of the compound annual growth rate is that it assumes that the growth is constant throughout a specific period. Since only the ending value and starting value is used, it does not take into account if the values in between are volatile or not.

5.3 Percentage share

To achieve a greater picture of the Norwegian economy, we have calculated the percentage share of GDP. To do this, we have taken the GDP of a certain sector, such as the manufacturing sector and looked at the relationship it has had with the total Norwegian Real GDP. We did this for all sectors to develop a sense of how Norway has evolved and how the economy has developed since the early 1900. To calculate the percentage share, we used the equation below.

$$Percentage\ share = \left[\frac{X_i}{\sum_{i=1}^{n} X_i}\right] * 100 \quad (5.13)$$

On top of the equation is the sector we want to calculate the percentage share of. Below is the sum of all sectors, also known as the total GDP. By dividing the GDP from an individual sector on the total GDP and multiplying it with 100, we get the percentage share of that sector of total GDP. We did this for every year from 1816 to 1939 and for all sectors in the Norwegian economy at that time.

6. Empirical analysis

In this chapter, we will examine and analyse the various macroeconomic variables when industrialization took place. There have been several industrial waves in Norway and therefore we will examine which waves led to the first major changes in Norwegian industrial development. As already discussed, there are different opinions on when Norway got its first breakthrough and thus could call itself an industrialized country. Therefore, we will apply the mentioned data and various methodology to be able to study the research question. We will first examine Norway's general economic development in Real GDP. The data shows the percentage of total real GDP, which illustrates the impact of various industries on total GDP throughout Norway's history.

Then, we conduct a deviation analysis on the logarithm of real GDP in various industries. To measure the cycles, we have created a trend value using the HP-filter. We have used a lambda of 2500. When using Norwegian GDP values, a higher lambda than the established standard of 100 can give better results. We will first look at real GDP for the industries agriculture and forestry, mining and quarrying, manufacturing, electricity and sanitation, and construction. We will look at relative deviations from the trend to detect increased growth in the industries. High deviations may be an indication that Norway experienced an industrial wave or overheating for a certain period.

Furthermore, we will analyse the monthly production index created by Jan Klovland (2015). The dataset deals with gross production and should give an indication of economic development in the industrial sector. We will use the monthly index for the total industry and run HP-filters to get a better overview of the cycle in the industry from 1896-1930.

Finally, we will look at figures for employment statistics, and Norwegian exports. At the same time, we will also observe the development of the number of employees in mining, manufacturing, and power supply for 1850-1900; while from 1900-1938, we look at the number of man-hours within the mentioned industries. Exports also play a major role in a small Norwegian economy and therefore we will consider the different product groups and look at how exports have changed over several decades.

6.1 Industrial development

To map industrial development in Norway, we have used Grytten's GDP data in fixed 2015 NOK. This will be illustrated in different figures below where one can observe industrial development for 5 different industries. Furthermore, Figure 6.1 illustrates the industry share of Norwegian GDP from the period 1816-1939. Using the data, we analyse and quantify the industries and development to examine if they can provide an accurate picture of the period when industrialization occurred and was most impactful.

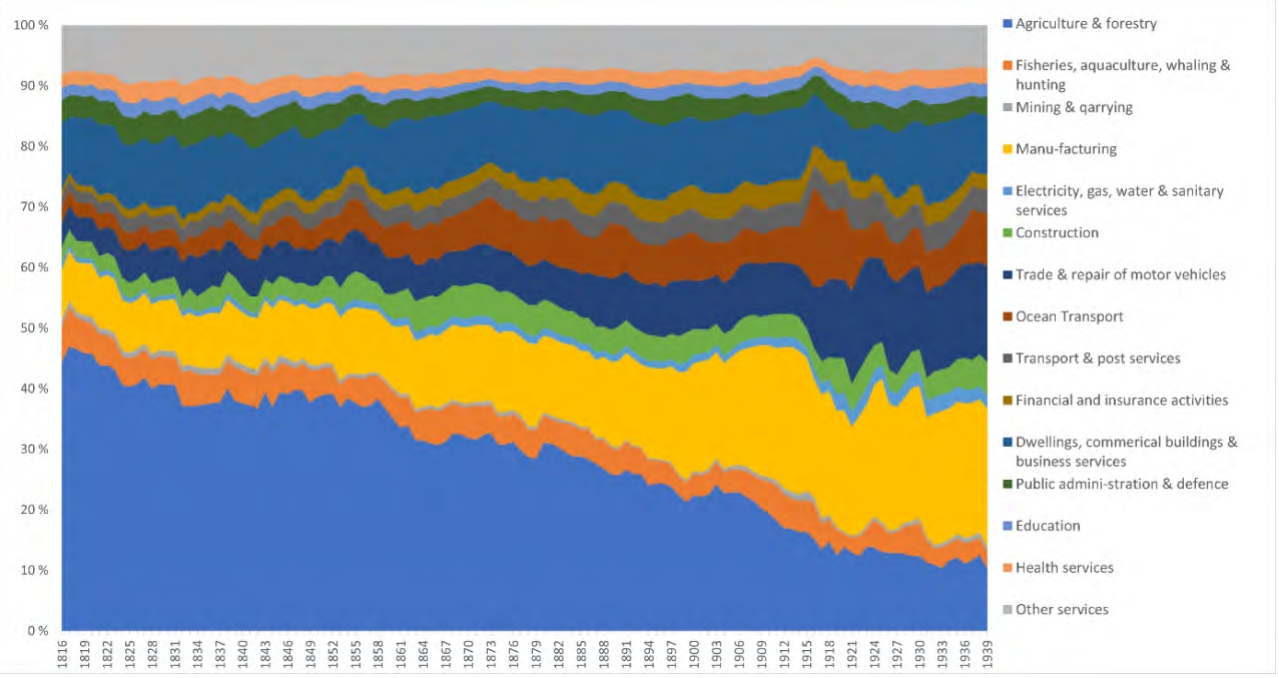

Figure 6.1: Industry share of Norwegian nominal GDP (Grytten, 2020)

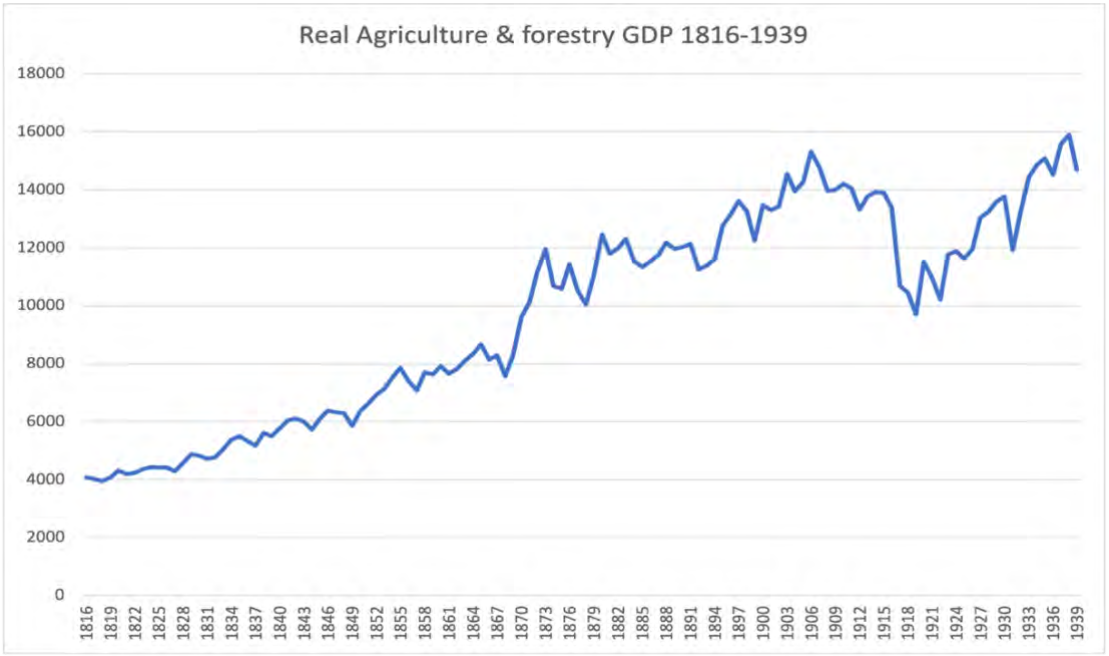

Figure 6.2: Agriculture & forestry GDP from 1816 – 1939 in million 2015-NOK (Grytten, 2020)

In figure 6.1, agriculture and forestry has the highest percentage share of the total real GDP. In the early 1900, Norway was a country where most of the economic activity occurred in the primary sector. The most prominent sector was the agricultural and forestry sector with fishing following behind. Agricultural sector stood for 44,42 percent of the total share in 1816, while in 1939 the share had decreased to 10.36 percent. The percentage share has slowly decreased throughout the period, since it did not have the growth as other emerging industries. As seen in figure 6.2 the agriculture and forestry sector did experience some growth, but not to the same degree as other industries. Several factors can be attributed to the reduced importance of agriculture and forestry. The biggest ones are market adaptation, increased efficiency, and inelastic food demand.

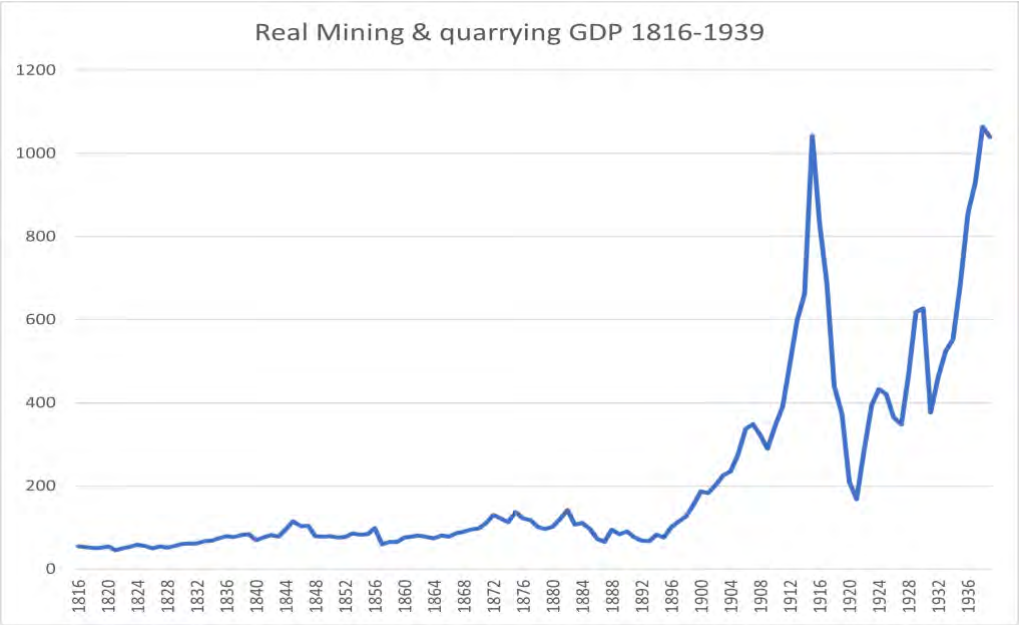

Figure 6.3: Mining and quarrying GDP from 1816 – 1939 in million 2015-NOK (Grytten, 2020)

The mining and quarrying industry has also been an important sector for Norwegian development and has been mentioned as a factor in the industrialization waves in the 1840s - 1850s. In 1816 the percentage share of total real GDP was 1.11 percent and in 1939 it had decreased to 0.89 percent. Throughout the time period, mining and quarrying had a few years with growth followed by some downturns. One great period is from 1890 to 1915 where the industry experienced an annual growth of 10.25 percent. It was a great period for mining caused by new innovative methods of mineral extraction.

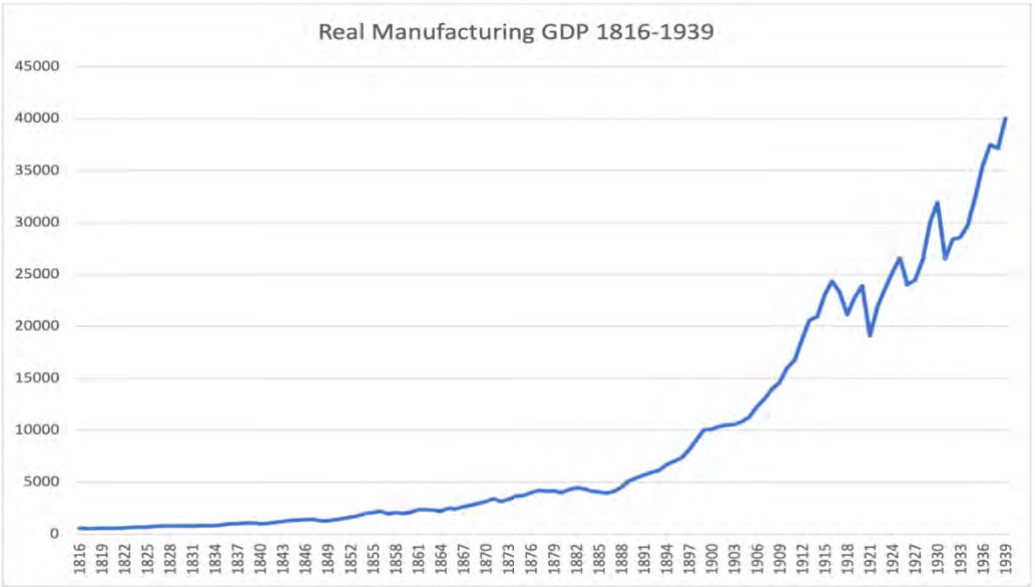

Figure 6.4: Manufacturing GDP from 1816 – 1939 in million 2015-NOK (Grytten, 2020)

The secondary sector consists of manufacturing, electricity, gas, water, and sanitary services (electricity), and construction. The most prominent sector is the manufacturing sector. In 1816 manufacturing had a percentage share of 8.23 percent of total GDP, while in 1939 it had a share of 22.8 percent. It was far from the biggest industry in the early 1900, but by 1909 it had become the biggest industry in Norway. As seen in figure 6.4, the manufacturing sector has had different periods of growth throughout the 19th- and 20th century. From the period 1835-1875, the manufacturing sector had an annual growth of 3.59 percent and in the later period 1890-1920 it had an annual growth of 5.06 percent.

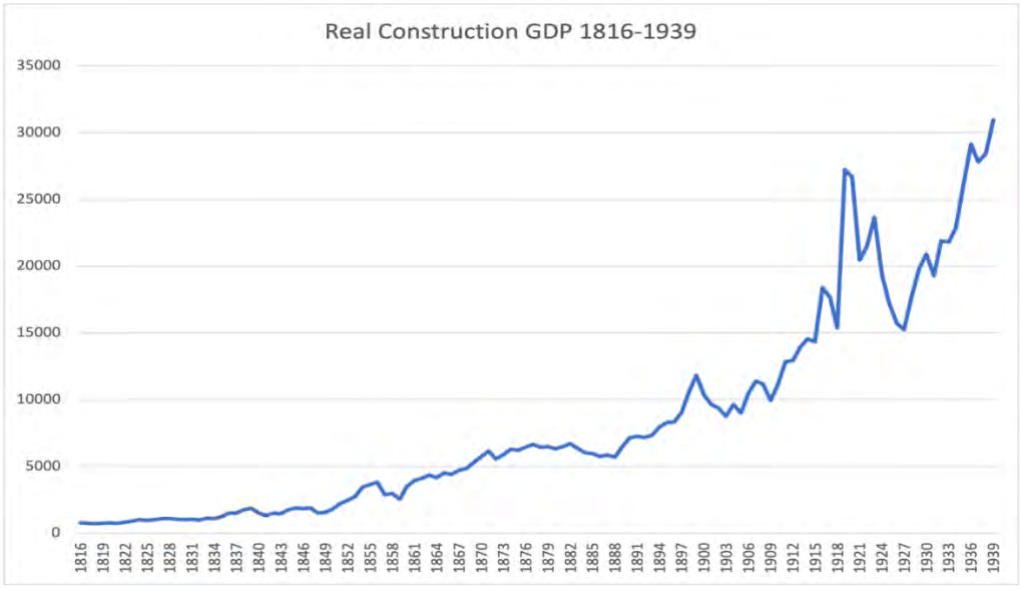

Figure 6.5: Construction GDP from 1816 – 1939 in million 2015-NOK (Grytten, 2020)

Construction is the second biggest industry in the secondary sector and accounted for 2.80 percent of the total GDP in 1816. Later in 1900, the share had increased to 4.25 percent, but the share has been volatile throughout the relevant period. In 1939, the percentage share had increased further to 5.54 percent. The annual growth of the construction sector was 4.11 percent in the period 1835-1875 and it increased to an annual growth of 4.50 percent in the period 1890-1920.

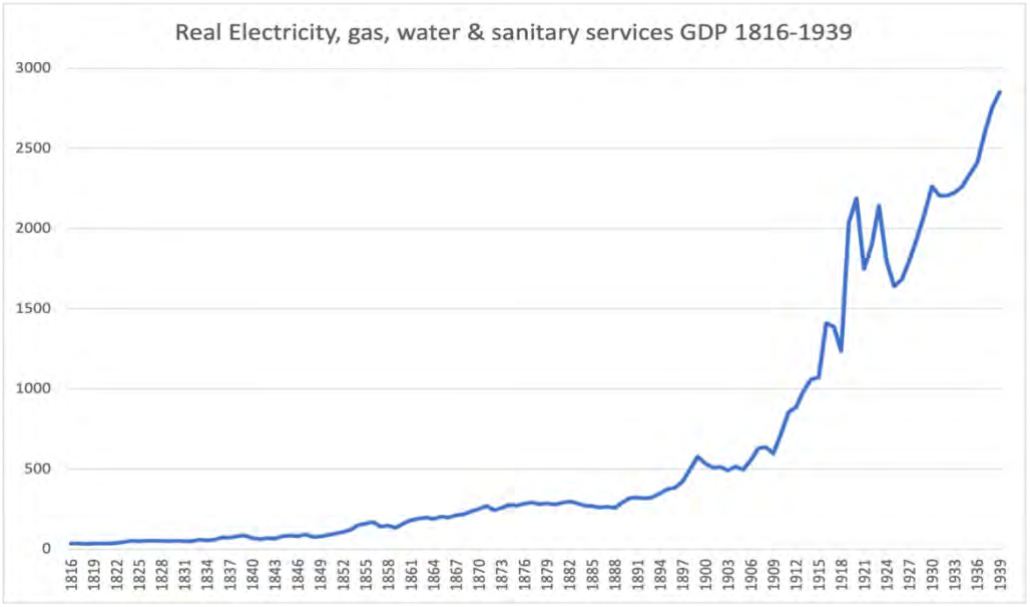

Figure 6.6: Electricity, gas, water & sanitary services GDP from 1816 – 1939 in million 2015-NOK (Grytten, 2020)

Lastly, is the electricity and sanitary industry. In 1816, the industry had a percentage share of 0.96 percent, and by the end it had a share of 2.14 percent. The electric sector experienced a great amount of growth in the 1850s, more accurately in the period 1850-1861 with an annual increase of 7.71 percent. This was the period where coal was introduced and used as a source to provide power, light, and heat to houses, streets and industries. Coal was an important strategic import for Norway. Especially for the manufacturing industry, energy and power were important, as it affected the factories' ability to produce goods (Grytten & Hodne, 2002). Later, Norway became electric and other sources of power such as hydropower were developed. Hydropower was of immense importance to the electro-based industry and allowed Norway to take the leap from a primitive industrial sector to a "modern" one at the beginning of the 20th century (Grytten & Hodne, 2002). From when hydropower was introduced in 1905 to the year 1920, the sector experienced an annual growth of 10.24 percent. Even before the electricity industry had great growth from 1889 and onwards.

6.2 Cycle analysis of GDP

6.2.1 Manufacturing, Construction, Electricity, Gas, Water, Sanitary Services

Figure 6.7 illustrates the output gap of three different industries. The industries in the figure are manufacturing, electricity, gas, water, and sanitation services (electricity) and Construction. We have used the HP-filter on the logarithm of real GDP value in each of the industries. We have thus calculated the cycle by subtracting the trend from the actual GDP value in each industry. The lambda value that we have used is 2500. When using Norwegian GDP values, it may be more accurate to use lambda values that are higher than 100 as the default value for annual time series. Also, by using a high lambda value, we can more easily discover distinct periods of growth.

