

# Two centuries of economic growth Norwegian GDP 1816-2020

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# Two centuries of economic growth Norwegian GDP 1816-2020

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## Abstract

Existing historical GDP series for Norway do not always coincide with our historical knowledge of the economic development. This is to a large extent a result of lack of calculations from the production side and in addition to insufficient data sets upon which these series rest. The present paper offers new knowledge of historical national accounting in Norway in several ways. Firstly, a new and novel set of annual gross domestic product series by industry are presented for the period 1816-2019. Secondly, the new estimations suggest revision of the long-run GDP series. Thirdly, this implies it is necessary to revise our understanding of parts of Norwegian economic history.

Keywords: Historical national accounting, national accounts, industrial development, Norwegian economic history.

JEL classification codes: L6, L7, L8, L9, N3, N13, N14, O11, O14, O16.

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## 1. Problem defined

### Introduction

Existing historical national accounts (HNA) for Norway start in 1830. For the period before 1930 these leaves writers on Norwegian economic growth with some puzzles, as they in several incidents report annual growth rates, which are contrary to our knowledge of movements in the economy. This also implies that they despite representing a small open economy, surprisingly often depart from developments in gross domestic product (GDP) for important trading partners. One reason for this might be that the existing historical GDP series basically have been calculated from the expenditure side. Secondly the data sets are limited.

The present paper presents new series of Norwegian historical GDP both from the production side and the expenditure side 1816-2019. This will equip us to understand better the industrial and economic development. One might, in the first place, be more able to measure the historical size of the Norwegian economy. Secondly, one may give a refined picture of economic growth. Thirdly it enables us to conclude more precisely on the sizes of the different industries, and thereby throw more light on industrial development and business cycles.

## 2. Approach

The key parameter in national accounts is GDP, which reflects the sum of gross value added in all production units of the economy. It can be calculated by three major approaches (Fløttum, 2006, pp. 93-131): production approach, expenditure approach and income approach. In the production approach we sum up gross value added ( $y$ ) in all production units ( $j$ ), by subtracting the gross value of intermediate consumption ( $h$ ) from gross value of output ( $g$ ) in period ( $t$ ):

$$(1) \quad \sum y_{j,t} = \sum (q_{j,t} - h_{j,t})$$

Economy wide aggregates are found by adding the sums of all production units:

$$(2) \quad Y^B_t = Q_t - H_t$$

One then reaches at GDP in base values (prices), denoted as  $Y^B$ . By adding net product taxes, calculated as gross product taxes,  $T^Q$ , deducted by product subsidies,  $S^Q$ , one reaches at GDP in market values (prices), denoted as  $Y^M$ .

$$(3) \quad Y^M_t = Q_t - H_t + (T^Q_t - S^Q_t)$$

When GDP ( $Y$ ) from the production side describes supply, GDP from the expenditure side describes demand or use, where  $C$  denotes private consumption,  $I$ , gross investments,  $G$ , public expenditures,  $X$  exports and  $M$  imports in period  $t$ :

$$(4) \quad Y_t = C_t + I_t + G_t + (X_t - M_t)$$

Finally, the income approach reports the income distribution of GDP by compensation of employees,  $W$ , gross operating surplus,  $S$ , and taxes,  $T$ , less subsidies,  $S$ , on production,  $Q$ , and imports,  $M$ , in period  $t$ .

$$(5) \quad Y_t = W_t + S_t + (T^Q_t - S^Q_t) + (T^M_t - S^M_t)$$

Here we use the production and the expenditure approach to GDP.

### 3. Previous work

The history of national accounting in Norway starts with Schweigaard (1840), who made estimations of domestic production for most industries in a normal year around 1835. Services were largely excluded, as they were not considered production. Tvethe (1848) estimated production by industry for a normal year around 1845. He applied similar definitions and sources as Schweigaard. Both of them tried to estimate output and input, and thus, value added. However, they were not always persistent in their approach. A third attempt came when Kiær (1887; 193-205) published estimates of total national income. He included several services.

He also had richer, more valid and reliable data. Additionally, he possessed a wider understanding of the importance of using value added figures in order to sum up industrial production into national aggregates.

The 1930s gave way to the idea of collecting data to produce sets of aggregated accounts for the overall economy. The idea was initiated by two of the most prominent Norwegian economists, i.e. Frisch and Wedervang. It resulted into the collection of relevant data by statistics Norway from 1930s onward, in addition to a historical archive of wages and prices, monitored by Wedervang and his staff at the Norwegian School of Economics (Grytten, 2007; 203-230).