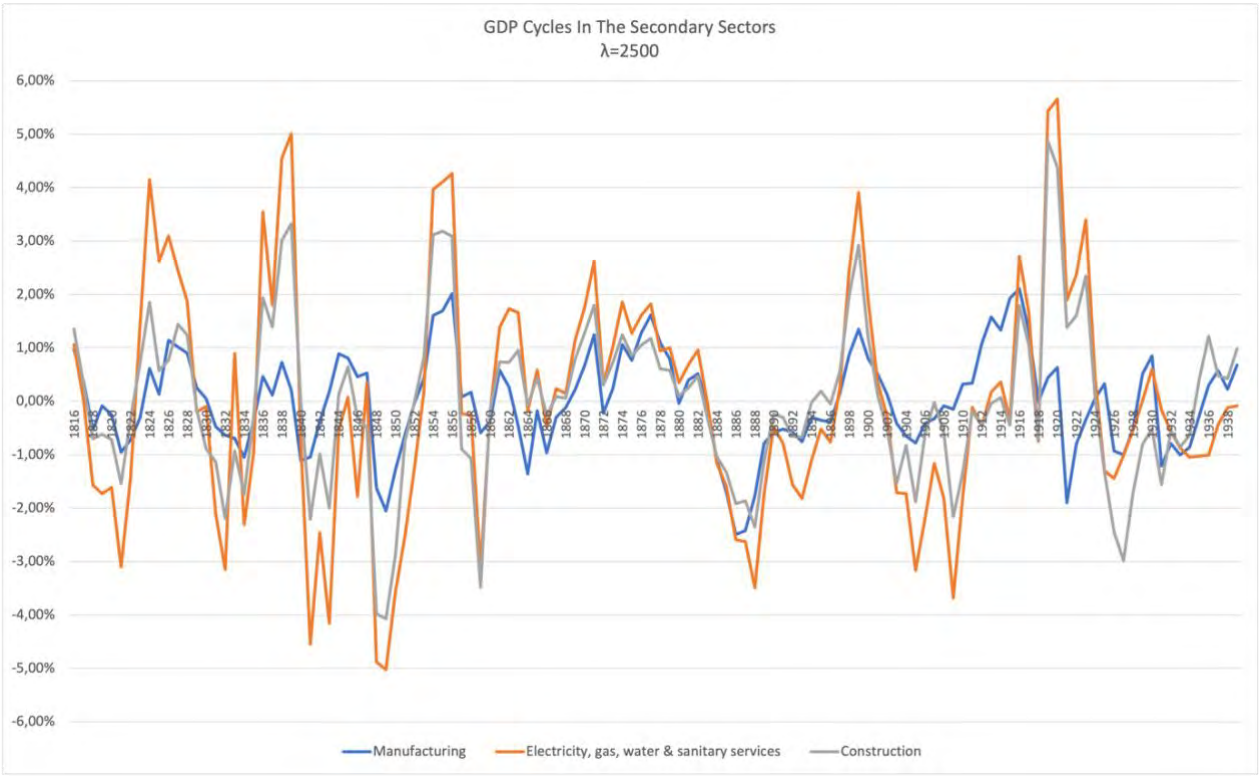

Figure 6.7: Output gaps in the secondary sector's GDP (Grytten, 2020)

Furthermore, one can observe from figure 6.7 several periods of positive deviation which are followed up by negative cycles. For the first half of the 19th century, there were positive deviations and periods of growth in most industries every ten years. First, positive deviations and growth cycles are seen during the 1920s, a period in which Europe experienced a longer period of stagnation (Grytten & Hodne, 2000). Then the deviations decrease, before the new

upswing in the middle of the 1830s. The 1830s and 1840s are the first relevant period in which industrialization in Norway is discussed. The deviations in these periods are 0.73 percent in 1838 and 0.89 in 1844. The periods of growth are quick and short and do not last longer than seven years. In general, the building and construction industry and the electricity industry experience larger deviations and greater growth than manufacturing, but during the 1840s the deviations were slightly lower.

Furthermore, in the second half of the 19th century, other patterns became apparent. First, the manufacturing and the other sectors experienced growth in the mid-1850s. Up to this point, the manufacturing has not been as volatile as the others, but from this point on, the patterns of all industries are changing. All industries experienced strong growth from 1849, and it is a sudden rise over a short period. Then the output gap of all three industries decreases. At the end of the 1860s, the deviation rose again, but what is unique in this period is that the deviation remains positive over a long period of time, for approximately 16 years. The experienced growth is smaller than the period before, but it is not as sudden. In the period after the growth, the manufacturing industry also experienced the largest decline, which is -2.50 percent during the long depression from 1873-1887. The negative deviation lasts for a number of years before the end of the 1890s. Then all the secondary industries grow, especially construction, and electricity. The manufactory industry is also growing, but the deviation is around 1.35 percent against 2.92 percent and 3.91 percent in the other industries. The rise may be due to the build-up of real estate bubbles and activities such as stock speculation. A bubble was built up that burst in 1899 and led to a decline in most industries (Grytten & Hunnes, 2016).

In the 20th century, most industries are in trend. Even though the century starts with a negative output gap, major changes are taking place with the introduction of electricity from waterfall power and the electric motor. This can be seen from 1905 when the manufacturing industry started to grow once more. The growth is strong and continues over a ten-year period until 1916. The construction and electricity industries lag and experience growth later. It is during this period that the manufacturing cycle impact is at its highest and rises to 2.11 percent in 1916. The actual rise in the period lasted until the post-war period in 1920, i.e., for ten years. Construction and the electrical industry lagged, and the deviation did not become positive until around 1915. The difference from the manufacturing for these industries is that they experience greater growth, later growth and are more volatile. In the period after the First World War, unrest and crises arose that led to a decline and volatility for the entire secondary industry. Construction is declining sharply after the war, while manufacturing and electricity

are moving above and below trend several times. Finally, all the discrepancies in the various industries grew and by 1939 all had a positive output gap.

6.2.2 Agriculture and Forestry, Mining and Quarrying

Figures 6.8 and 6.9 illustrate the output gap for two different industries. The industries in Figure 6.8 are mining and quarrying, and the industries in Figure 6.9 are Agriculture and forestry. The output gap is calculated based on the lambda of real GDP in the period 1816-1939 for the mentioned industries. The same lambda value of 2500 was used using the HP-filter to estimate the trend.

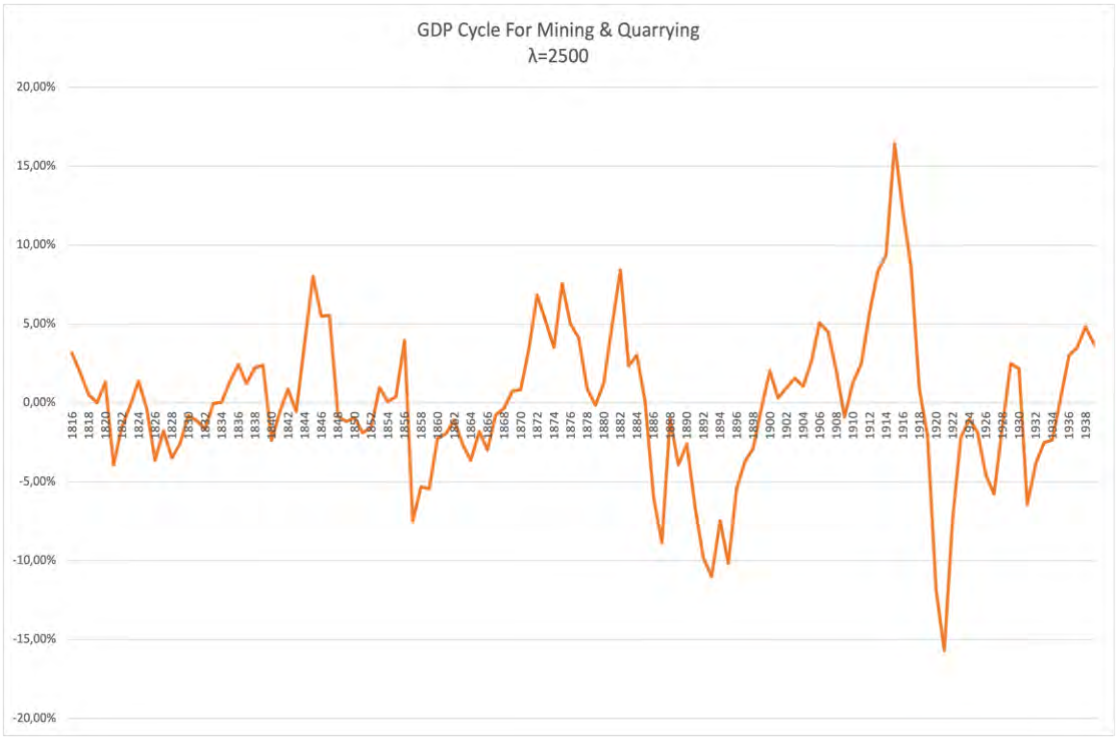

Figure 6.8: Output gap for Mining & quarrying GDP (Grytten, 2020)

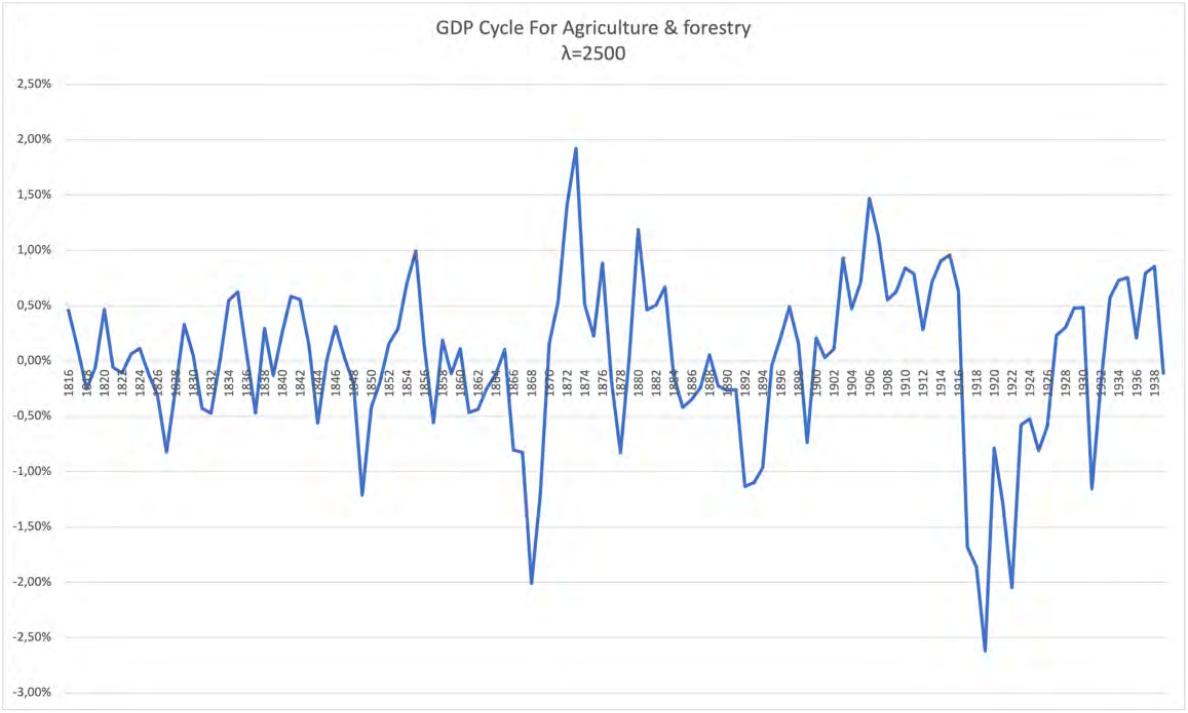

Figure 6.9: Output gap for Agriculture and forestry GDP (Grytten, 2020)

Figure 6.8 and 6.9 above, illustrate two primary industries that experienced very different growth. The first half of the 19th century was different for agriculture and mining. Mining is usually under trend until the middle of the 1830s, while agriculture and forestry remain around trend. The agricultural industry has several periods of positive deviation, but often stays around + - 0.5 percent. In the last half of the 1830s, the cycle value of mining rose to a level of 2.44 percent. Later towards the 1840s, the deviation of mining again rose to a level of 8.01 percent. Agriculture and forestry, on the other hand, experience periods of positive deviations, but also negative deviations. Agriculture and forestry varied widely until 1851.

During the later half of the 19th century, both agriculture and mining grew during the 1850s. The deviation from Agriculture and Forestry increases to 0.99 percent, while mining and quarries increase to 3.95 percent. Thereafter, the deviation from mining decreased and was negative until the end of the 1860s. Agriculture, on the other hand, is also declining, but stays around the trend line. At the end of the 1860s, the deviation from agriculture and forestry fell to 2.01 percent. Towards the beginning of the 1870s, both industries grew again, and the iodine use deviation was at its highest in 1873 with a value of 1.92 percent. Mining grew more and the highest cycle impact was 8.42 percent in 1882. The positive deviation of mining lasted until 1885 when the decline was large. The deviation from mining from 1886 is negative until

the 20th century. Like the development of mining, the agricultural industry also experienced negative deviations in large parts of the 1880s and 1890s.

By the next century, agriculture will grow and throughout much of the 20th century, the agricultural output gap will be positive. The output gap for mining was also positive at the turn of the century, and by 1904, changes were taking place. The deviation from mining increases around 1906 but decreases rapidly. The decline did not last long before mining deviations experienced strong growth around 1909. Mining deviations are positive between the years 1910 to 1918 and the highest cycle estimate is 16.43 percent in 1915. The steep increase may be due to the new technology that made it easier to develop minerals such as pyrite and copper ore from ore. In the post-war period, the deviation from mining is negative and agriculture at its lowest in the period 1816-1939. Both industries have negative deviations until the end of the 1920s, when they both grow gradually. At the end of the period in 1939, both output gaps were positive.

6.2.3 Peaks

λ = 2500	(1822-1829)	(1835-1840)	(1842-1848)	(1853-1857)	(1868-1883)	(1896-1901)	(1911-1922)
Manufacturing	1.14%	0.73%	0.89%	2.02%	1.61%	1.35%	2.11%
	(1826)	(1838)	(1844)	(1856)	(1877)	(1899)	(1916)
Electricity	4.15%	5.01%	0.37 %	4.26%	2.62%	2.45%	5.66%
	(1824)	(1839)	(1847)	(1856)	(1871)	(1899)	(1920)
Construction	1.85%	3.32 %	0.64 %	3.18 %	1.80 %	2.92 %	4.87 %
	(1824)	(1839)	(1845)	(1855)	(1871)	(1899)	(1919)
Agriculture	0.33 %	0.62 %	0.55 %	0.99 %	1.92 %	0.49 %	0.96 %
	(1829)	(1835)	(1842)	(1855)	(1873)	(1897)	(1915)
Mining	1.37 %	2.44 %	8.01 %	3.95 %	8.42 %	2.03 %	16.43 %
	(1824)	(1836)	(1845)	(1856)	(1882)	(1900)	(1915)

Table 6.1: Highest annual deviation in selected periods, λ = 2500

Table 6.1 illustrates the peaks within certain periods for the various industries. The periods are selected based on manufacturing growth and output gaps. All industries except agriculture and forestry are in a way intertwined. They all move in the same direction most of the time and experience great growth around the same time periods. Mining is not as closely correlated with the secondary industries as the others but has obvious patterns that can be linked to manufacturing and industrialization. In the 19th century, the upswing in the 1850s and 1870s was greatest for manufacturing. In the period from 1911, manufacturing is experiencing the greatest growth and the same applies to the other industries apart from agriculture and forestry. The output gap development may indicate overheating in the periods of 1830s, 1840s, 1850s, 1870s, 1890s, and 1910s.

6.3 Breakpoint analysis of manufacturing GDP cycle component

To carry out the breakpoint analysis, we have utilized the real manufacturing GDP. The mentioned data will give the greatest sign of an industrial breakthrough. We first used the HP-filter with lambda value 2500 to calculate the cycle. Furthermore, we have calculated the trend for the cycle, also with the HP-filter, but with a lambda value equal to 100 as we wanted to have a less even trend line so that it is easier to find peaks and troughs. The results are illustrated in Figure 6.10.

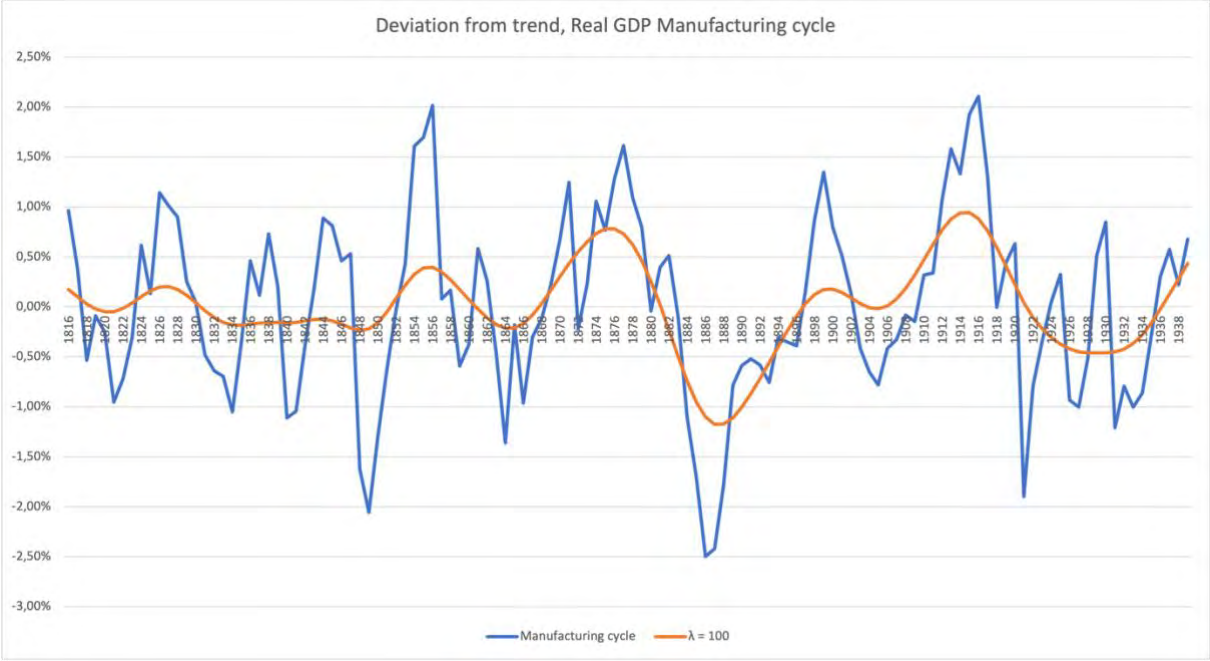

Figure 6.10: Deviation from trend, Real GDP manufacturing cycle (Grytten, 2020)

No. cycle	Throughs	Peaks
1.	1820	1827
2.	1835	1938
3.	1840	1844
4.	1848	1856
5.	1864	1876
6.	1887	1900
7.	1905	1915
8.	1929	

Table 6.2 Troughs and Peaks

The breakpoint analysis describes the cycles in Norwegian manufacturing. Based on Figure 6.10, the development is varied with some periods that stand out. Table 6.2 also illustrates the peak and troughs from Figure 6.10. There are three noticeable periods where the manufacturing industry experienced great growth. First period is after the trough in 1848 and to the peak in 1856. It is a short period of sudden growth and is the smallest of the three noticeable periods. The expansion period lasts a total of eight years, followed by the period from 1864 to 1876. The latter expansion lasted a total twelve years and is more obvious than the period before. The last and the most noticeable period is from 1887-1915 and during this period, there occurred two waves of expansions. The first expansion was from 1887 to 1900. It started during the long depression and ended after the housing crash in Christiania. It lasted for thirteen years and ended with a small negative deviation under trend. The second wave started from 1905 and ended during the first world war in 1915. It lasted for ten years and contains the highest recorded positive cycle value. We have connected these two periods together because, from 1875, there is a constant growth with a small break in the middle. In the other periods mentioned, there is growth, but after each cycle the long term-growth is nullified. Towards the beginning of the 1930s, there seems to be a new expansion period, but it is hard to conclude since the growth could occur because of the endpoint problem caused by the HP-filter.

When discussing the industrial breakthrough, it would seem that the three expansion-periods are the most likely candidates for when it could have happened. From this point, it is the period from 1887 to 1915 which seems to be the most influential period for manufacturing.

6.4 Cycle analysis of production index

The production index describes the production volume of industry and mining in the period 1896-1930. It provides a broader insight into the industry than GDP does. We have used the HP-filter on the monthly production index to get an overview of the various economic conditions in Norwegian industry and mining. A lambda value of 140 000 was first used to find the cycles of production. We then also used the hp-filter a second time on the cycle-values to create a trendline to identify contractions and growth. The second time we used a lambda value of 1000, and the results are illustrated below in figure 6.11.

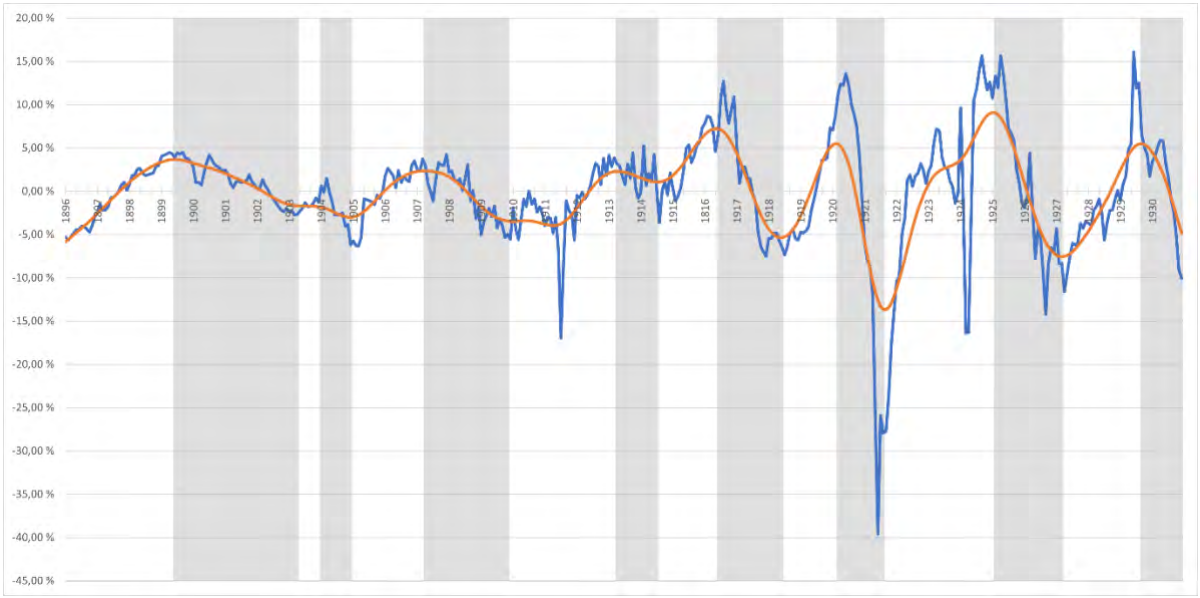

Figure 6.11: Monthly production index cycle 1896-1930. (Klovland, 2015) Contraction periods are shaded.

From figure 6.11, it can be observed that the period before the First World War starts with a significant growth from the start of the period in 1896. It grew until the Stock and housing crash around the period 1899. From there the production experienced a contraction until 1905; a period of electrification. The growth period is small until another contraction and a negative deviation from trend. From 1911 the production started with a two-wave growth, the first wave was from May 1911 until March 1913. Meanwhile, the second wave is from August 1914 to May 1916. The peak of the production cycle in the first wave is 2.20 percent and in the second

wave it is 7.23 percent. The cycles have not been higher than 5 percent up to this point. From 1916, the production values started to become more volatile which means the peaks become more extreme, but so do the troughs. After the peak in 1916 the production experiences another contraction, which is deeper than periods before. In the interwar periods, there were three cycles and one quick and deep recession. The biggest contraction is between the peak in 1920 and the trough in 1921 and is followed by tremendous growth from 1921 to 1925. Lastly, the cycles continue until the start of the great depression from 1929 where Norway, similar to the period in 1921 experiences a contraction.

Similar to the GDP analysis, the production starts off with a contraction at the start of the century. Then slow down and continue around the trend line. From 1911, the production grew and reached a peak in 1916. By the end of the first world war, the production cycle became volatile which continues until the end of the period. The business cycles are similar to the ones discovered in the annual GDP cycle analysis. The main difference between them is the stable period after the housing crash in Christiania around 1900.

6.5 Statistics

The data for employment and hours are from the period 1850-1900 and 1900-1939. Figure 6.12 illustrates the development of the number of employees in mining, manufacturing, and power supply. On the other hand, figure 6.13, shows the number of man-hours for mining, industrial and power supply companies in connection with accident insurance. Both figures show the development in Norwegian manufacturing and mining.

Figure 6.12: Employees in Manufacturing 1850-1900 (NOS, 1978)

Furthermore, figure 6.12 shows a steep development in the Norwegian manufacturing, mining, and power supply. At the beginning of the period in 1850, there were a total of 12,279 workers in the industries, while at the end of the period in 1900, it had grown to 79,635 workers. This corresponds to an annual growth of 3.73 percent during the entire period 1850-1900. Specific periods that may seem interesting are in 1875 and 1890 as these are years of further growth. Annual growth in these periods is 5.84 and 4.98 percent. Finally, there is also a marked increase from 1995, as with the periods before, the annual growth is around 4.25 percent.

Most workers in Norway in the 19th and 20th centuries were employed in primary industry, more specifically agriculture, forestry, fishing, and hunting and in 1865 59.8 percent worked in these industries. In the secondary sector, 13.6 percent were employees in manufacturing, mining, construction, and power supply. Furthermore, towards 1900, the proportion of employees in the secondary industry had increased up to 26.3 percent and the proportion persisted towards 1930 when it was 26.5 percent (Bjerke, 1966).

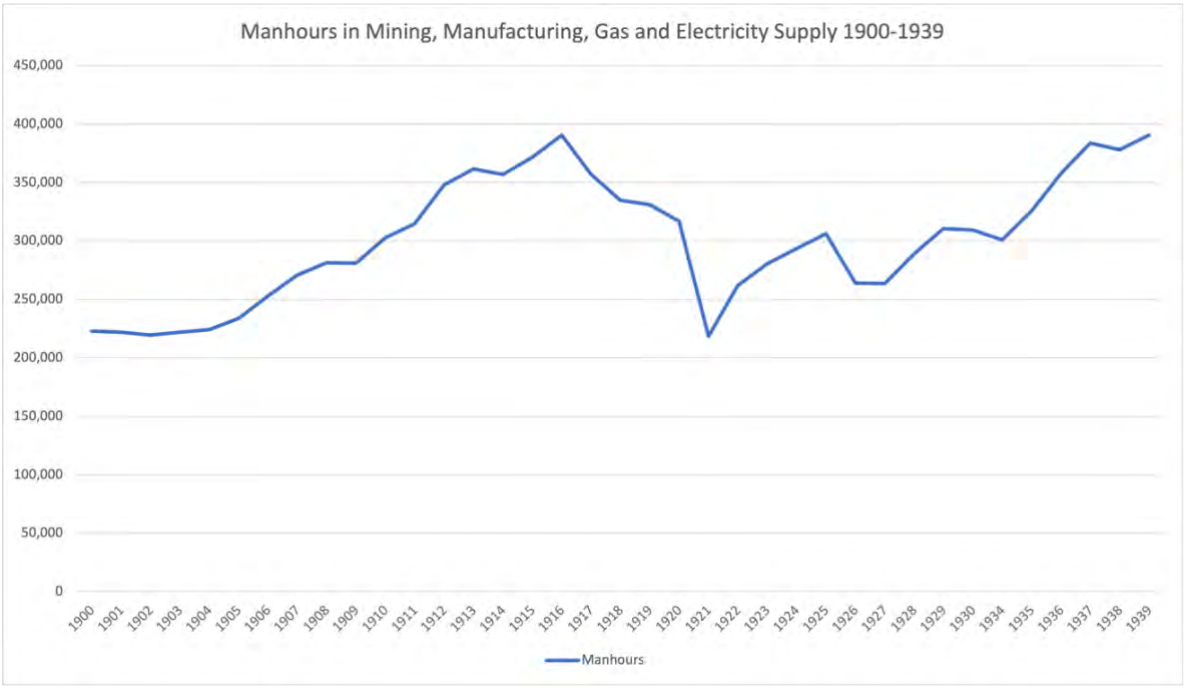

Figure 6.13: Man-hours in Mining, Manufacturing, Gas and Electricity Supply 1900-1939 (NOS, 1978)

Figure 6.13 illustrates a decrease in the number of hours worked at the beginning of the 20th century. Then the number of man-hours began to increase from around 1905. It is said that around this time great changes are taking place in industry. In 1905 the number of man-hours was 233,910 and with the gradual growth it was up to 390,483 at the end of 1916, which is an annual average growth of 4.77 percent. Furthermore, from 1917-1919, the definition of one man-year changed from 3,000 man-hours down to 2700. It may have influenced total man-hours after a normal working day changed from nine to eight hours. In the middle of the First World War, the decline began, which reached a low point in 1921. In the post-war period, there was rising unemployment and many industries had problems. It was in manufacturing and construction that unemployment rose the most and many were pushed into the primary industry instead of the secondary industry (Grytten & Hunnes, 2016, p. 197). Many had historically immigrated to the United States, but from 1924 the United States had set immigration restrictions so that many young men had to remain in Norway. This restriction was further extended to stop immigration in 1930 (Grytten & Hunnes, 2016, p. 214). Man-hours in mining, manufacturing and power supply show a marked increase in the first half of the 1920s before declining again from 1925. But from 1928 the man-hour rate gradually grew towards 1939.

Based on the figures above, it is clear that mining, manufacturing, and power supply were growing industries within the Norwegian economy. From the middle of the 19th century, the industry employed increasing numbers of workers, even during negative economic conditions right up to the 20th century. Since the start of the first industrial revolution, the secondary sector has become a larger part of value creation within the Norwegian economy.

6.6 Norwegian exports

Exports data used have mainly been divided into twenty-five different groups. We have therefore aggregated the groups so that it provides a better insight into the Norwegian export's development. The groups are divided into food and beverages, lumber and wood products, leather and textiles, chemicals, oil and fuel, minerals and metals, paper and similar products, and miscellaneous commodities. The results are illustrated by Figure 6.14.

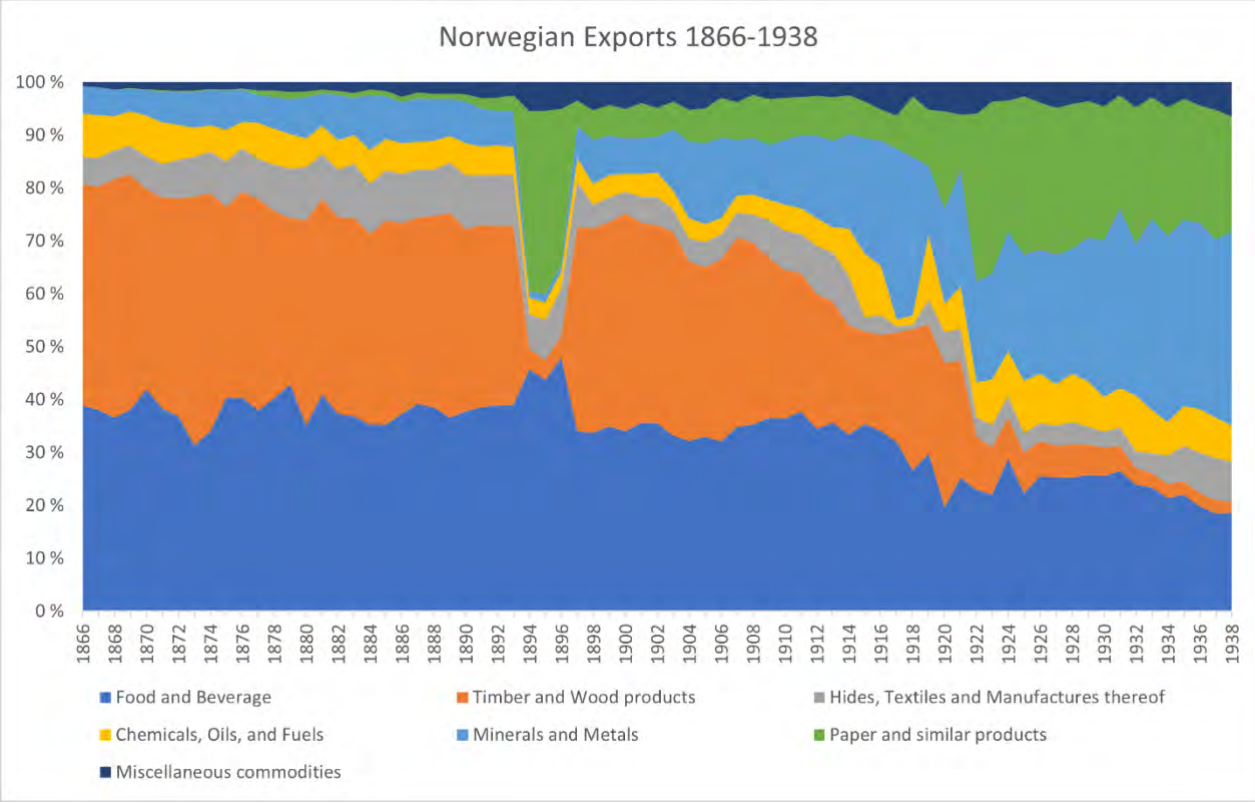

Figure 6.14: Norwegian Exports 1866-1938 (NOS, 1969)

From Figure 6.14, it can be observed that Norwegian exports for much of the 19th century consisted largely of food and beverages, and lumber and wood products. In 1866, these commodity groups accounted for about 80 percent of all exports. More specifically, it was

foods of animals and lumber that accounted for large parts of exports during this period. Furthermore, these goods continued to dominate in exports, but the share gradually declined until the beginning of the new century. By 1900, food from animals and lumber accounted for around 75 percent of all exports, but there have been some changes. The industry grows and produces goods that become part of the Norwegian exports. The product groups from industry are growing gradually and by 1916 the traditional exports goods had only 52.3 percent share in exports. The same development continues, and it is the product groups for minerals, metals and paper that are beginning to play a greater role in Norwegian exports.

Exports Group	**1890**	**1900**	**1910**	**1916**	**1926**	**1938**
Raw, Minerals	3 201	4 251	15 544	34 921	29 170	62 503
Minerals Fabricated	1 875	2 615	9 664	119 187	67 884	76 481
Raw Metals	1 588	2 474	6 743	70 858	86 918	140 057
Paper and Manuf. thereof	1 848	9 774	22 455	58 308	225 810	171 278
Sum	8 512	19 114	54 406	283 274	409 782	450 319
Total Exports	131 096	172 946	282 595	988 333	811 906	786 529
Per cent of total exports	6,5%	11,1%	19,3%	28,7%	50,5%	57,3%

Table 6.3: Exports of minerals, metals and paper, and total exports of goods 1890-1938(NOS, 1969)

Furthermore, Table 6.3 illustrates the development within the product groups for minerals, metals, and paper. From 1890, the product groups accounted for a small share of all exports, which is 6.5 percent because Norway exported mostly food and lumber. At the beginning of the new century, changes were taking place that led to a new balance within Norwegian exports. In 1900, the share of minerals, metal and paper covers of total exports almost doubled to 11.1 percent. The development continues and towards the middle of the First World War, the four product groups account for 28.7 percent of all Norwegian exports. At the beginning

of the post-war period, the share of minerals and metals was reduced, but by 1826 it was growing and then the product groups accounted for 50.5 percent of Norwegian exports.

To give a better picture of the Norwegian economy, exports accounted for 30 of total value creation around 1900. This share increased to 33 percent in the period 1905-1914 according to Bjerke's national accounts, and 39 percent in the period 1910-1919 (Grytten & Hodne, 2002). Exports created a lot of value for the Norwegian economy and new technology created great opportunities for manufacturing and mining. There was an innovation in the Norwegian economy which meant that Norway had other product groups to rely on in the international market, which was also not as cyclically exposed as food from animals and lumbers.

7. Discussion

In this chapter, we will first discuss and compare the various research of the different historians that were presented in chapter 2.0. The purpose of comparing the research will be to map the time when historians thought an industrial breakthrough took place. Furthermore, we will discuss the development of the business cycle in Norway during industrialization. The main purpose of this will be to study whether industrialization took place in waves. Finally, the most relevant individual breakthroughs of the industrialization era will also be discussed. In this chapter, relevant highlights from chapter 6.0 will also be used to conduct the relevant discussion on the research question.

7.1 Perspectives of industrialization in Norway

As we discussed earlier in this thesis, different historians have divided opinions when it comes to the Norwegian industrial breakthrough. Hence, in this subchapter, we will compare the different views of the historians that were used to form this thesis. We will do this using Table 7.1 which illustrates/elaborates the different perspectives of the historians. In the first column of the table, we can observe various historians that have been presented earlier in the thesis. From the right, the table illustrates/elaborates the period historians believed the industrial breakthrough took place, which school they belong to, and the most important factors as to why the industrial breakthrough took place in that period.

Historians	Period	School	Factors
Kristine Bruland	(1840-1875)	Ante	Emphasizes the leading role of the textile industry in the early phase around 1840 and the rapid growth in the iron and metal industry after 1860, and especially a strong display in industrial employment in the 1860s.
Francis Sejersted Even Lange	(1880)	Ante	Shift in the technical paradigm caused by the international economic crisis.

Edgar Hovland Helge W. Nordvik	(1880 - 1890)	Ante	Emphasizes the increased capital stock per worker and the steady growth of workers in factories and a general strengthening of the manufacturing industries during the 1880s and 1890s.
Ola H. Grytten Fritz Hodne Jan Tore Klovland	(1880-1890)	Ante	Emphasizes the growth in wood pulp factories in the 1870s and 1880s. The results show that Norway made a profit on this export business, and this increased the demand for manufacturing products. The implementation of electricity in industries.
Christian Venneslan	(1890)	Ante	Emphasizes the development in electricity and the use of it in different industries.
Ola H. Grytten Fritz Hodne Jan Tore Klovland	(1890 – 1905)	Post	How the use of electricity was implemented in the manufacturing industry after the 20th century. Emphasis also the effect of international markets and foreign capital in the companies that began to spread around Norway after the 20th century.
Per Fuglum Gunnar Nerheim	(1900)	Post	Emphasizes the development of the electrochemical and electrometallurgical industry (based on the use of hydropower). In other words, the importance of electricity in Norwegian industrial development.

Pål T. Sandvik	In waves	Different approach	Strong development in several industries, and an exponential growth in the secondary industry.

Table 7.1: The different perspectives of historians

From table 7.1, we can observe that the research of the historian Bruland stands out in particular from the others. This is because she places the greatest emphasis on the first wave of industrialization. At the same time, the historian provides support for the work developed by Sejersted and Lange. This is because Bruland also believed that the development that was driven by the international crisis meant that most sectors in Norway at that time became more industrialized.

Furthermore, it can be observed from table 7.1 that several historians believed that an industrial breakthrough took place between 1880 and 1900. A common factor for historians who believed that industrialization took place between the period is a shift in the technical paradigm due to the international crisis. This applies in particular to the research of Sejersted and Lange. At the same time, the other different historians emphasize different factors and periods that are illustrated in the table.

After the 20th century, it can be observed from table 7.1 that a significant similarity for historians with a post-school approach is that industrialization was driven by the use of electricity. This is also the opinion of Grytten, Hodne, Klovland, and Venneslan, although they also discuss in their work that the breakthrough may have taken place before the turn of the century.

Finally, the research that stands out in terms of what has been reviewed so far is from Sandvik as he emphasises that industrialization has had different stages. He defines the stages as breakthroughs, and they extend throughout the industrialization period until a total breakthrough takes place. In addition, the historian also considers the various breakthroughs of the other mentioned historians in his research. At the same time, Sandvik believes that the greatest industrial breakthrough in Norway took place in the early 1890s.

7.2 Cycles during the industrialization

Throughout the analysis in chapter 6, we used the HP-filter to analyse the business cycles for different industries. By doing so, we have been able to track the cycles throughout the Norwegian industrialization period. In table 7.2 we have dated all business cycles which was visible from our cycle analysis in chapter 6.2. We have only focused on the manufacturing GDP cycle to date all cycle movements.

Periods of positive business cycles	Periods of negative business cycles
1836-1839	1840-1842
1843-1847	1848-1852
1853-1858	1859-1868
1869-1882	1883-1896
1897-1902	1903-1909
1910-1920	1921-1923

Table 7.2: Business cycles during industrial development

From the various sources, there is a view that industrialization started during the 1840s. From the cycle analysis we saw a small positive cycle during this period from 1843-1847. It is one of the smallest deviations, but it is noticeable. It is the first positive cycle during the industrialization process in the textile industry and the mechanical workshops. Furthermore, a new positive cycle became apparent in the 1850s. It was led by the same textile industry, the mechanical workshops and the iron and metal industry (Bruland, 1989).

From 1869, we discovered another positive business cycle in the Norwegian manufacturing GDP. It is during this period where manufactures of paper and other related products began to spring up and grow. Hodne (1981) and Grytten (Grytten & Hodne, 2000) argued that the pulp mills and production of cellulose and paper was an innovation the world waited for and had great effects on other industries from the increased exports. The length of the positive cycle is 13 years, which is significantly longer than other cycles in the 1840s and 1850s. The long depression which started in 1873 (Grytten & Hunnes, 2016) did cause a decline in

manufacturing GDP, but we did not see a negative cycle until 1883. The long depression did have a significant impact on manufacturing GDP and the cycle value was down to -2.50 percent in 1886 which was the largest contraction in the period between 1816-1939.

After the long depression and towards the end of the 1890s, a new positive cycle developed. It was a positive growth caused by industrialization, but also other factors. The positive growth started at the end of the long depression and quickly developed into a positive cycle. The positive business cycle only lasted six years until it declined again. Fortunately, this was also a short-lived period before a sudden rise in the manufacturing GDP caused by new technology created to work with electricity. Electricity and the electric motor caused even further growth and a new industry also was renewed. The mineral and metals industry were innovated and a new method of extracting raw materials caused great growth.

The manufacturing industry experienced multiple periods of growth and positive business cycles. Once the industrialization development started the pattern which had occurred before the 1850s changed and there are clearly periods with higher deviation peaks and some periods with longer lasting positive business cycles. This can also be applied to the negative business cycles. The several peaks may coincide with manufacturing development and may indicate several breakthroughs. If there were more breakthroughs, industrialization could have taken place in waves. First in the early 1840s, then in the 1850s, again in the 1870s, in the 1890s and lastly in the 1910s. It may also be possible that the industrial breakthrough happened during a single wave, but that is not something we can conclude with yet.

7.3 The industrial breakthrough

One of the objectives of this thesis is to identify the time when Norway attained its industrial breakthrough. As forementioned, there are various points of view on the subject matter, and it is hard to determine a common date because there exists no standardized explanation for what a breakthrough is. We have throughout the thesis examined data from the Norwegian national accounts. With that, we have come to a conclusion based on the analysis of the GDP in different industries, the cycle analyses and the export statistics.

In chapter 6 we started with an analysis of the GDP share of all industries in Norway. From there we could conclude that it was the agriculture and forestry industry which was the largest throughout most of the 19th century. Manufacturing was not the most influential industry, but

over time this changed. From the start of the industrialization process, the manufacturing industry gradually increased its total share reflecting the increasing industrialization in Norway. It was not until the late 1880s and early 1890s when manufacturing started to become bigger faster and took up more space in the Norwegian economy. The growth became greater, and the total share of total GDP became more dominated by manufacturing.

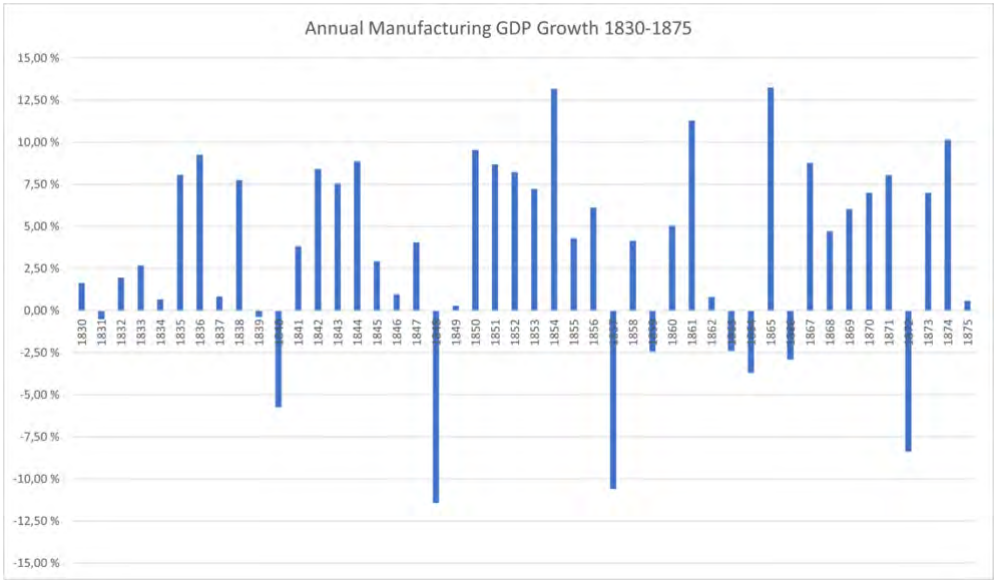

Figure 7.1: Annual manufacturing GDP growth 1830-1875 (Grytten, 2020)

The annual growth in the manufacturing industry also paints a similar picture. From figure 7.1 there is a pattern of growth for 6-7 years followed by major declines in the manufacturing GDP. The figure also shows a fast-growing industry with a much higher growth rate compared to the agriculture and forestry industry.