After World War II, Statistics Norway (1965) published their first full HNA. These were calculated on the basis of the System of National Accounts of 1958, SNA1958. Skoglund (2009) has revised these from 1946 according to SNA2010.

From 1994 a new generation of HNA series were constructed. Brautaset (2002) gave accounts on Norwegian exports 1830-1865. Grytten calculated annual GDP contribution for agriculture 1830-1865 (Grytten 2004a, 47-76). Bjørsvik (2004) established GDP series on public services for the same period. Venneslan (2007) calculated detailed series for value added in manufacturing by 60 industries, 1896-1939. Klovland (2015) revised the output series for 45 industries 1896-1948. Hodne and Grytten (1994) published total GDP figures 1835-1865. This was concluded with historical GDP series 1830-2003 (Grytten 2004b; 241-288). Lately Grytten (2015) and Dean (2018) has been working on a comprehensive set of HNA accounts from the production side.

#### 4. New series

This paper presents both the production and expenditure approach to annual HNAs. It reports the gross product of 17 industries and 78 sub-industries. In principle we follow SNA2010 and calculate annual series of input and output and use double deflation technique when possible to arrive at fixed price series. This is a novel approach in historical national accounting, as data usually limits one to apply simple deflation. For the period until 1930 we give new estimates, for 1930-1946 revised figures, then we splice with updated series by Statistics Norway.

## 4.1. GDP from the production side

The approach depends on available sources. For the period since 1970 we are using Statistics Norway's last versions of GDP from the application and the expenditure side.<sup>2</sup> In the following section we offer a description of the historical sources.

### 4.1.1. Agriculture and forestry

The series are mostly taken from previous work (Grytten, 2004a; 47-76) constructed on the basis of decadal agriculture censuses. We use production reports from counties, farm accounts, exports and imports statistics to interpolate. For some years there is lack of sufficient data. Hence, demand and production functions are constructed in order to estimate volumes. Price data are taken from Grytten and Hodne (1998) and the Wedervang Archive.

Brautaset (2002; 168-189) offers detailed series of forestry exports 1830-1865. Thereafter, it is possible to make similar calculations on the basis of records from foreign trade accounts, tax records and production records from Statistics Norway (Mork, 1941; 194-278, Benterud, 1978; 194-278, Grytten 1997; 143-164). Since 1901 Statistics Norway (1949; 162-184) has reported annual series of variables regarding cultivation of private forests. To reach at value series we use price series from Brautaset (2002; 262-268) and the Wedervang Archive.

### 4.1.2. Fisheries, whaling and hunting

The contribution of fisheries to GDP is by definition limited to the values of catches. This means that the preserving of fish is considered industry. We find value of catches on the basis of volume series of exports and domestic fish consumption. Brautaset (2002; 168-189) offers detailed series of fish exports till 1865. Consumption surveys give us information on domestic fish consumption. Thus, it is possible to calculate total production figures.

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<sup>2</sup> <https://www.ssb.no/statbank/table/09170/> and <https://www.ssb.no/statbank/table/09189/>

From 1865 there is detailed figures on volumes and prices on fish exports and consumption in benchmark years (Statistics Norway, 1949; 91-104). From 1866 they report quantity and prices of fish brought on shore, and from 1908 values of catches. As for whaling and hunting our data are basically taken from Kiær (1877).

To interpolate we use foreign trade statistics and records on catches and oil production. These are coupled with the 1930 values of the whaling industry in the revised historical national accounts by Dean (2018).

#### 4.1.3. Mining and quarrying

This industry is basically calculated on fairly accurate records given by Statistics Norway (1949; 111-146) Schweigaard (1840) and Tvethe (1848). With the help of foreign trade statistics, it is possible to interpolate annual output and input between decadal benchmark years. The industry was under strict public regulation, and both price and volume data are available. Hence, the reported data seem both valid and reliable. Since 1930s onwards we splice the Dean (2018) estimates with the series by Statistics Norway (Skoglund, 2009).

#### 4.1.4. Oil and gas extraction

Oil and gas extraction constitutes a new industry in Norway, and we solely use the national accounts figures from Statistics Norway running from 1971, two years after the discovery of oil in the Norwegian seabed in 1969.<sup>3</sup>

#### 4.1.5. Manufacturing

Both Schweigaard (1840) and Tvethe (1848) give reliable estimations of input and output in manufacturing industry. In addition, we can add decadal benchmark years from Bjerke (1966; 53-56). By drawing on population and manufacturing censuses, export and import statistics and public reports from county officials, it is possible to come up with fairly valid and reliable accounts until 1896.