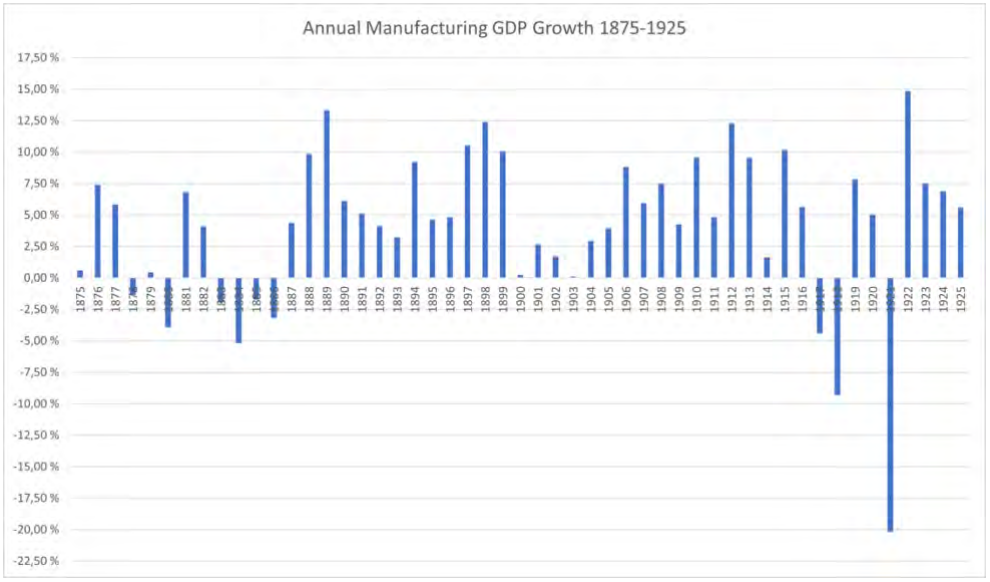

Figure 7.2: Annual manufacturing GDP growth 1875-1925 (Grytten, 2020)

Figure 7.2 illustrates a period of fifty years with constant annual growth. There are not many years where manufacturing GDP experiences a decline. Furthermore, there is a clearer period where the growth is uninterrupted, but with a short period of stabilisation in the middle. The long depression was hard for the Norwegian economy, but it was from the 1870s and during the crises when the wood pulp industry grew and later during the 1880s and 1890s when paper and cellulose industries developed (Mikkelsen, 1975). Taking the place of the traditional lumber production. As Bruland (1989) mentioned, Norway took advantage of importing technology and knowledge from other European countries such as Great Britain. It was a factor which caused growth in the period from 1840-1875 in the textile industry and mechanical workshops. In the 1860s, the import of German technology from 1840 in the wood production grew the paper industry in the period 1870-1895 and so on.

We also used the hp-filter in order to analyse the cycles of different industries. It created a greater picture of periods where Norway grew more than usual. This is because we created a long-term trend and were able to determine periods where manufacturing experienced an unusual amount of growth compared to the trend. Figure 7.3 depicts the breakpoint analysis of the manufacturing GDP cycle, with the green shaded areas indicating important periods of expansion.

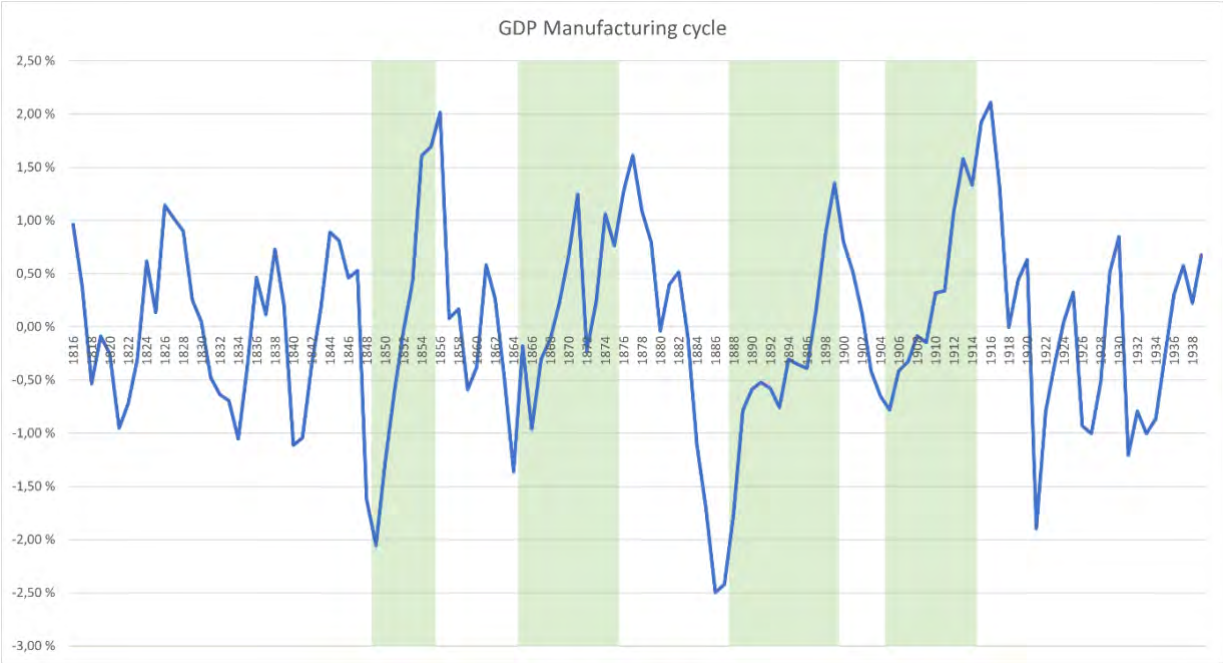

Figure 7.3: Manufacturing GDP cycle 1816-1839, Shaded areas indicate expansion. (Grytten, 2020)

According to the breakpoint analysis, there are several times where the cycle experiences significant growth during the industrialization period. The first expansion period, which lasted from 1848 to 1856, was the shortest of all. It has an eight-year duration and ranges from -2% to 2%. It is brief, yet it contains one of the highest cycle peaks recorded. The second point we noticed was from the years 1864-1876. It does not have the same rapid growth as the previous phase, but the length of the expansion is extended. It now lasts 12 years instead of eight, which is a considerable change.

The following period runs from 1887 to 1900, immediately following the protracted downturn that caused the greatest decline in Norwegian manufacturing / GDP between 1816 and 1939. It is at this period in 1887 that the Norwegian manufacturing industry began a 13-year rapid development. It comes following the expansion of other industrial businesses in Norway, such as the paper and cellulose industries, and during a difficult economic period. A new expansion occurred only five years after the original one. It began in 1905 and lasted until 1915, a period of ten years of expansion. The most intriguing aspect of this phase is that the contraction between these periods was not as strong as the contractions in previous periods. This means that a long-term view of these two periods shows an upwards growing trend. Furthermore, one can observe from figure 7.3 that there are signs of industrial growth phases in several periods

that are marked in green. The periods of growth vary, and this means that some are larger and longer than others.

Additionally, the Norwegian exports were analysed and also gave a clear picture of the important role manufactory has had throughout the relevant period. development of new and old export groups from the 1870 and 1880. In 1866 around 81 percent of all exports was from those groups. Manufacturing accounted for significantly less and it was not until the early 1890s when the paper and similar products experienced an increase in exports. As mentioned above, the paper consumers waited for an innovation which could fill the demand for raw material.

Hence, the wood pulp developed from the 1860s and the paper and cellulose industry developed from the 1880s and 1890. Norway started first with export of wood pulp in the late 1860s, then cellulose from 1881 and lastly paper in the 1890s (Grytten & Hodne 2000). This was also reflected in the export's statistics. Norwegian exports changed quickly from the late 1880s when paper and similar products increased dramatically in a short amount of time. It was the first point when other goods than the traditional foods of animals and lumber goods would become important. It was the start of the paper industry which marked the start of the industrial breakthrough in Norway. This provides support for growth caused by exports.

	Time of industrial breakthrough
New view	1887-1916

Table 7.3: Time of the industrial breakthrough

We believe therefore that the largest industrial breakthrough occurred from 1887 until towards 1916. At the same time, we also find support from the previous chapter that it also happened in waves. This means that industrialization in Norway came with different waves, but the biggest breakthrough took place in 1887.

The period between 1887 and 1916 is the largest due to various factors. First, the amount of growth between the periods is constant over a longer period. Such an occurrence is something which did not often happen in the period from 1816 to 1939. The expansions in the 1850s and in the 1870s lasted for a short amount of time and the total growth was lower than in the later period. The cycle analysis shows a clear change in pattern and the trend from 1887 is clearly greater and occurs over a longer period of time. The exports also show that the demand for

Norwegian products changed over the course of 100+ years. Norway had most of the time exported goods such as foods from animals and lumber, but from the late 1880s another industry came forth and caused major changes in the Norwegian exports. It was also later in the second wave from 1905 when goods such as minerals and metals became more popular abroad.

8. Conclusion

This thesis seeks to study the time when Norway was industrialized, and has especially considered the following three points:

- *Was Norway industrialized before the 20th century?*
- *Was Norway industrialized in the 20th century?*
- *Was Norway industrialized in waves?*

Previous research presented in chapter 2.0. has shown that there are divided opinions about when Norway was industrialized. Several authors show through their previous research that the industrial breakthrough took place in different time periods. At the same time, the previous research shows several similarities and differences according to chapter 7.2. In summary, to answer the thesis research question, we have analysed different relevant data.

Furthermore, we performed a deviation analysis of industrial agriculture and forestry, mining, manufacturing, construction, and electricity, gas, water, and sanitation services. We did this by estimating cycles in a time series and used an HP filter to estimate a trend. For most industries, we found several major discrepancies in the periods 1850s, 1870s, 1890s and 1910s. After 1850 the pattern during industrial development also changed with larger fluctuations. The analysis of the production index gave similar results as the deviation analysis of the manufacturing GDP.

A breakpoint analysis was also performed to analyse the industrial cycle. From there, we found three periods in which the manufacturing industry experienced great growth. The first period was from the 1850s, the second was from the 1870s and the last that came in two waves took place from 1887-1916. Based on these figures in the context of the industrial breakthrough, we argue that the manufacturing growth from 1887 may be a sign of a breakthrough in Norwegian industrialization.

Based on available data, the secondary industry increased its share of total production, and it could be observed that the primary industry began to have smaller shares. We also found support for this in the growth of various industries where we could observe a greater growth in secondary industries compared to the primary industry. The analysis also shows that the number of employees in the secondary sector grew from 12,000 workers in 1850 to 80,000 by

1900. Simultaneously, before the 20th century, many employees were still employed in the primary sector. After the 20th century the results showed that the employment in the secondary sector started to stabilize.

The export analysis also shows that during the industrialization period, the Norwegian industries began exporting more goods from the secondary industry. It can be seen from the early 1870s that the paper industry was formed and began to develop rapidly. From 1890, exports of paper and similar products grew sharply. The same happens with the mineral and metal industry from 1905 and towards 1920 as both industries account for the largest share of exported goods. Based on the demand theory of several historians, the development of exports can give an accurate picture of an industrial breakthrough around 1890.

To conclude, the results of our analysis show different possible industrial breakthroughs through the period that we have analysed. By mapping the business cycles during the industrialization period, we have observed that industrialization may have taken place in waves. At the same time, through other analysis we can observe an influential breakthrough that took place in 1887. This therefore indicates that the industrialization started in different waves from 1840 to 1916, but Norway became fully industrialized (before 1900) after the breakthrough that took place from 1887 to 1916.

References

Abramowitz, M. (1956). Resource and output trends in the United States since 1870. *The American Economic Review, 46*(2), pp. 5-23. Retrieved from https://www.jstor.org/stable/1910656

Ashton, T. S. (1997). *The Industrial Revolution 1760–1830.* Oxford: Oxford University Press.

Bea. (2008, January 11). *How is average annual growth calculated?* Retrieved from Bea: https://www.bea.gov/help/faq/463

Bjørnland, H. C., Brybakke, L., & Jore, A. s. (2004). Produksjonsgapet i Norge - en sammenlikning av beregningsmetoder. *Penger og Kreditt (4)*, pp. 199-209.

Bjerke, J. (1966). Langtidslinjer i norsk økonomi 1865-1960. *Samfunnsøkonomiske studier nr. 16*.

Brautaset, C. (2002). *Norwegian Exports 1830-1865: in Perspective of Historical.* Bergen: Norwegian School of Economics.

Bruland, K. (1989). Norsk mekanisk verkstedindustri og teknologioverføing 1840-1900. In E. Lange, K. Bruland, H. W. Andersen, O. Wicken, F. Wildhagen, H. Lundgaard, & E. Lange (Ed.), *Teknologi i Virksomhet: Verkstedindustrien i Norge etter 1840* (pp. 33-72). Oslo: Ad Notam Forlag AS.

Burns, A. F., & Mitchell, W. C. (1946). *Measuring Business Cycles.* New York: National Bureau of Economic Research.

Dørum, K. (2021, Januar 5). *Den industrielle revolusjon i Norge*. Retrieved from Store Norske Leksikon: https://snl.no/den_industrielle_revolusjon_i_Norge

Dørum, K. (2022, April 19). *Norsk industrihistorie før 1940*. Retrieved from Store Norske Leksikon: https://snl.no/norsk_industrihistorie_f%C3%B8r_1940

Dean, S. L. (2018). *Norwegian gross domestic product by industry 1830-2006:.* Bergen: Norwegian School of Economics.

Dennison, E. F. (1967). *Why Growth Rates Differ. Postwar Experience in Nine Western Countries.* Washington DC: Brookings.

Encyclopædia Britannica. (2022). *Industrial Revolution*. Retrieved from Encyclopædia Britannica: https://www.britannica.com/event/Industrial-Revolution/The-first-Industrial-Revolution

Fuglum, P. (1978). Norge i støpeskjeen 1884-1920. In K. Mykland (Ed.), *Norges historie.* Oslo: J.W Cappelens Forlag AS.

Grytten, O. H. (2004). Output, Input and Value Added in Norwegian Agriculture. (G. Jonsson, Ed.) *Nordic Historical National Accounts*.

Grytten, O. H. (2011). Financial crises and monetary expansion. *Working Paper (21)*.

Grytten, O. H. (2015). *Norwegian gross domestic product by industry 1830-1930. Working Paper 19/2015.* Oslo: Norges Bank.

Grytten, O. H. (2020). Two centuries of economic growth: Norwegian GDP 1816-2020.

Grytten, O. H. (2020). Two centuries of economic growth: Norwegian GDP 1816-2020.

Grytten, O. H., & Hodne, F. (1998). Norwegian Production of Landcrops in the Nineteenth Century: Prices and Output 1830-1910. (J. P. Christen, Ed.) *Nordiske historiske nasjonalregnskaper*.

Grytten, O. H., & Hodne, F. (2000). *Norsk økonomi i det nittende århundre.* Bergen: Fagbokforlaget.

Grytten, O. H., & Hodne, F. (2002). *Norsk økonomi i det tyvende århundre.* Bergen: Fagbokforlaget.

Grytten, O. H., & Hunnes, A. (2016). *Krakk og kriser i historisk perspektiv.* Oslo: Cappelen Damm Akademisk.

Grytten, O. H., & Koilo, V. (2019). Maritime financial instability and supply chain management effects. *Problems and Perspectives in Management, 17*(4), pp. 62-79. doi:10.21511/ppm.17(4).2019.06

Grytten, O. H., & Minde, K. B. (2019). Generational links between entrepreneurship, management and puritanism. *Problems and Perspectives in Management, 17(1)*, pp. 244-256. doi:10.21511/ppm.17(1).2019.21

Hodne, F. (1981). *Norges økonomiske historie 1815-1970.* Oslo: J.W Cappelens Forlag AS.

Hodne, F. (1983). *Stortingssalen som markedsplass: Statens grunnlagsinvesteringer 1840-1914.* Oslo: Universitetsforlaget.

Hodrick, R. J., & Prescott, E. C. (1997). Postwar U.S. business cycles: An empirical investigation. *Journal of Money, Credit, and Banking*.

Hovland , E., & Nordvik, H. W. (1997). Det industrielle gjennombrudd i Norge 1840-1914 med samtidens og ettertidens øyne. In B. L. Basberg, H. W. Nordvik, & G. Stang (Eds.), *I det lange løp : essays i økonomisk historie tilegnet Fritz Hodne* (pp. 61-85, 77-80). Bergen: Fagbokforlaget.

Jörberg, L. (1965). Structural change and economic growth: Sweden in the 19th century. *Economy and History, 8:1*, pp. 3-46. doi:10.1080/00708852.1965.10418997

Kiesewetter, H. (1989). *Industrielle Revolution in Deutschland 1815–1914.* Frankfurt am Main : Suhrkamp.

Klovland, J. T. (2015). *Measuring trends and cycles in industrial production in Norway 1896-1948.* Oslo: Norges Bank.

Kristensen, N. B. (1989). Industrial growth in Denmark, 1872–1913 — in relation to the debate on an industrial break-through. *Scandinavian Economic History Review, 37:1*, pp. 3-22. doi:10.1080/03585522.1989.10408129

Landes, D. (2003). *The Unbound Prometheus.* Cambridge: Cambridge University Press.

Lange, E. (1989). Industrien bak det moderne Norge. In E. Lange, K. Bruland, H. W. Andersen, O. Wicken, F. Wildhagen, H. Lundgaard, & E. Lange (Ed.), *Teknologi i virksomhet: Verkstedindustrien i Norge etter 1840* (pp. 11-28). Oslo: Ad Notam Forlag AS.

Mikkelsen, P. R. (1975). *Norsk tremasseindustri 1863-1895 : en studie i et industrielt gjennombrudd.* Oslo: Universitetet i Oslo.

Minde, K. B. (2015). *Norwegian energy consumption in the nineteenth and twentieth century, unpublished manuscript* . Stord: HSH.

Nerheim, G. (1980). *Fra Laugstol Bruk til Alta - norge under elektrisiteten.* Oslo: Samtiden.

NOS. (1949). *Statistical Survey 1948.* Oslo: Statistics Norway.

NOS. (1969). *Historisk Statistikk 1968.* Oslo: Statistics Norway.

NOS. (1978). *Historical Statistics 1978.* Oslo: Statistics Norway.

NOS. (1978). *Historical Statistics 1978.* Oslo: Statistics Norway.

OECD. (2002). *Glossary of statistical terms: GDP*. Retrieved from OECD: https://stats.oecd.org/glossary/detail.asp?ID=1163

Sandvik, P. T. (2018). *Nasjonens velstand norges økonomiske historie 1800-1940.* Bergen: Fagbokforlaget.

Schweigaard, A. M. (1840). *Norges Statistik.* Christiania.

Sejersted, F. (1992). A Theory of Economic and Technological Development in Norway in the Nineteenth Century. *Scandinavian Economic History Review, 40:1*, pp. 40-75. doi:10.1080/03585522.1992.10408239

Sejersted, F. (1993). *Demokratisk kapitalisme.* Oslo: Universitetsforlaget AS.

Skoglund, T. (2009). Bruttonasjonalprodukt etter næring og sluttanvendelse i historisk nasjonalregnskap. Beregninger for 1946-1969. *Notater 2009/28*.

Solow, R. (1956). A contribution to the Theory of Economic Growth. *Quarterly Journal of Economics, 70*(1), pp. 65-94. doi:https://doi.org/10.2307/1884513

Statistics Norway. (2008). *Fra håndkraft til høyteknologi – norsk industri siden 1829.* Oslo: Statistics Norway.

Steigum, E. (2004). *Moderne makroøkonomi* . Oslo: Gyldendal akademisk.

Svendsen, A. S., Holst, W., & Wasberg, G. C. (1963). Industrialiseringens gjennombrudd. In J. T. Ruud, A. Eskeland, G. Randers, & M. Skodvin (Eds.), *Dette er Norge 1814-1964* (pp. 363-414). Oslo: Gyldendal Norsk Forlag.

Try , H. (1979). To kulturer en stat 1851-1884. In K. Mykland (Ed.), *Norges histore.* Oslo: J.W Cappelens Forlaf AS.

Tvethe, B. M. (1848). *Norges Statistik.* Christiania.

Venneslan, C. (2007). *Industrial development in Norway 1896-1939: in view of historical national accounts.* Bergen: Norwegian School of Economics.

Venneslan, C. (2009). Electrification and industrialisation: An assessment of the industrial breakthrought in Norway. *Scandinavian Economic History Review, 57:2*, pp. 125-155. doi:10.1080/03585520902799638

Appendix – Figures

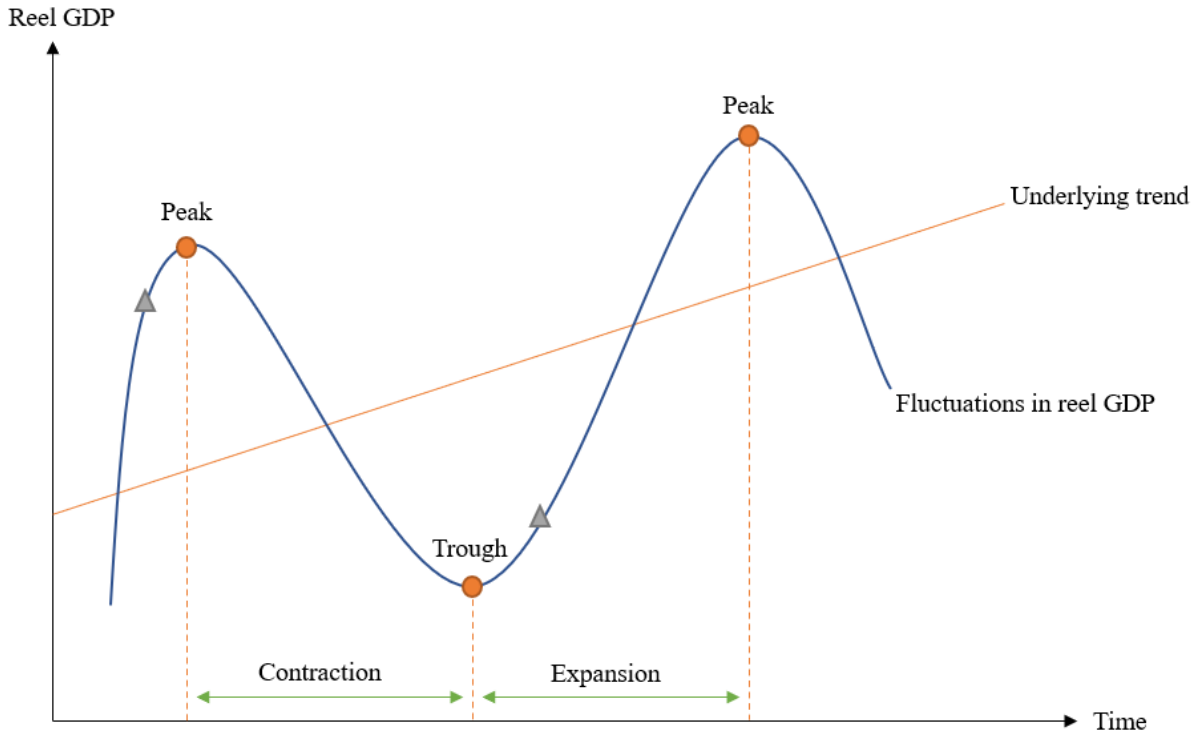

Figure 3.1: Classic business cycle

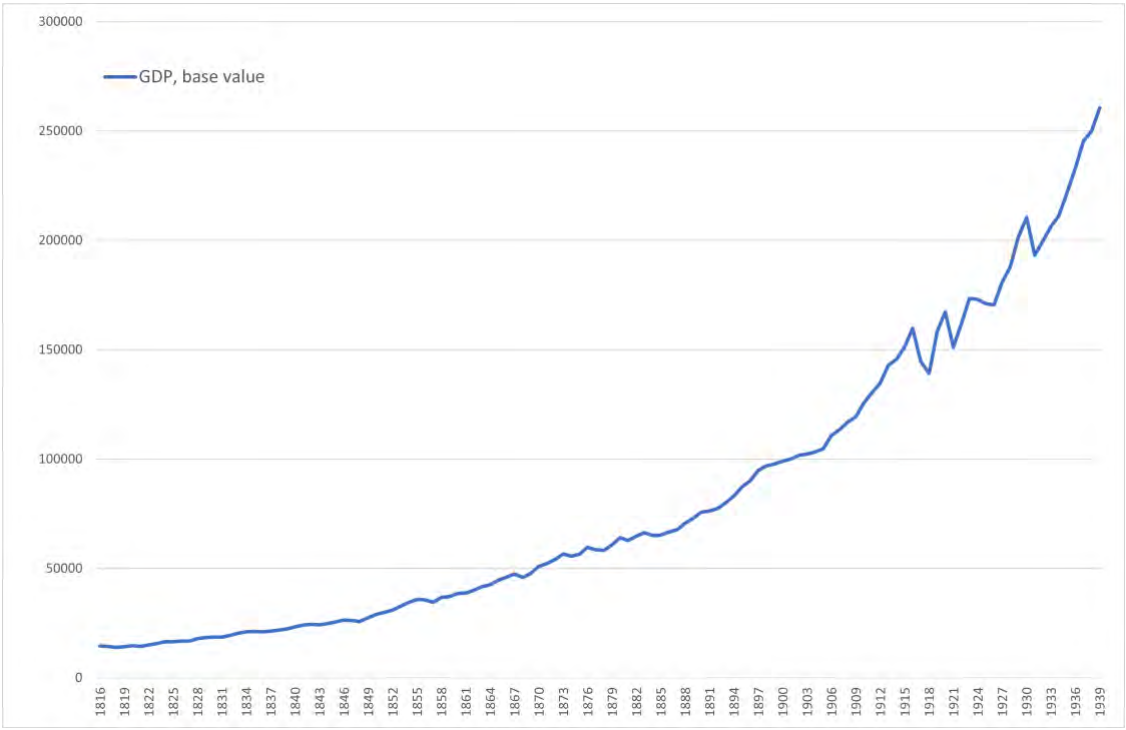

Figure 4.1: Real Manufacturing GDP 1816-1939 (Grytten, 2020)

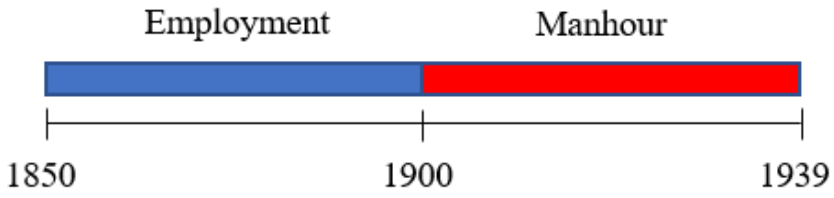

Figure 4.2: Labour statistics

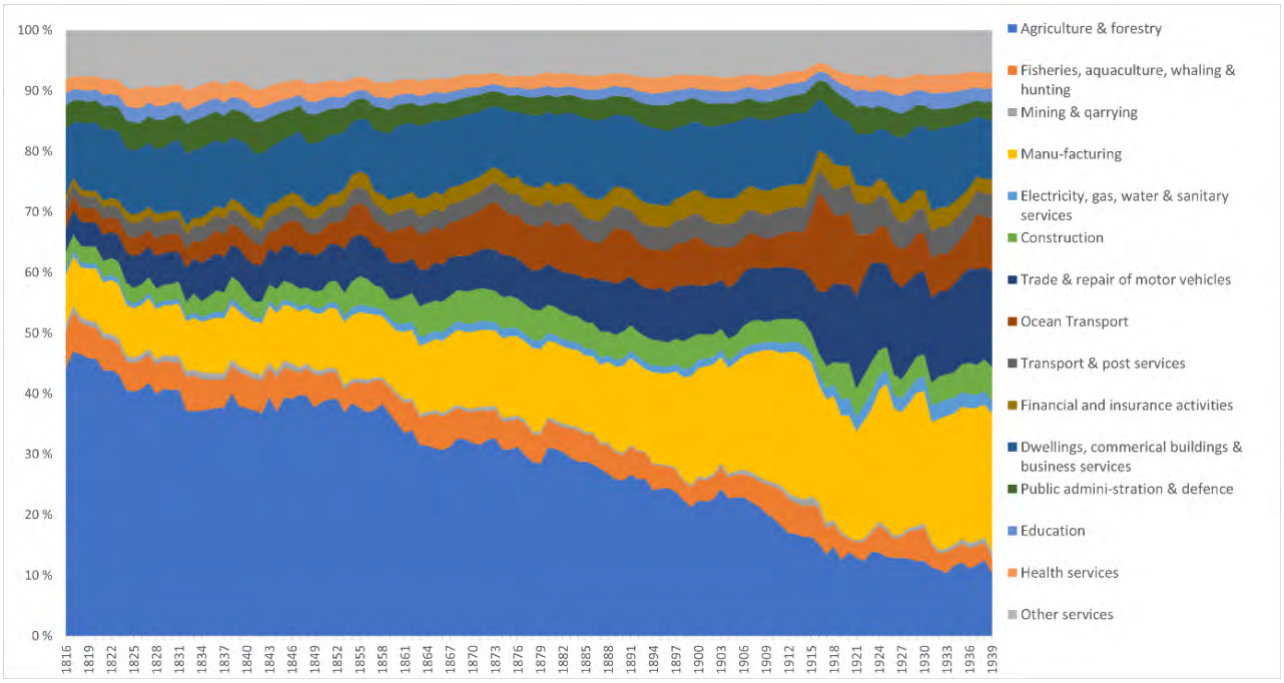

Figure 6.1: Industry share of Norwegian GDP in 2015 NOK prices (Grytten, 2020)

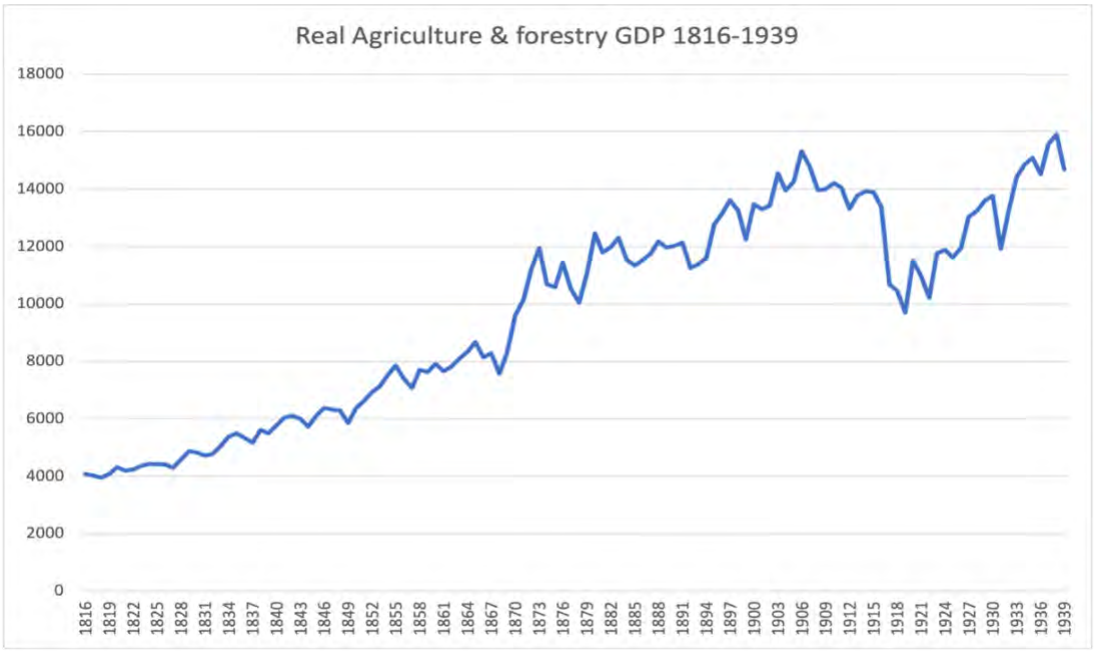

Figure 6.2: Agriculture & forestry GDP from 1816 – 1939 in million 2015-NOK (Grytten, 2020)

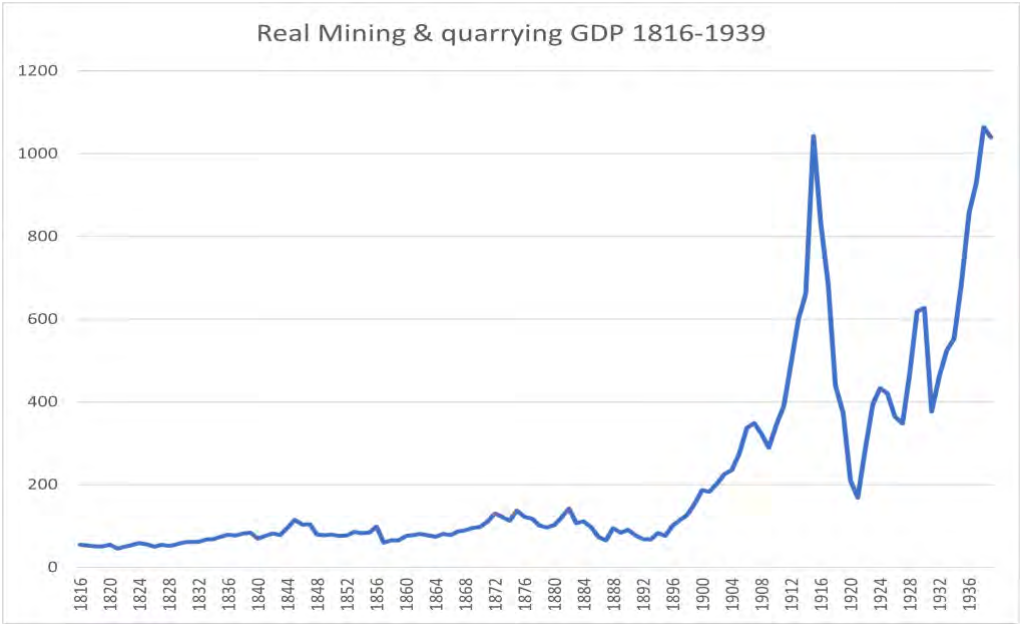

Figure 6.3: Mining and quarrying GDP from 1816 – 1939 in million 2015-NOK (Grytten, 2020)

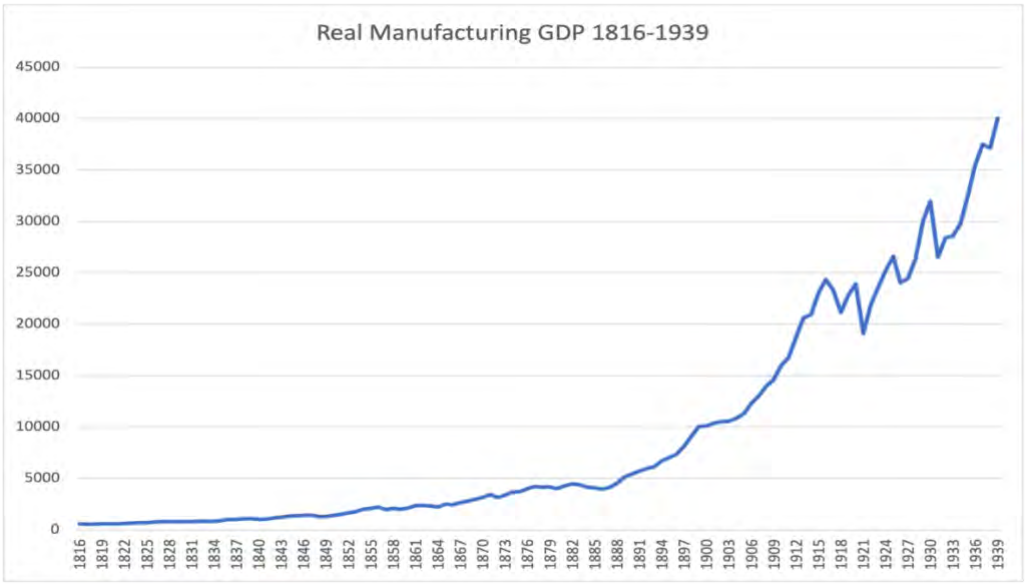

Figure 6.4: Manufacturing GDP from 1816 – 1939 in million 2015-NOK (Grytten, 2020)

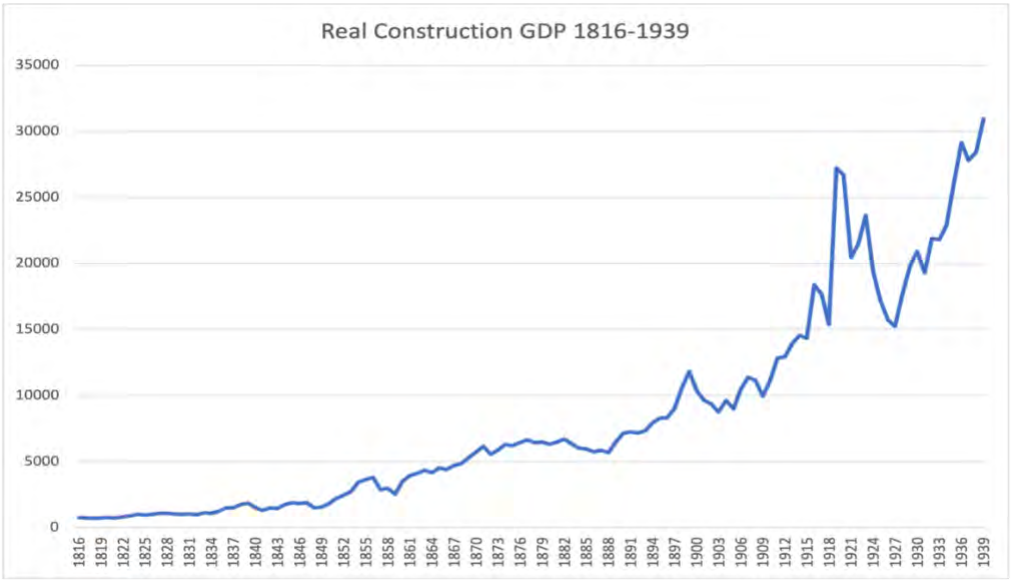

Figure 6.5: Construction GDP from 1816 – 1939 in million 2015-NOK (Grytten, 2020)

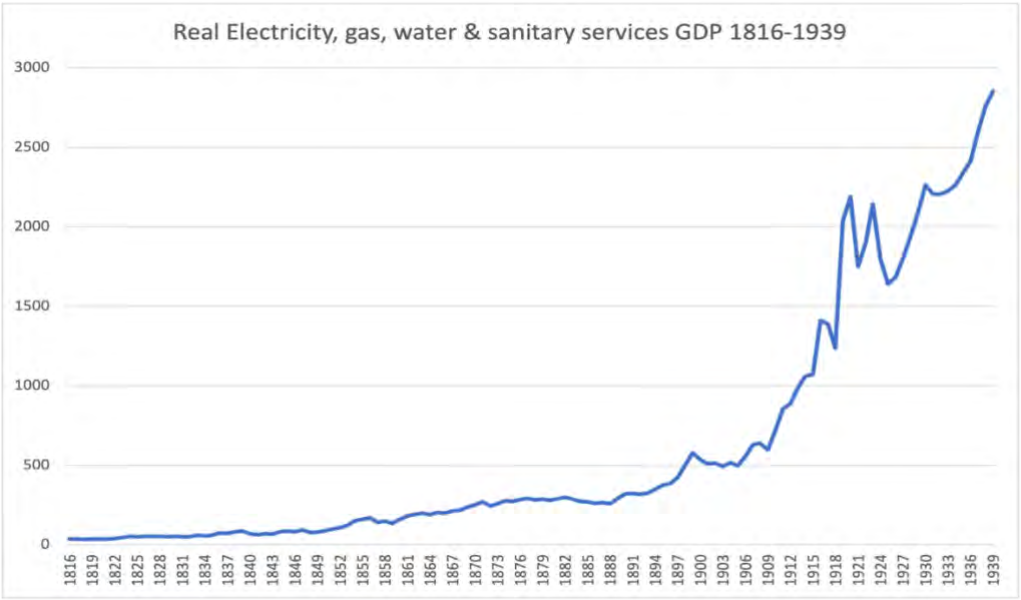

Figure 6.6: Electricity, gas, water & sanitary services GDP from 1816 – 1939 in million 2015-NOK (Grytten, 2020)

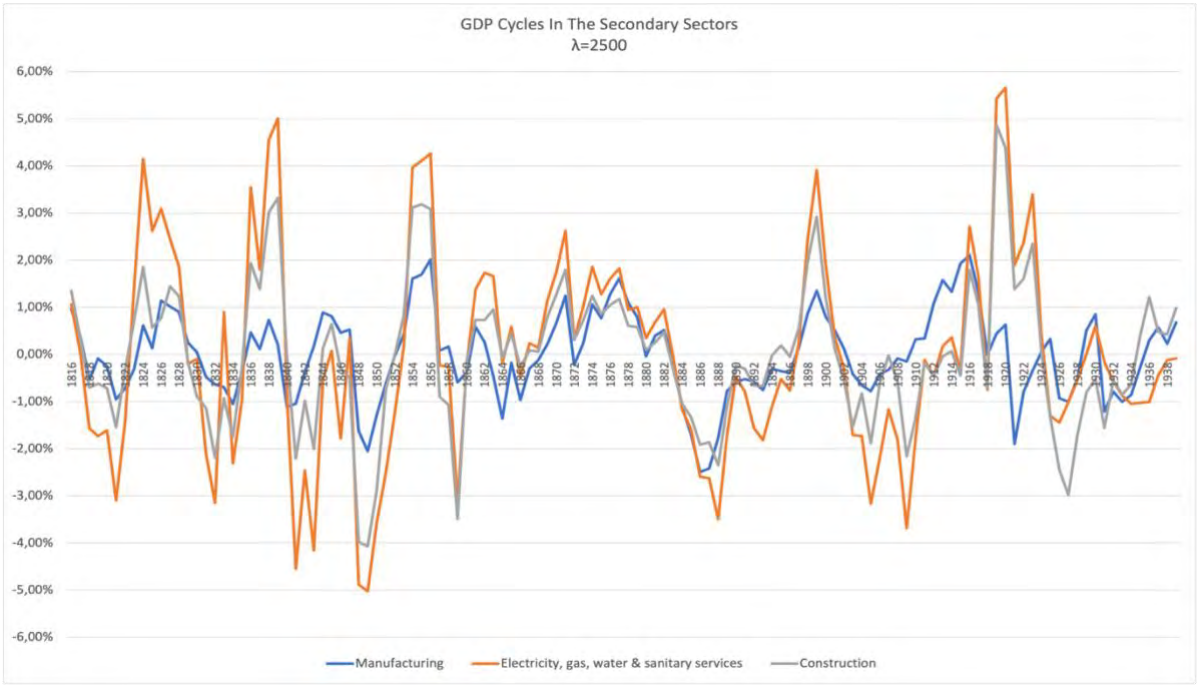

Figure 6.7: GDP Cycles in The Secondary sectors (Grytten, 2020)