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<sup>3</sup> <https://www.ssb.no/statbank/table/09170/>

From then on, we use accounts for manufacturing industries calculated by Venneslan (2007; 12-48). These are established on the basis of impressively informative data recorded by Statistics Norway. They are revised with data for 45 manufacturing industries by Klovland (2015; 51-73). We use these to refine the gross product series for manufacturing until 1939. From then on, we use the revised series from Statistics Norway according to the SNA2010 standard. All in all, the new estimates rest on 37 sub-industries, covering different periods 1816-2019.

#### 4.1.6. Electricity, gas, water and sanitary services

This includes pre-electricity products, such as paraffin and other fuels. Industrial censuses kept by Statistics Norway, along with farm and institutional accounts kept at the Wedervang Archive provide necessary information on value added in benchmark years. These have been interpolated by data which are basically taken from industrial censuses and trade statistics and county reports (Dean, 2018). In addition, we find output figures for power supply from Minde (2015). Finally, we apply Statistics Norway's series from 1930s, revised by Dean (2018).

#### 4.1.7. Construction

Input figures are taken from Hodne (1983; 298-313) on the size of Norwegian infrastructure. From 1914 we find relevant series in public budgets and accounts from both the central and local governments (Statistics Norway, 1949; 151-155). We also use estimates of construction in the work of Schweigaard (1845; 72-91) and Tvethe (1848; 93-118). In addition, benchmark year calculations by Bjerke (1966; 53-56) Thus, we establish decadal benchmark years of construction.

We interpolate by using annual figures on public and private construction, before we use revised and refined accounts from 1930 onwards (Dean, 2018).

#### 4.1.8. Trade and repair of motor vehicles

Despite trade not being always esteemed as value creation activity in the 1800s, Schweigaard, Tvethe and Kiær all report data for it. The same is found in population censuses and county reports. These have been compiled and summed up to



aggregated trade figures in benchmark years in the historical national accounts published by the central bank (Grytten 2004b, pp. 250-258). Adding the work by Bjerke (1966; 53-56), we reach at decadal benchmark figures for trade 1830-1930. These report input, output and value-added figures. To obtain annual figures we interpolate between the benchmark year figures. For the 19<sup>th</sup> century, the Wedervang Archive holds records on trade activity and monthly prices.<sup>4</sup>

Repair of motor vehicles enters into the series in 1946 (Skoglund, 2009). Before 1946 repairs are included as an assumed repair value share of number of vehicles as of 1946-1950.

#### 4.1.9 Ocean transport

Estimations of value-creation in the Norwegian merchant fleet by Kiær (1877) and Brautaset (2002; 257-261) serve as reliable sources on this industries contribution to GDP from 1830 and towards the turn of the century.

The Wedervang Archive give us detailed information on income and cost structures, freights and wages in the merchant fleet (Brautaset, 2004; 119-142). The data is best for the fleet engaged in foreign ports. However, the data for the coastal fleet is also adequate.<sup>5</sup>

In addition, publications by Statistics Norway (1978; 376-408) reports volumes of the fleet and the ships' engagements. Thus, drawing on this information and incalculating the new time series with the 1930 figures of value creation in ocean going transport, which leads us to value added for this industry 1830-1930.

#### 4.1.10. Transport and post services

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<sup>4</sup> Wedervang Arvhive, files W139, W267, W268, W269, W271, W272, W273 and W383.

<sup>5</sup> Wedervang Archive, W030, W032, W034, W035, W036, W038, W039, W043, W044, W063, W172, W173, W174, W176, W182, W184, W185, W186, W187, W188, W189, W193, W320, W327, W329, W330 and W407.

Other transportation includes horse, railway, auto car as well as postal services. The number of horses is taken from the agricultural census held about every tenth year. Costs from horse transport are taken from the Wedervang Archive.<sup>6</sup>

Statistics Norway (1978; 419-445) provides information on kilometres of road, number of cars, kilometres of railways and other types of communication, public income and costs from transport and communication. With the help of these data we have been able to interpolate between benchmark years and splice with the 1930 estimates by Statistics Norway.

#### 4.1.11. Information and communication

This industry enters into the national accounts in 1970, and include telecommunication, internet, data communication, along with other information activity connected to information and communication technology.<sup>7</sup>

#### 4.1.12. Financial and insurance activities

Due to extensive work on Norwegian bank's balance sheets (Klovland, 2007a; 109-106, Klovland, 2007b; 161-202) we have reliable historical data on input, output and value added for the banking sector are available, as he compiled data for almost every savings and commercial bank in Norway since 1822. Using similar data for publicly owned banks and other public and private credit institutions, compiled by Skånland (1967; 262-385), we arrive at valid and reliable series on value added in the registered finance market. In addition, we add the volumes of unregistered finance services. This is done by using information found in bank history (Liseth, 2012; 91-131, Grytten, 2013; 403-411).

By splicing these with the finance industries contribution to GDP in 1930 according to Statistics Norway, one arrives at value added series for the entire Norwegian finance industry.

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<sup>6</sup> Wedervang Archive, W118, W119A, W120A and W249.

<sup>7</sup> <https://www.ssb.no/statbank/table/09170/>

#### 4.1.13 Dwellings, commercial buildings and business services

It is possible to trace values of Norwegian housing and property management directly back to 1819. The series presented here reflect the value creation of providing private housing and business properties. Stocks of dwellings are calculated on the basis of censuses 1825-1930. Between the census data, we interpolate on the basis of population records and estimated numbers of people per square meter (Statistics Norway, 1994; 77-79). Thus, we arrive at annual volume figures of the stock of buildings. These are multiplied with prices of buildings as they are reported in the central bank's house price index (Eitrheim, 2004; 349-376).

Since housing in national accounts should reflect value creation and not market prices of buildings, we use smoothed series, with the help of a HP-filter, with a smoothing parameter ( $\lambda$ ) of 10.

#### 4.1.14. Public administration and defence

For the period 1816-1865 we use Hodne (1983; 300-313) and Bjørsvik (2004; 293-310) series on public administration and defence. These are basically constructed on the basis of wages, depreciation and estimations of increase in productivity within the sector. Records from the Wedevang Archive give us relevant information on the income and cost structure of Norwegian garrisons during the nineteenth century.<sup>8</sup>

From 1915 we are using more recent computations of the size of public administration (Grytten, 2019; 189-202). They also provide us with information on wages, depreciations and productivity growth. By splicing them with the series of Dean (2018) in 1914 and Statistics Norway from 1946 (Skoglund, 2009), we establish an annual gross product series for public administration and defence.

#### 4.1.15. Education

We basically use the same sources as for public administration and defence for education. We have included estimations of private schooling and education, where

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<sup>8</sup> Wedevang Archive, files W052-W078.

schools, and training programs connected to the church were quite important. This is done by drawing on information on the scale of these from popular censuses and county reports, reported annually by Statistics Norway (1876-1930). We assume the same value creation per employee in private and public schools.

#### 4.1.16. Health services

Bjørsvik (2004; 293-310), Hodne (1983; 300-313) and Grytten (2019, 189-202) are primary sources for this series, as they report the volumes and values of public health production from the second decade of the nineteenth century until 1930 respectively. We also add a substantial contribution for private health care. According to contemporary sources, private health care made up a huge part of the sector until 1930. With churches and humanitarian bodies as main players.

#### 4.1.17. Other services

This industry consists of both public sector and private sector services. The public records are found in the work by Bjørsvik (2004; 293-310) until 1865, Hodne (1983; 300-313) up to 1914, Grytten (2019; 189-202) from 1914. A challenge is to find the size of private services. However, we already have decadal benchmark year calculations (Grytten, 2004b; pp. 252-255, Bjerke, 1966; 51-54). By refining these on the basis of SNA2010 and new knowledge of other industries' contribution to GDP, presented here, we have a departure for interpolating annual series.

Grytten (2009; 48-87) and the Wedervang Archive give data for domestic and other private services.<sup>9</sup> Thus, it is possible to construct value added series for this industry. Board and lodging were significant parts of wages and are included.

## 4.2. GDP from the expenditure side

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<sup>9</sup> Wedervang Archive, W009, W013, W014, W021, W028 and W204.

The original annual historical national accounts for Norway from 1830 onwards were basically constructed from the expenditure side. Here, we revise and extend them back to 1816.