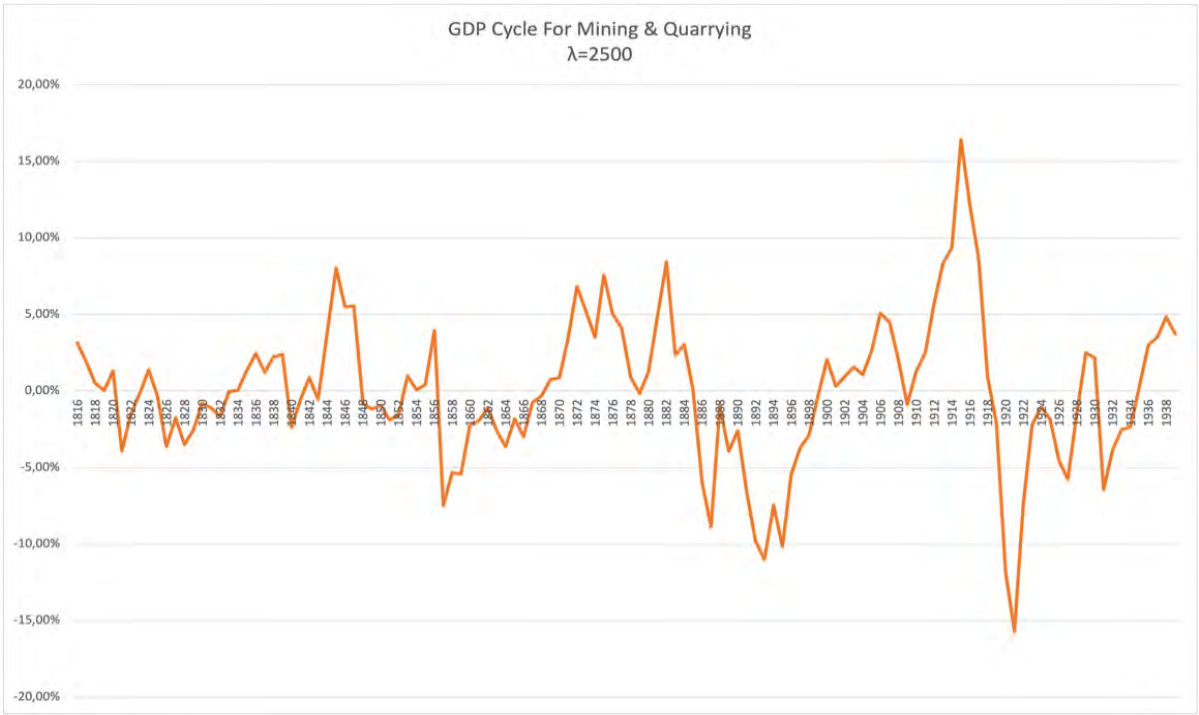

Figure 6.8: GDP Cycle for Mining & quarrying (Grytten, 2020)

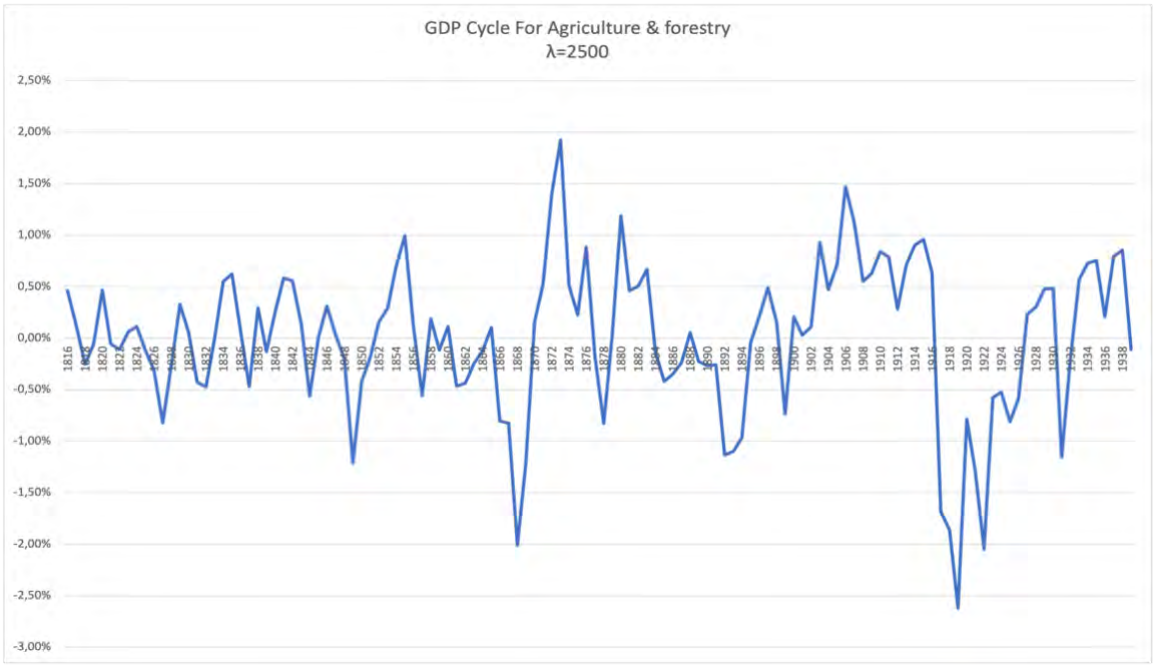

Figure 6.9: GDP cycles for Mining and quarrying, and Agriculture and forestry (Grytten, 2020)

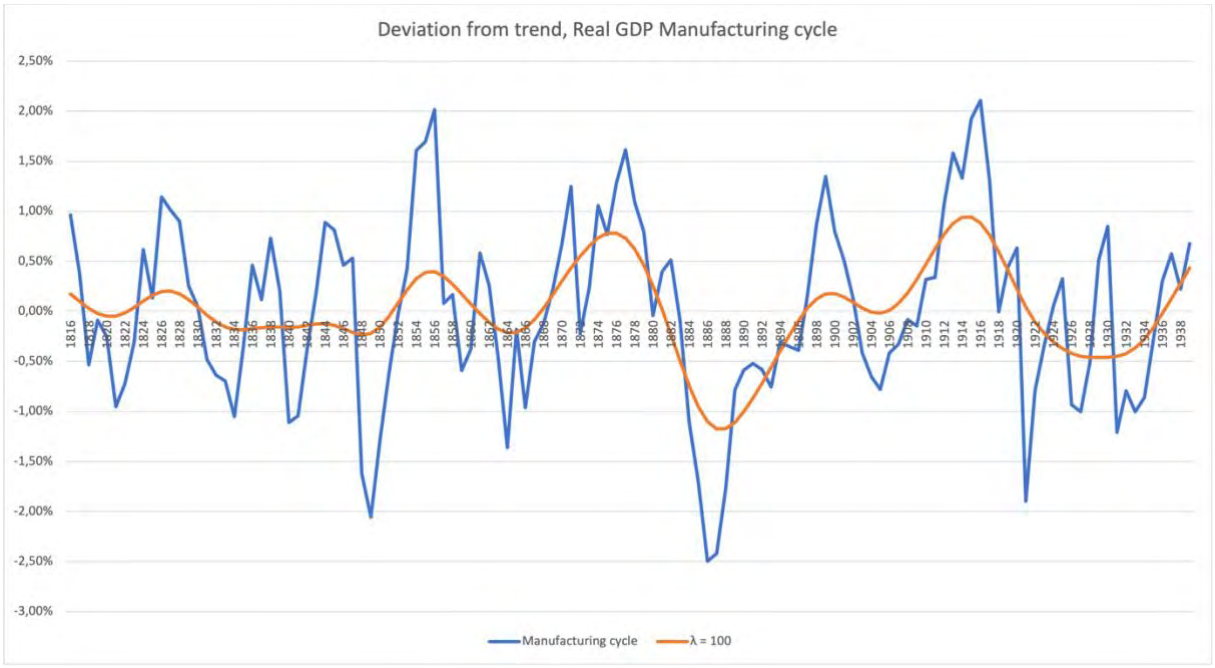

Figure 6.10: Deviation from trend, Real GDP manufacturing cycle (Grytten, 2020)

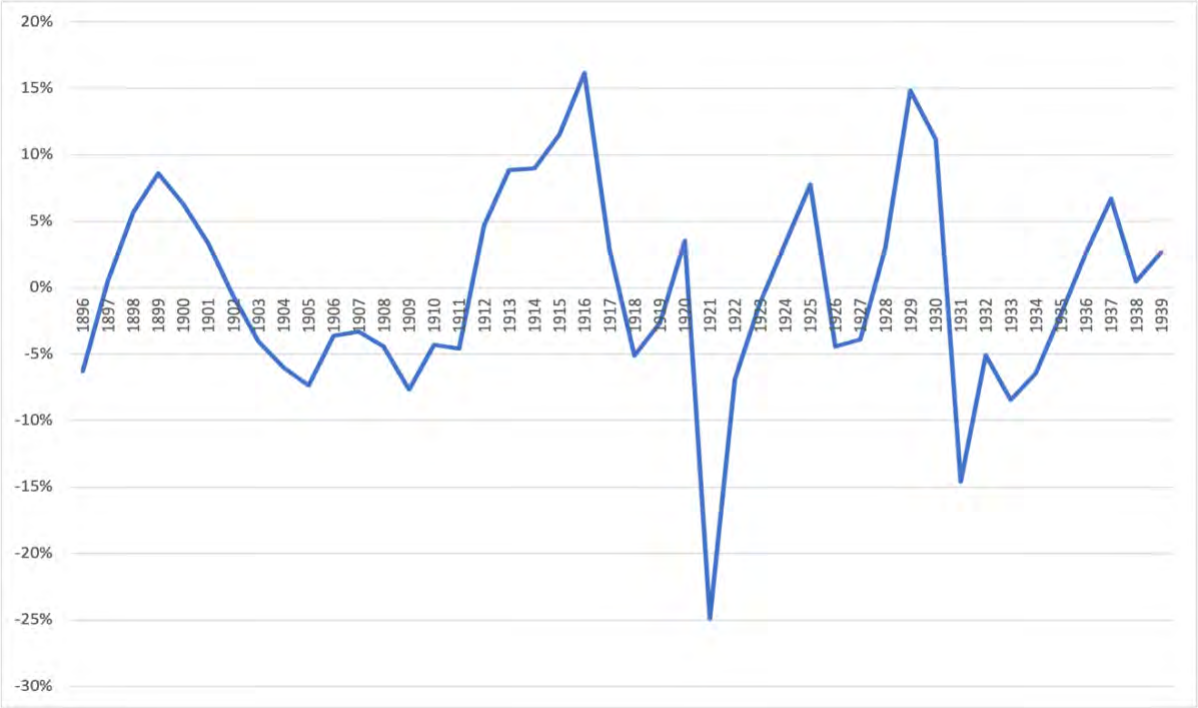

Figure 6.11: Production index deviation from trend (Klovland, 2015)

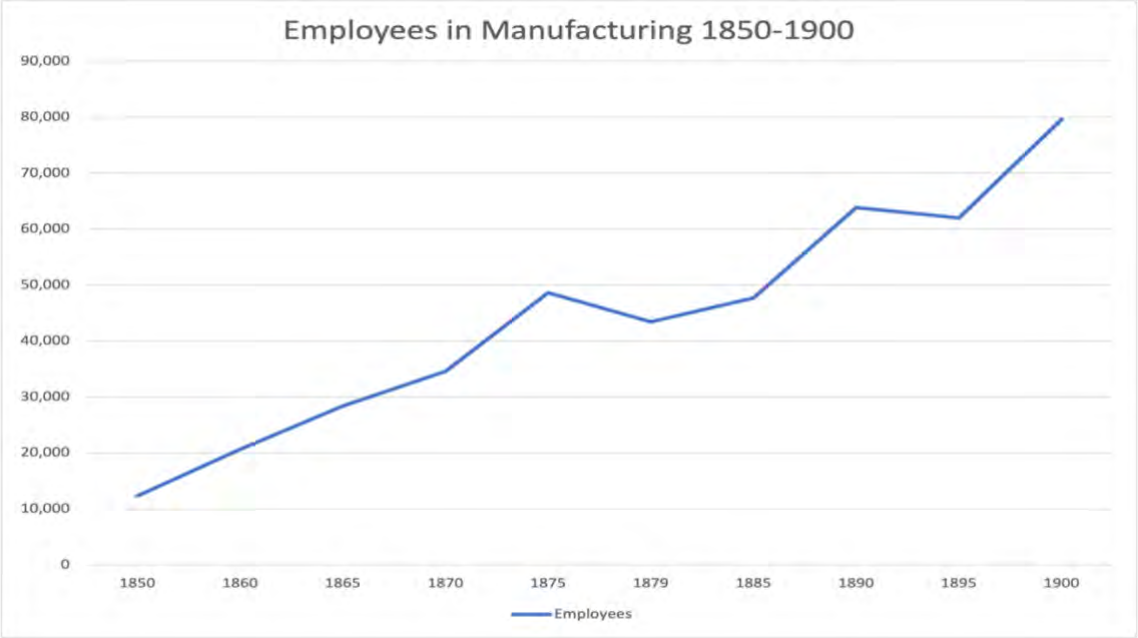

Figure 6.12: Employees in Manufacturing 1850-1900 (NOS, 1978)

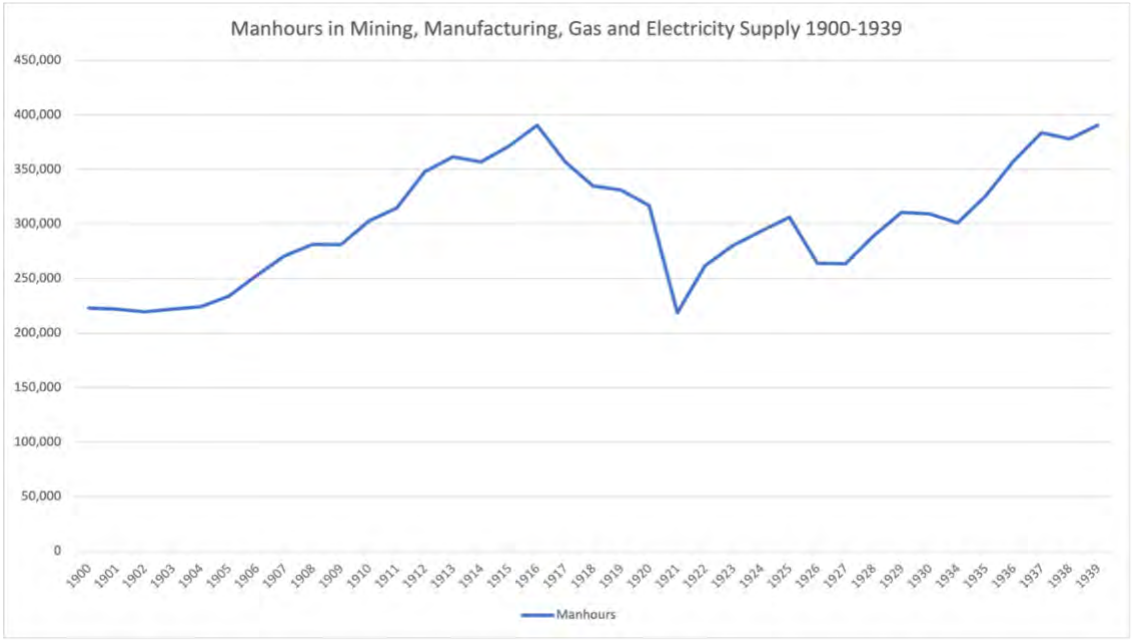

Figure 6.13: Manhours in Mining, Manufacturing, Gas and Electricity Supply 1900-1939 (NOS, 1978)

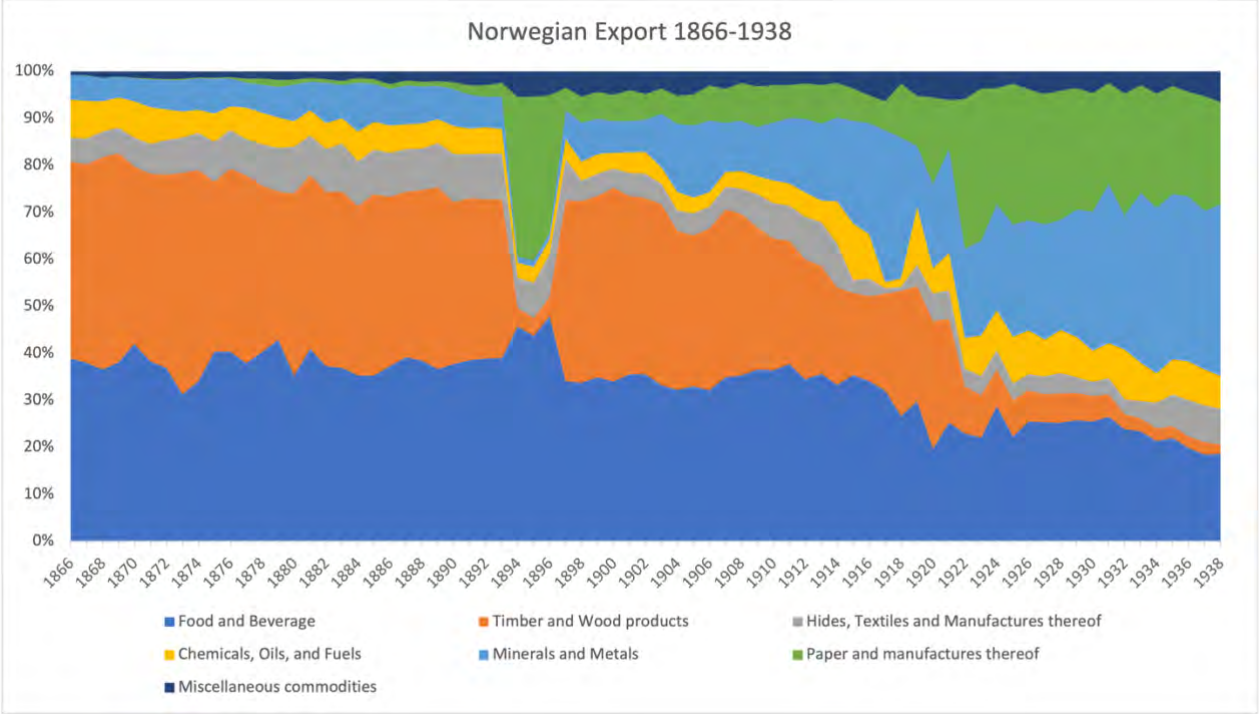

Figure 6.14: Norwegian Exports 1866-1938 (NOS, 1969)

Figure 7.1: Annual manufacturing GDP growth 1830-1875 (Grytten, 2020)

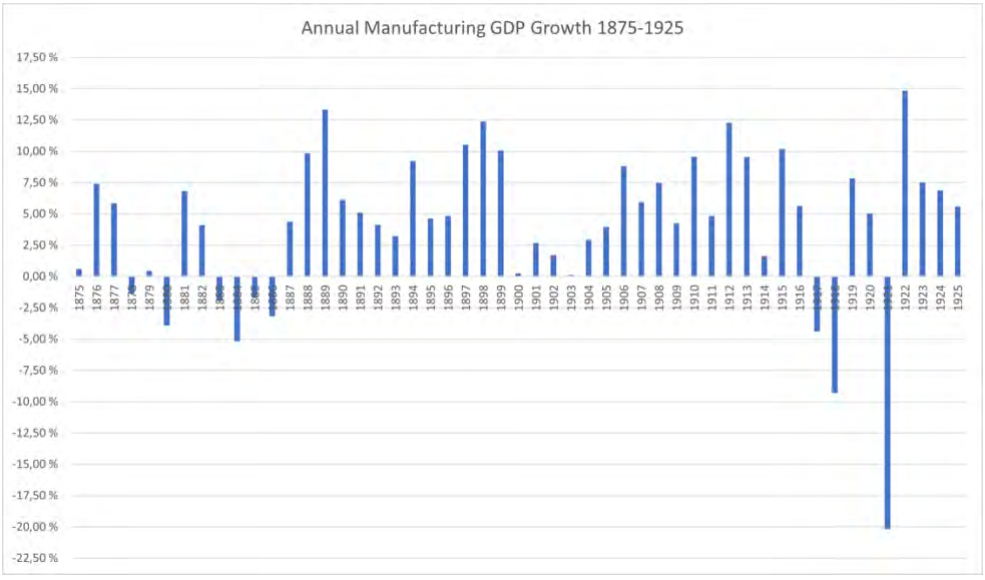

Figure 7.2: Annual manufacturing GDP growth 1875-1925 (Grytten, 2020)

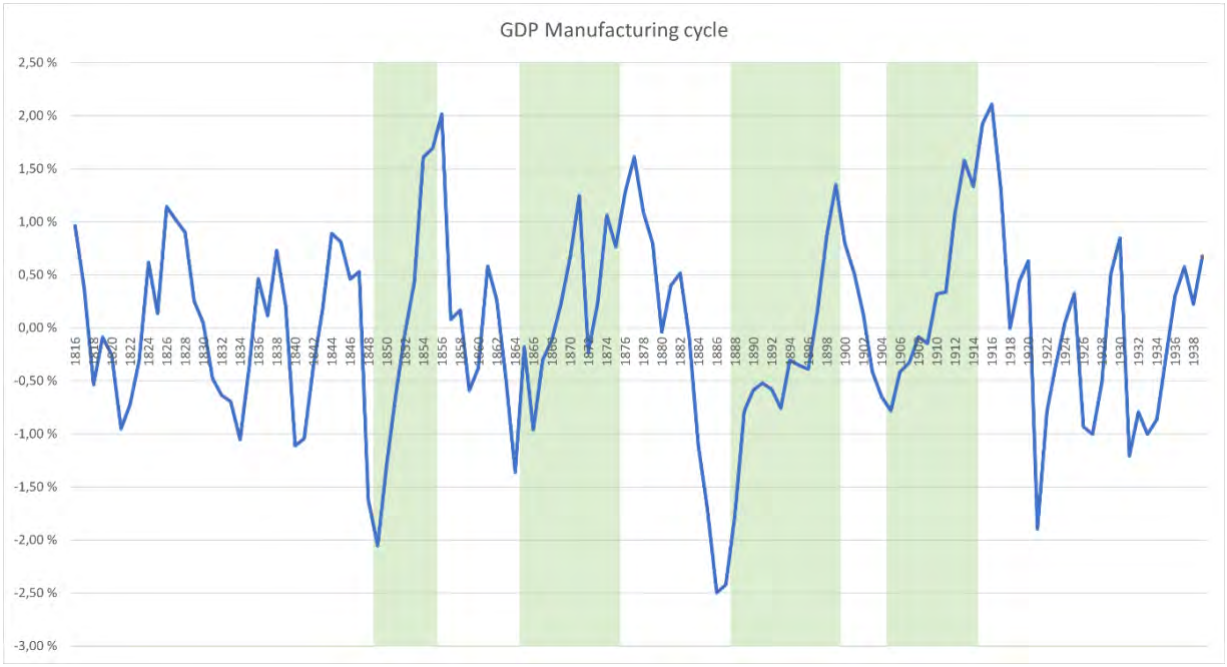

Figure 7.3: Manufacturing GDP cycle 1816-1839, Shaded areas indicate expansion. (Grytten, 2020)

Appendix – Tables

Table A: Norwegian GDP by industry in fixed 2015 million NOK.

	Agriculture & forestry	Fisheries, aquaculture, whaling & hunting	Mining & quarrying	Manu-facturing	Electricity, gas, water & sanitary services	Construction	Trade & repair of motor vehicles
1816	4077,622	221,257	54,604	555,428	35,406	768,163	325,057
1817	4019,621	217,064	52,905	551,414	35,275	740,946	324,105
1818	3953,020	210,451	50,991	536,150	34,385	712,980	318,897
1819	4074,661	214,114	50,835	567,967	35,297	738,795	325,665
1820	4317,285	221,283	54,409	578,954	36,600	756,191	343,801
1821	4192,551	217,077	44,957	570,164	35,775	737,579	336,770
1822	4233,880	224,635	50,327	595,976	39,270	825,029	362,238
1823	4357,869	242,986	54,136	630,518	45,131	912,667	366,263
1824	4441,076	251,333	58,647	689,758	51,687	1016,766	390,213
1825	4418,130	245,561	55,717	688,850	50,384	961,209	386,544
1826	4414,576	250,906	49,761	758,285	52,967	1004,607	411,792
1827	4291,356	254,128	54,800	774,956	53,315	1085,137	443,825
1828	4572,106	270,201	52,105	792,740	53,770	1103,749	470,190
1829	4876,484	269,295	55,229	782,691	51,100	1032,760	459,019
1830	4837,436	282,780	60,678	795,523	52,859	1011,996	454,305
1831	4717,681	310,591	61,205	791,538	50,254	1026,400	446,699
1832	4775,003	341,262	61,127	807,154	49,603	983,282	478,518
1833	5052,924	342,284	66,908	828,864	60,174	1109,454	528,259
1834	5377,790	350,010	68,587	834,343	54,422	1081,582	585,704

1835	5499,892	345,636	74,095	901,610	59,263	1241,519	568,588
1836	5332,687	337,405	79,153	985,197	73,633	1504,339	564,826
1837	5170,441	431,902	76,673	993,400	70,659	1496,950	546,460
1838	5609,621	315,056	81,457	1070,483	81,861	1743,028	532,629
1839	5494,934	350,993	83,547	1066,528	86,246	1846,940	585,622
1840	5772,855	403,406	69,037	1005,295	69,639	1499,662	638,797
1841	6032,875	381,354	75,716	1043,851	61,108	1322,797	665,178
1842	6113,253	403,949	81,633	1131,569	69,075	1499,943	670,435
1843	5990,778	332,953	77,590	1216,972	66,318	1443,170	681,622
1844	5725,164	474,156	95,128	1324,846	80,493	1756,589	725,745
1845	6112,573	420,178	115,028	1363,666	85,790	1898,662	745,802
1846	6375,708	514,377	103,623	1376,908	81,991	1840,112	729,999
1847	6321,216	509,718	104,346	1432,867	93,843	1890,244	745,013
1848	6293,137	416,903	79,016	1269,268	76,976	1511,915	727,207
1849	5853,935	480,109	77,981	1273,018	79,559	1566,443	773,399
1850	6378,143	406,913	78,938	1394,692	88,677	1792,692	873,210
1851	6616,314	463,311	75,716	1515,926	97,165	2211,239	857,604
1852	6936,486	410,265	77,005	1640,911	107,801	2453,763	852,298
1853	7138,395	434,361	86,047	1759,625	120,696	2746,980	1088,518
1854	7526,309	392,315	82,746	1991,635	151,565	3449,765	1175,499
1855	7859,599	518,027	83,977	2077,272	159,922	3639,912	1123,031
1856	7399,622	547,248	98,350	2204,395	168,757	3787,783	1072,338
1857	7083,026	481,403	59,487	1970,950	141,340	2882,973	1013,710
1858	7699,919	406,097	65,658	2052,838	147,288	2972,481	1181,643
1859	7625,113	493,050	65,599	2003,031	132,918	2552,344	1079,566
1860	7920,211	599,725	75,930	2104,021	160,508	3494,005	1066,638

1861	7655,014	544,414	77,590	2341,860	181,326	3925,460	1006,383
1862	7813,553	607,904	81,281	2361,168	192,202	4092,972	1066,013
1863	8095,598	590,459	76,673	2304,711	198,975	4343,446	1148,559
1864	8338,727	634,175	73,938	2219,923	187,491	4149,932	1126,465
1865	8671,688	688,114	81,125	2514,424	202,187	4500,202	1349,790
1866	8139,757	822,522	77,883	2441,326	197,694	4399,938	1192,485
1867	8280,155	863,210	87,140	2655,405	212,021	4692,968	1230,415
1868	7576,654	852,378	89,874	2781,005	217,470	4839,997	1082,621
1869	8303,452	600,903	95,460	2948,588	236,312	5318,685	1269,445
1870	9601,623	672,222	97,042	3154,933	250,943	5712,166	1437,723
1871	10125,042	771,922	110,361	3408,593	269,916	6143,620	1563,505
1872	11185,547	725,424	129,910	3122,822	243,780	5548,769	1752,547
1873	11952,863	739,556	121,356	3341,296	258,889	5892,679	1815,971
1874	10683,341	771,521	113,271	3680,740	276,841	6301,499	1819,914
1875	10584,229	793,145	136,862	3702,655	273,194	6218,912	1856,579
1876	11434,182	721,438	122,039	3976,853	283,223	6446,190	1987,289
1877	10522,147	881,211	117,372	4209,272	291,385	6632,315	1885,704
1878	10053,396	760,727	101,123	4152,317	281,747	6414,296	1907,716
1879	11036,221	837,340	96,319	4170,834	286,892	6493,984	2102,080
1880	12461,233	837,366	102,373	4007,821	280,531	6314,032	2084,947
1881	11791,406	700,758	120,301	4281,462	289,779	6485,754	1919,067
1882	11981,293	667,278	141,627	4457,132	298,505	6699,470	2120,084
1883	12304,317	664,237	107,177	4370,117	286,349	6338,350	2362,645
1884	11534,215	783,634	110,517	4143,616	272,695	6019,693	2313,726
1885	11342,002	708,108	96,827	4072,745	270,394	5951,884	2449,922
1886	11522,545	858,797	73,606	3942,955	259,865	5735,642	2644,040

1887	11749,791	704,407	65,053	4115,373	264,337	5850,403	3022,633
1888	12183,641	923,710	94,405	4520,415	256,739	5698,604	3157,088
1889	11968,043	926,518	83,801	5122,426	290,539	6466,019	3242,344
1890	12022,250	863,468	90,949	5435,736	320,669	7136,630	3152,882
1891	12128,930	830,610	77,376	5713,597	323,448	7238,671	2955,643
1892	11253,749	955,403	68,529	5949,971	318,412	7166,653	2879,619
1893	11379,822	973,379	67,103	6141,725	323,622	7325,093	3122,213
1894	11610,973	916,890	82,570	6708,491	348,976	7943,608	3553,553
1895	12764,535	823,053	75,813	7019,604	374,548	8298,461	3924,738
1896	13156,616	731,648	100,147	7359,136	383,231	8324,369	3879,070
1897	13607,182	892,974	115,165	8133,653	424,151	9031,644	4288,103
1898	13259,326	755,629	127,430	9140,911	504,948	10539,349	4466,549
1899	12252,699	738,391	154,986	10061,213	576,975	11802,942	4387,469
1900	13464,635	724,544	186,604	10085,237	533,689	10364,168	4038,527
1901	13293,153	755,318	183,186	10354,806	508,378	9653,432	4232,744
1902	13434,888	790,208	202,891	10530,564	512,372	9348,430	4317,031
1903	14554,777	674,267	225,213	10542,517	491,988	8765,831	4254,312
1904	13949,533	639,092	235,212	10852,722	516,496	9636,410	4352,726
1905	14272,995	643,505	274,174	11280,529	496,091	9001,995	4531,912
1906	15319,043	711,046	336,668	12274,573	557,372	10447,596	4868,633
1907	14785,489	856,674	348,346	13004,528	629,204	11392,251	4834,119
1908	13962,256	949,437	322,275	13976,599	638,451	11161,980	5000,295
1909	13998,189	1174,849	289,348	14570,934	597,597	9947,865	5253,189
1910	14211,812	1208,755	345,456	15966,916	719,140	11113,250	5538,263
1911	14056,278	1396,559	390,237	16739,410	854,358	12822,607	5693,366
1912	13312,348	1644,811	493,723	18793,186	887,376	12930,915	5729,768

1913	13770,811	1759,122	600,256	20588,730	984,888	13931,407	6052,247
1914	13919,874	1743,372	661,305	20924,366	1060,844	14560,865	6208,106
1915	13893,659	1661,894	1042,461	23054,286	1072,023	14329,565	6361,600
1916	13387,022	1651,165	830,567	24355,811	1411,926	18374,649	7265,150
1917	10692,840	1272,892	686,850	23288,258	1387,700	17646,798	7022,708
1918	10461,228	1579,303	440,174	21123,210	1236,765	15365,504	6640,652
1919	9704,618	1724,672	372,914	22777,070	2039,914	27218,297	7978,613
1920	11511,028	1085,696	209,863	23922,350	2188,613	26710,242	8448,483
1921	10967,470	1166,450	167,953	19096,506	1748,854	20464,019	7830,995
1922	10221,938	1583,741	282,317	21927,991	1899,030	21451,791	8904,766
1923	11770,170	1530,527	394,319	23570,894	2143,287	23629,266	10020,494
1924	11879,680	2145,872	432,674	25191,560	1797,762	19339,226	9020,848
1925	11627,711	1790,465	420,273	26598,029	1639,056	17200,378	8264,047
1926	11955,868	1305,750	364,829	24016,044	1684,013	15739,812	9107,568
1927	13027,495	1823,323	347,233	24457,709	1803,927	15247,282	9603,145
1928	13241,447	2025,518	469,800	26371,733	1936,150	17686,548	9754,750
1929	13602,795	2369,976	618,302	30062,171	2089,799	19810,337	10015,932
1930	13765,195	2445,165	627,168	31938,489	2262,594	20896,128	10308,965
1931	11928,205	1933,091	377,191	26520,742	2205,545	19281,798	9849,861
1932	13226,354	1577,607	463,199	28409,863	2205,545	21882,590	9877,684
1933	14426,511	2309,540	523,916	28538,891	2224,562	21792,989	10016,810
1934	14842,899	1826,843	552,409	29735,325	2262,594	22869,146	10350,706
1935	15087,826	1838,271	684,272	32473,409	2338,637	26097,713	10990,662
1936	14524,482	2097,252	857,439	35434,185	2414,701	29146,982	11714,100
1937	15577,703	2032,209	929,601	37485,177	2604,819	27801,738	12507,101
1938	15896,120	2115,783	1064,393	37131,669	2756,926	28429,513	12618,404

1939	14695,942	2127,379	1039,180	40040,120	2852,007	30940,610	13578,339

	Ocean Transport	**Transport & post services**	**Financial and insurance activities**	**Dwellings, commercial buildings & business services**	**Public admini-stration & defence**	**Education**	**Health services**
1816	96,883	181,705	335,373	1350,787	847,521	474,459	927,690
1817	90,184	179,330	330,507	1338,104	799,972	469,022	920,449
1818	86,717	174,316	328,534	1312,868	744,770	460,414	903,484
1819	87,978	177,958	339,713	1333,614	762,830	473,402	926,035
1820	93,652	177,114	365,360	1352,966	802,013	493,564	953,861
1821	91,051	171,572	324,194	1360,114	797,013	494,471	940,413
1822	99,116	204,293	396,530	1462,670	871,908	540,912	1037,444
1823	108,205	228,833	450,452	1527,437	961,395	596,340	1115,545
1824	115,745	251,263	495,169	1568,015	1034,351	641,724	1215,265
1825	136,971	262,662	527,260	1518,066	1197,917	665,965	1328,433
1826	132,452	267,517	535,151	1581,482	1208,937	696,473	1372,708
1827	137,181	277,070	602,488	1733,681	1250,058	739,441	1398,983
1828	153,127	298,708	634,579	1744,403	1339,034	760,283	1473,876
1829	149,265	304,249	559,219	1805,161	1311,382	775,159	1488,772
1830	143,275	298,655	555,142	1838,024	1375,978	792,829	1507,806
1831	138,652	296,280	533,046	1896,994	1355,728	798,946	1535,736
1832	150,762	292,955	576,974	1999,812	1404,032	809,518	1643,111
1833	164,160	326,045	631,686	2082,187	1425,256	821,072	1636,594
1834	163,372	341,878	708,756	2071,552	1431,072	832,173	1598,941
1835	173,591	329,845	697,182	2094,260	1406,073	841,914	1542,874
1836	179,554	334,859	702,048	2141,027	1386,686	848,484	1503,151

1837	186,699	331,956	759,785	2157,153	1405,359	859,585	1509,047
1838	183,889	334,859	761,363	2122,373	1455,867	870,761	1491,876
1839	205,509	346,786	809,499	2387,936	1548,109	886,921	1557,046
1840	223,346	381,354	879,204	2324,476	1591,577	901,118	1646,111
1841	213,994	379,506	982,184	2380,570	1568,822	903,836	1661,835
1842	216,962	365,310	1022,297	2184,656	1506,375	910,633	1633,181
1843	203,748	381,881	1042,682	2457,106	1462,295	905,951	1573,597
1844	266,901	418,349	1169,598	2430,998	1471,989	912,671	1681,282
1845	273,626	414,496	1208,396	2411,298	1451,581	916,900	1707,040
1846	293,617	395,603	1140,006	2748,864	1458,928	925,282	1682,731
1847	327,952	383,834	1165,916	2649,533	1557,088	929,209	1626,871
1848	289,756	418,560	1246,668	2571,560	1565,353	929,285	1782,658
1849	335,597	449,697	1270,210	2691,419	1546,986	940,234	1827,346
1850	371,481	471,388	1316,636	2758,147	1614,739	945,143	1837,277
1851	408,915	481,732	1326,369	2792,972	1560,353	954,658	1840,173
1852	410,544	487,379	1341,888	2840,741	1596,474	987,809	1839,966
1853	502,383	523,583	1627,284	2839,608	1602,597	989,470	1890,861
1854	586,237	585,805	1834,426	2906,598	1627,392	998,985	1889,413
1855	719,477	580,316	1864,150	2938,371	1637,391	1006,234	1905,033
1856	842,971	575,936	1952,004	3081,897	1632,595	1011,973	1885,482
1857	695,729	621,745	1614,132	3422,296	1797,998	1109,916	2054,510
1858	654,591	674,836	1999,877	3570,964	1925,136	1178,408	2249,916
1859	769,495	680,061	2091,941	4052,622	1873,301	1199,854	2332,051
1860	803,750	692,886	1989,093	4132,470	1853,098	1215,788	2317,362
1861	886,553	701,594	2077,473	4322,457	1889,729	1255,962	2466,529
1862	907,280	711,251	2297,242	4487,209	1861,159	1285,261	2569,663

1863	1058,410	744,711	2572,511	4671,791	1904,321	1322,641	2605,558
1864	1207,780	805,666	2635,245	4906,497	1928,299	1341,671	2675,901
1865	1230,897	860,077	2743,749	4927,679	1920,442	1363,646	2737,243
1866	1248,445	799,122	2689,168	4587,323	1872,383	1397,476	2563,457
1867	1346,327	799,861	2766,633	4662,159	1869,832	1337,895	2553,629
1868	1325,048	771,310	2846,333	4935,699	1830,956	1191,698	2602,869
1869	1438,350	895,120	2939,843	5105,070	1896,566	1177,426	2820,930
1870	1534,865	976,130	3012,310	5329,707	1968,196	1192,756	2714,278
1871	1516,187	989,535	3150,011	5332,714	2090,232	1246,673	2897,479
1872	1828,193	1116,882	2692,325	5389,026	1857,996	1104,554	2659,039
1873	1818,894	1292,570	2595,527	5583,154	1816,058	1130,305	2598,214
1874	1816,766	1339,593	2608,021	5919,848	1902,892	1138,989	2616,317
1875	1760,102	1307,717	2855,277	6052,957	2047,683	1247,655	2788,655
1876	1855,277	1351,098	3105,689	6610,148	2151,761	1294,776	2895,306
1877	1860,400	1383,713	3304,019	6313,900	2293,491	1353,451	3104,988
1878	1928,491	1368,936	3534,572	6679,840	2204,412	1427,153	3172,124
1879	1942,467	1260,430	3807,737	6692,306	2589,501	1638,368	3656,554
1880	2136,390	1530,059	3922,290	6792,638	2388,385	1577,277	3613,211
1881	1894,708	1593,072	4147,582	6869,610	2443,383	1591,398	3617,348
1882	2158,667	1720,419	4154,026	6929,800	2426,955	1534,611	3742,309
1883	2299,421	1709,758	4277,654	7172,351	2461,648	1537,405	3612,693
1884	2144,245	1678,304	4516,361	7450,075	2635,213	1724,833	3664,829
1885	2033,176	1653,078	4849,893	7731,198	2749,291	1798,762	3830,961
1886	1981,267	1610,699	4911,181	7950,954	2877,245	1861,892	3917,027
1887	2005,147	1591,278	4830,297	8051,374	2976,630	1946,620	3974,335
1888	2389,237	1738,785	4900,922	8136,931	3027,138	2013,148	3996,058

1889	2990,684	1972,420	4735,209	8243,061	2990,405	1958,098	4021,713
1890	2920,123	2149,639	4665,109	8406,722	3082,442	1969,349	4364,217
1891	2655,744	2132,593	4874,224	8475,935	3005,710	1941,107	4010,851
1892	2660,762	2263,423	5127,267	8892,608	3221,111	2176,789	4523,211
1893	2493,765	2566,141	5469,873	9238,063	3447,429	2392,157	4837,993
1894	2454,071	2632,638	5697,927	9488,590	3674,360	2425,836	5244,426
1895	2338,431	2703,199	6083,804	9660,620	4116,385	2696,708	5392,351
1896	2634,255	2834,556	6115,763	10033,185	4748,608	3071,110	5526,312
1897	2860,543	2867,488	6426,411	10189,176	4865,645	2926,726	5704,236
1898	2897,190	3237,125	6934,600	10217,201	4864,318	3001,108	5656,859
1899	3268,067	3478,783	6786,773	10285,673	4771,464	2718,607	4888,991
1900	3387,752	3570,084	7106,364	10635,268	4538,717	2871,826	5634,722
1901	3455,291	3618,954	7919,809	10857,072	4599,838	3447,626	5834,990
1902	3330,536	3750,575	7815,514	10993,450	4594,532	3522,462	5903,677
1903	3026,831	3794,906	8158,647	11210,024	4407,396	3461,672	5809,646
1904	3665,134	3671,623	8247,948	11332,629	4216,280	3452,837	5842,645
1905	3421,640	3859,134	8142,865	11642,562	4206,586	3396,276	5769,303
1906	3332,664	4116,993	8026,997	11864,409	4144,752	3388,196	5712,926
1907	3604,924	4250,462	8230,325	12352,474	4131,283	3489,764	5620,343
1908	3748,882	4471,959	8646,056	13119,919	4146,282	3844,608	6776,541
1909	3432,437	4523,046	9385,719	13555,377	4455,149	4138,662	6150,909
1910	3548,785	4939,284	9660,988	14295,887	4509,025	4427,053	6172,426
1911	3832,447	5153,973	10010,829	14906,077	4597,797	4341,495	6547,412
1912	4041,948	5075,444	10515,861	15777,778	5042,985	4600,963	6717,268
1913	4117,395	5739,303	10888,323	16213,628	5166,144	4688,712	6914,950
1914	4194,392	5676,976	11133,080	17172,498	5595,925	4857,940	6855,883

1915	5497,478	5281,003	10479,957	18044,199	6876,798	4995,604	6594,893
1916	6463,655	5264,854	10118,806	18828,729	7042,507	5205,988	6411,589
1917	5304,264	4453,646	9432,803	18785,144	7121,586	5051,107	5274,735
1918	4627,975	4730,558	10214,288	19177,409	7172,910	4832,945	5538,001
1919	5314,535	6326,849	9565,374	19613,260	7684,627	5404,818	7369,588
1920	6855,731	6542,911	8980,378	20049,110	7939,717	5976,540	8663,058
1921	5795,562	8063,048	7748,702	20484,960	7965,467	5970,952	8289,002
1922	6556,361	7678,528	8636,982	20702,885	8747,601	6470,558	8294,278
1923	4774,718	8158,729	8908,568	21051,565	9119,780	6875,468	9175,935
1924	6122,358	7760,910	9085,067	21400,245	7786,460	6884,983	9365,549
1925	6651,799	7514,766	9156,876	21574,585	8055,736	6977,035	9991,801
1926	6566,291	8115,507	10588,460	21662,366	8931,318	7647,758	10437,543
1927	7119,322	8563,251	12639,498	21797,784	9513,848	8591,390	11806,320
1928	7378,001	8432,369	14202,075	21841,239	9051,824	8650,518	11697,600
1929	8930,230	8735,246	14637,666	21923,309	9220,287	8518,216	12320,956
1930	10166,092	9671,161	15120,472	22054,805	9358,956	8521,614	13028,826
1931	9463,454	9299,201	15814,103	22184,166	10112,092	8509,381	13200,337
1932	9595,197	9216,556	15952,724	22433,908	10319,636	8540,191	13482,430
1933	9880,645	9340,524	15952,724	26984,097	10185,355	8768,623	13693,043
1934	10275,874	9629,838	16230,229	23286,213	10347,798	8812,724	14295,193
1935	10517,398	9919,152	16507,602	23819,345	10839,618	8950,387	14625,802
1936	11154,151	10745,770	16923,860	23906,471	11172,667	9225,336	14945,031
1937	12164,172	11820,326	17339,986	24557,544	12078,145	9655,771	15462,253
1938	12537,440	12068,316	18033,617	25017,846	13549,318	9962,134	15699,451
1939	12757,002	12853,559	18727,116	25531,582	17305,541	10354,735	16397,081

	Other services	GDP, base value
1816	4396,435	14606,494
1817	4308,543	14303,632
1818	4175,974	13905,520
1819	4313,290	14142,823
1820	4528,638	14745,436
1821	4151,854	14399,962
1822	4333,458	15060,485
1823	4468,417	15593,346
1824	4647,179	16423,797
1825	4527,266	16461,482
1826	4698,140	16756,522
1827	4871,674	16869,534
1828	5226,845	17888,280
1829	5521,684	18492,276
1830	5706,845	18602,262
1831	5748,128	18674,175
1832	6173,852	19337,421
1833	6527,533	20343,980
1834	6369,396	21061,160
1835	5880,059	21227,458
1836	5743,625	21095,950
1837	6270,702	21388,397
1838	5762,328	21796,751
1839	6056,887	22412,286

1840	6489,171	23270,741
1841	6949,830	24156,856
1842	7405,751	24509,287
1843	7321,048	24235,899
1844	7507,633	24808,001
1845	7475,117	25551,371
1846	6831,658	26450,796
1847	6346,948	26292,190
1848	7501,405	25795,674
1849	8053,487	27506,924
1850	8170,135	29010,993
1851	7879,807	29939,676
1852	8025,278	30874,279
1853	8686,324	32745,171
1854	8955,555	34560,789
1855	8488,333	35903,920
1856	8467,602	35666,358
1857	9768,160	34559,666
1858	10566,819	36765,012
1859	10554,439	37128,291
1860	10057,096	38530,628
1861	10115,211	38701,420
1862	10494,947	40066,807
1863	11017,983	41673,473
1864	11312,319	42408,112
1865	11562,950	44628,541

1866	11004,248	46032,002
1867	10553,263	47532,181
1868	9887,113	45846,300
1869	10958,638	47757,124
1870	12125,960	50977,672
1871	12341,972	52208,612
1872	12839,223	54193,078
1873	12907,412	56648,043
1874	13092,036	55586,599
1875	13889,361	56430,188
1876	15301,460	59721,827
1877	15135,441	58648,066
1878	15607,543	58265,426
1879	15415,944	60882,151
1880	14857,532	64038,782
1881	14677,849	62741,029
1882	15797,775	64765,081
1883	16811,011	66365,912
1884	17154,586	65119,760
1885	17669,429	65235,451
1886	18333,394	66654,340
1887	18453,843	67696,855
1888	18768,867	70656,418
1889	18710,671	73011,510
1890	18704,418	75749,846
1891	18328,657	76304,964

1892	19107,820	77459,843
1893	20649,403	80005,174
1894	23092,682	83068,068
1895	23765,267	87370,977
1896	24756,739	90098,121
1897	25037,523	94768,069
1898	24759,229	96958,851
1899	25723,957	97727,157
1900	25715,597	98962,677
1901	26893,887	99953,981
1902	27077,059	101768,864
1903	28010,947	102322,815
1904	27832,872	103327,905
1905	27789,539	104709,498
1906	28041,745	110674,909
1907	27421,425	113444,837
1908	29943,295	116841,493
1909	31358,840	119344,688
1910	32760,630	125754,279
1911	32821,539	130374,053
1912	31846,322	134625,405
1913	34702,701	142849,404
1914	33603,541	145632,254
1915	29449,092	151268,311
1916	30639,129	159727,884
1917	24811,770	144718,352

1918	25892,518	139198,245
1919	33480,867	158272,174
1920	35882,935	167296,589
1921	30834,733	151257,852
1922	31263,424	161864,083
1923	38315,624	173435,256
1924	34898,989	173016,313
1925	34474,786	170966,634
1926	36059,145	170484,596
1927	38359,423	180732,820
1928	39430,927	187784,740
1929	41014,751	201352,176
1930	42902,795	210560,564
1931	41569,958	193353,465
1932	41345,479	199555,185
1933	42098,771	206266,299
1934	43344,479	211304,064
1935	44315,310	221769,149
1936	46100,787	233044,460
1937	48813,271	245425,340
1938	49929,453	249955,136
1939	50858,408	260542,957

Source: (Grytten, 2020)

Table B: Norwegian exports by product group 1866-1938

	Food and Beverage	Timber and Wood products	Hides, Textiles and Manufactures thereof	Chemicals, Oils, and Fuels	Minerals and Metals	Paper and manufactures thereof	Miscellaneous commodities	Total
1866	26755	28845	3483	5601	3581	30	505	68800
1867	26358	29290	3820	5553	3682	42	609	69354
1868	24964	30883	3717	4390	3389	22	944	68309
1869	29660	34563	4262	5021	3389	53	858	77806
1870	33786	30414	4980	6193	3904	86	1120	80483
1871	30924	32224	5119	6296	4770	217	1170	80720
1872	38627	43109	7657	6894	6488	190	1755	104720
1873	37894	56931	9103	6649	8143	376	1837	120933
1874	41196	54583	9553	5991	8131	144	1602	121200
1875	41747	37421	8865	6148	7730	169	1410	103490
1876	47657	46005	9751	5891	7117	332	1387	118140
1877	41378	43620	8370	7333	5846	850	1713	109110
1878	36881	32477	8044	6138	5518	1184	1388	91630
1879	38282	28116	8305	5750	5876	1294	1599	89222
1880	38226	42180	10901	5913	8465	1201	1853	108739
1881	49598	44649	10269	6431	7388	970	1629	120934
1882	45894	45652	11137	6727	10613	936	1996	122955
1883	42829	43593	11882	6233	8235	1033	2334	116139
1884	39639	40399	10672	7141	11654	1135	1559	112199
1885	35978	39334	9663	6032	8195	1075	1661	101938
1886	38368	37058	9602	5920	8063	1038	2795	102844
1887	41794	37600	9662	5563	8823	1147	2039	106628

1888	47062	44398	10762	6563	9682	1226	2663	122356
1889	48581	51312	12593	6710	9335	1331	2807	132669
1890	49514	45055	13470	7884	10333	1848	2992	131096
1891	50309	44916	12229	7086	9359	2545	3938	130382
1892	49149	42939	12147	7150	8237	3109	3692	126423
1893	53112	45967	13195	7161	9340	3932	3380	136087
1894	60387	5194	8497	4171	1700	44790	7256	131995
1895	60064	5162	10347	4542	2102	47648	7415	137280
1896	70788	6130	13389	4633	1861	43507	7463	147771
1897	57125	64676	14506	7222	10383	7980	5805	167697
1898	53726	61697	6981	6353	13269	8829	8494	159349
1899	55689	61527	7496	6593	12088	9076	6918	159387
1900	58839	71286	7058	5867	11483	9774	8639	172946
1901	58740	62512	8158	7192	11192	10760	6552	165106
1902	64287	67808	9461	8334	12415	9774	8763	180842
1903	64154	74395	8475	6715	22189	10221	7118	193267
1904	62062	65411	8341	7463	27993	11482	10058	192810
1905	71905	69888	10425	7288	33307	14364	10783	217960
1906	78878	84710	11552	7529	37583	18354	7317	245923
1907	79904	81864	10965	7351	23921	16491	8540	229036
1908	77313	75329	11623	8226	23407	17662	5307	218867
1909	89083	73528	17282	9348	25526	20847	7835	243449
1910	102741	79507	21053	13819	34687	22455	8333	282595
1911	112582	78078	22354	14293	41397	21053	8596	298353
1912	115828	85635	30388	17416	52484	25382	8540	335673
1913	139872	89973	36672	18349	64204	32251	11292	392613

1914	136685	85078	38101	36690	73292	30158	10018	410022
1915	239313	118415	18713	81181	147663	46719	24756	676760
1916	336808	179703	36740	92583	233717	58308	50474	988333
1917	253191	163559	9504	10200	255644	48995	50279	791372
1918	201174	201327	6381	13300	226561	86291	20021	755055
1919	232960	191555	36001	95128	102581	82981	40881	782087
1920	245330	339533	73181	66088	224514	228975	69051	1246672
1921	161171	141010	38406	50965	141489	66057	38868	637966
1922	181019	79042	28987	51767	149400	250354	46821	787390
1923	183412	74380	34537	71668	166926	269684	30338	830945
1924	306789	82698	44050	90271	240854	263544	37446	1065652
1925	234190	80364	38356	103035	251135	313030	28172	1048282
1926	207208	53910	27484	75994	190515	225810	30985	811906
1927	173560	40512	26467	53050	168300	189541	33308	684738
1928	172561	42678	29216	62576	160727	187119	28172	683049
1929	194123	43379	25409	63853	204365	194197	26720	752046
1930	174455	36886	20709	45278	202447	172673	31553	684001
1931	123592	22367	16053	34848	158293	100133	11382	466668
1932	135984	17764	18112	59996	162795	146799	27141	568591
1933	130805	14986	20904	45350	201621	128120	16099	557885
1934	123511	15442	31414	36523	203510	140595	27292	578287
1935	133153	15047	41006	45195	212727	138947	19002	605077
1936	136073	16686	52984	56346	241362	151682	30036	685169
1937	152099	21210	65151	62597	278446	200661	43094	823258
1938	146150	16207	59894	54323	287394	171278	51283	786529

Source: (NOS, 1969, p. 252)*, table 153*

TABLE C: Production index 1896-1930

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC
1896	24,5	24,6	24,9	25,2	25,5	25,7	26	26,2	26,3	26,4	26,8	27,3
1897	27,6	28,1	28,1	28,3	28,6	29,1	29,3	29,6	29,9	30,3	30,6	30,5
1898	30,9	31,4	31,6	32	32,2	32,2	32,3	32,5	32,7	32,9	33,3	33,5
1899	34	34,2	34,4	34,6	34,7	34,7	35	35,1	35,3	35,2	35,3	35,3
1900	35,2	34,7	34,8	34,8	35,4	35,9	36,3	36,2	36,1	36,1	36,1	36,1
1901	36,2	36,1	35,8	35,7	36	36,1	36,1	36,2	36,3	36,6	36,4	36,3
1902	36,2	36,3	36,7	36,5	36,4	36,2	36,1	36	35,9	35,8	35,8	36
1903	35,9	36	35,9	36	36,2	36,4	36,7	36,6	36,7	36,9	37,2	37,1
1904	37,9	37,7	38,4	37,9	37,6	37,1	37,2	37,3	37,5	37	37,2	36,4
1905	36,7	36,6	36,7	37,2	39,1	39,2	39,3	39,4	39,4	40	40	40,5
1906	41,4	41,9	41,9	41,9	41,5	42,5	42,1	42,6	42,6	42,7	43,7	44,1
1907	43,9	44	44,8	44,7	44	43,8	43,5	44,8	45,9	46	46,2	47
1908	46,3	46,6	46,4	46,5	46,9	46,5	47,4	48,4	46,7	47,5	46,2	47,1
1909	45,8	46,8	47,4	48,1	47,9	48,8	47,8	48,6	48,5	48,1	48,6	48,6
1910	50,8	49,8	49,5	51	52,6	52,5	53,8	53,3	54	53,5	54,2	54,1
1911	53,7	54,6	54,9	54,3	55,7	53,9	48,3	53,8	58,3	58	58,1	56,7
1912	60,2	60,4	61,2	61,1	61,8	62,8	64,1	65,2	65,4	64,4	66,7	65,8
1913	67,7	67,2	68,2	68,1	68,3	67,9	67,5	69,4	68,6	70,9	68,5	67,9
1914	68,6	72,6	69,7	70,9	70,5	72,9	70,2	67,8	70,7	71,5	70,6	72,6
1915	71,5	70,6	71,1	72	73,5	75,4	75,8	74,4	75	75,9	76,3	77,5
1916	77,9	78,5	78,4	77,7	75,5	76,9	79,9	81,2	78,9	77,5	78,5	79,5
1917	75,2	72,1	73,2	73,2	72,2	71,9	70,6	69,7	67,1	65,8	65,2	64,7
1918	66	65,8	66,1	65,9	65,1	64,5	63,7	64,2	65,1	65,3	64,4	64,1
1919	64,6	64,4	64,4	64,6	65,8	66,5	67,3	68,2	69,1	69	69	71,2
1920	70,9	71,9	73,4	74,1	73,9	74,7	73,7	72,2	71,4	70,4	68,3	65
1921	61,5	60,1	59,7	57,6	48,3	39,5	48,5	47,2	47,4	50,1	54,1	56,6
1922	59,1	59,6	63	64,3	67,4	68	67,3	68,3	68,7	69,7	69,4	68,6
1923	69,8	70,5	72,5	73,9	74	72,2	71,6	71,8	71,1	70,9	69,8	70,9
1924	78,2	70,5	60,1	60,4	70,3	80,4	81,7	83,6	85,1	83,7	82,8	83,8

1925	82,7	84,9	84,2	87,3	86,1	84,2	81,8	81,7	81,3	79	78,1	76,6
1926	76,4	77,6	81,9	77,1	72,9	75,8	75,3	72,4	68,8	73,8	75,6	75,4
1927	78	75	75,4	73	75	77,1	78,7	78,9	79,5	81,8	81,7	82,8
1928	83	83,2	85,2	86	87,2	86,4	83,9	86,2	87,9	88,4	90	91,4
1929	90,8	93	94,4	97,8	98,9	109,4	106	107,1	102	101	100,8	98,8
1930	101	102,1	103,6	104,9	105,3	103,2	102,1	100	99,1	96,7	93,1	92,5

Source: (Klovland, 2015)

Table D: Workers in mining, manufacturing, gas, and electricity supply

Year	**Total workers**
1850	12279
1860	20643
1865	28364
1870	34597
1875	48645
1879	43434
1885	47696
1890	63855
1895	62020
1900	79635

Source: (NOS, 1978, p. 79)

Table E: Manhours in mining, manufacturing, gas, and electricity supply. Establishments under compulsory accident insurance 1900-1939

Year	Manhours in 1000
1900	222765
1901	221955
1902	219441
1903	221982
1904	224040
1905	233910
1906	252819
1907	270753
1908	281250
1909	281175
1910	302892
1911	314706
1912	347913
1913	361500
1914	356928
1915	371592
1916	390483
1917	357393
1918	334933
1919	331050
1920	316914
1921	218647
1922	261890

1923	280464
1924	293510
1925	306246
1926	264078
1927	263753
1928	288963
1929	310681
1930	309470
1931-1933	-
1934	300918
1935	325819
1936	357488
1937	383741
1938	378202
1939	390564

Source: (NOS, 1978, p. 200)

Table F: Data information and sources

Data	**Background**	**Source**	**Time period**
Manufacturing	The reason why we want to analyse manufacturing data is due to a strong development in various manufacturing industries in Norway during the industrialization period. This strong development can be interpreted as an industrial breakthrough. The industries that go under manufacturing are the following: - Textile industry - Mechanical industry - Metal and canning industry - Electrochemical industry - Aluminium and nickel industry - Paper industry	Two centuries of economic growth Norwegian GDP 1816-2020	(1816-1939)
Mining and quarrying	In this case, we want also to analyse mining and quarrying data because of a strong development in two industries under the industrialization period. The industries that go under mining and quarrying are the following: - Iron industry - Metal industry	Two centuries of economic growth Norwegian GDP 1816-2020	(1816-1939)

Agriculture and forestry	It will be interesting to analyse agriculture and forestry data since Norway experienced a strong demand for planned cargo and wood pulp during the industrialization period. In addition, developments in the paper industry were also a decisive factor in the industrialization.	Two centuries of economic growth Norwegian GDP 1816-2020	(1816-1939)
Construction	During the industrialization, the Norwegian government began to develop steamship routes, trains, railway tracks, factories, and the power-intensive industry. For this reason, it will also be crucial to analyse the construction data for Norway during the industrialization.	Two centuries of economic growth Norwegian GDP 1816-2020	(1816-1939)
Electricity, gas, water, and sanitary services	Electricity and electric motors made a huge leap after the 20th century, and many historians believe that it was an important cause of an industrial break through. For this reason, we want to use electricity, gas, water, and sanitary services data to analyse it.	Two centuries of economic growth Norwegian GDP 1816-2020	(1816-1939)
Labour statistics	A crucial consequence of the industrialization is that it created more jobs in Norway. For this reason, labour statistics will be a decisive factor to analyse.	Historical statistic of Norway (Statistics Norway)	(1850-1948)
Exports	The increased exports were a decisive factor in Norwegian the industrialization. This is because during the	Historical statistic of Norway	(1896-1948)

	industrialization, Norway began exporting industrial goods around the world.	(Statistics Norway)	
Production index	The production index is a quantity index that shows the changes in production. This is useful to analyse since it may explain an industrial breakthrough. Since this index explains renewals of production processes through mechanization of production, and technological development.	Measuring trends and cycles in industrial production in Norway 1896-1948	(1896-1948)

Table G: HP-Filter deviations from trend

λ = 2500	(1822-1829)	(1835-1840)	(1842-1848)	(1853-1857)	(1868-1883)	(1896-1901)	(1911-1922)
Manufacturing	1,14%	0,73%	0,89%	2,02%	1,61%	1,35%	2,11%
	(1826)	(1838)	(1844)	(1856)	(1877)	(1899)	(1916)
Electricity	4,15%	5,01%	0,37 %	4,26%	2,62%	2,45%	5,66%
	(1824)	(1839)	(1847)	(1856)	(1871)	(1899)	(1920)
Construction	1,85%	3,32 %	0,64 %	3,18 %	1,80 %	2,92 %	4,87 %
	(1824)	(1839)	(1845)	(1855)	(1871)	(1899)	(1919)
Agriculture	0,33 %	0,62 %	0,55 %	0,99 %	1,92 %	0,49 %	0,96 %
	(1829)	(1835)	(1842)	(1855)	(1873)	(1897)	(1915)
Mining	1,37 %	2,44 %	8,01 %	3,95 %	8,42 %	2,03 %	16,43 %
	(1824)	(1836)	(1845)	(1856)	(1882)	(1900)	(1915)

Table H: Throughs and peaks from Breakpoint analysis

No. cycle	Throughs	Peaks
1.	1820	1827
2.	1835	1938
3.	1840	1844
4.	1848	1856
5.	1864	1876
6.	1887	1900
7.	1905	1915
8.	1929	

Table I: Exports of minerals, metals and paper, and total exports of goods

Exports Group	**1890**	**1900**	**1910**	**1916**	**1926**	**1938**
Raw, Minerals	3 201	4 251	15 544	34 921	29 170	62 503
Minerals Fabricated	1 875	2 615	9 664	119 187	67 884	76 481
Raw Metals	1 588	2 474	6 743	70 858	86 918	140 057
Paper and Manuf. thereof	1 848	9 774	22 455	58 308	225 810	171 278
Sum	8 512	19 114	54 406	283 274	409 782	450 319
Total Exports	131 096	172 946	282 595	988 333	811 906	786 529

Per cent of total exports	6,5%	11,1%	19,3%	28,7%	50,5%	57,3%

(NOS, 1969, p. 256)

Table J: Perspectives of historians

Historians	Period	School	Factors
Kristine Bruland	(1840-1875)	Ante	Emphasizes the leading role of the textile industry in the early phase around 1840 and the rapid growth in the iron and metal industry after 1860, and especially a strong display in industrial employment in the 1860s.
Francis Sejersted Even Lange	(1880)	Ante	Shift in the technical paradigm caused by the international economic crisis.
Edgar Hovland Helge W. Nordvik	(1880 - 1890)	Ante	Emphasizes the increased capital stock per worker and the steady growth of workers in factories and a general strengthening of the manufacturing industries during the 1880s and 1890s.
Ola H. Grytten Fritz Hodne Jan Tore Klovland	(1880-1890)	Ante	Emphasizes the growth in wood pulp factories in the 1870s and 1880s. The results show that Norway made a profit on this export business, and this increased the demand for manufacturing products.

			The implementation of electricity in industries.
Christian Venneslan	(1890)	Ante	Emphasizes the development in electricity and the use of it in different industries.
Ola H. Grytten Fritz Hodne Jan Tore Klovland	(1890 – 1905)	Post	How the use of electricity was implemented in the manufacturing industry after the 20th century. Emphasis also the effect of international markets and foreign capital in the companies that began to spread around Norway after the 20th century.
Per Fuglum Gunnar Nerheim	(1900)	Post	Emphasizes the development of the electrochemical and electrometallurgical industry (based on the use of hydropower). In other words, the importance of electricity in Norwegian industrial development.
Pål T. Sandvik	In waves	Different approach	Strong development in several industries, and an exponential growth in the secondary industry.

Table K: Business cycles during industrialization

Periods of positive business cycles	Periods of negative business cycles
1836-1839	1840-1842
1843-1847	1848-1852
1853-1858	1859-1868
1869-1882	1883-1896
1897-1902	1903-1909
1910-1920	1921-1923