#### 4.2.1. Final private consumption expenditure

Consumption expenditures of households and non-profit institutions serving households (NPISHs) 1816-1865 are estimated on the basis of detailed calculations of private consumption together with previous estimates of private consumption. Consumption is in principle found by domestic output less exports plus imports in every fifth year 1825-1865. Data are taken from agricultural censuses and the foreign trade statistics (Grytten and Minde, 1998; 42-58). Annual proxies of consumption are thereafter interpolated between the benchmark years on the basis of established consumption functions with normal consumption, price elasticities and exports and imports as parameters.

According to consumption surveys agricultural products accounted about 50% of total consumption 1830-1865.<sup>71</sup> In addition we use previous series of private consumption estimated on the basis of the elasticity of private consumption to GDP 1865-1910 (Hodne and Grytten, 2000; 91-92). From 1865 we use the historical national account figures constructed by Statistics Norway revised to the SNA2010 standard until they are spliced with Statistics Norway's GDP series from the expenditure side in 1970. In the years of revisions, we assume same relative distribution of expenditures as in the existing accounts level adjusted with the revised figures since 1970.<sup>10</sup>

#### 4.2.2. Final consumption expenditure of general government

This series is extrapolated backwards from 1865 by using data from Hodne (1983; 300-313), Bjørsvik (2004; 293-310) and Grytten (2019; 189-202). These are mostly taken from departmental sources, basically expenditure accounts made by the administration of the central government.

We also use these sources to adjust the series from 1865-1930 according to SNA2010. Furthermore, we do the same on the basis of government consumption

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<sup>10</sup> <https://www.ssb.no/statbank/table/09189/>

expenditure series from Statistics Norway (1965; 364-365) from 1930 to 1970 (Skoglund, 2009). From then on, we splice with Statistic Norway's revised series.

#### 4.2.3. Total exports

Export figures are provided by Brautaset (2002; 251-268). Her data on volumes are taken from the official foreign trade statistics, which in some cases have been corrected by her. Her price data were basically selected from the very rich export price data archives in Bergen and partly calculated on the basis of import price data from importing countries of Norwegian commodities.<sup>11</sup> She has also established reliable freight rates for the period.

#### 4.2.4. Total imports

Imports are extrapolated on the basis of public sources from the national statistical office and later Statistics Norway. They have published fixed price calculations of exports with traditional goods back to 1851 (Statistics Norway, 1969; 261). We have spliced these with the export series since 1865 (Statistics Norway, 1965; 364-365). For the period before 1851 we also use the foreign trade statistics (Statistics Norway, 1949; 190-192). The figures are in volumes. We have used the import price index by Klovland (2018; 73-92) to inflate the figures to current import series 1816-1865.

This series is spliced with a revised and refined version of the series of imports in the existing national accounts from 1865, and then with revised series by Statistics Norway in 1930, 1946 and 1970.

#### 4.2.5. Gross capital formation

Gross capital formation has been found as a residual previous to 1865. In principle GDP plus total imports less consumption expenditures of households and NPISHs less consumption expenditures of general government and total exports give gross fixed capital formation. Admittedly, we do not know changes in stocks during the period.

The indicator for 1816-1865 is thereafter connected to a revised set of the existing historical national account figures since 1865 (Statistics Norway 1865; 364-365), thereafter with revised series from 1930 (Dean, 2018) and 1946 (Skoglund, 2009).

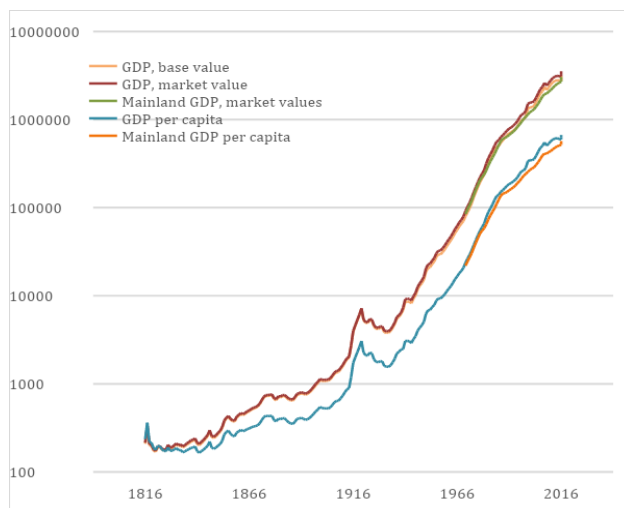
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<sup>11</sup> W370 and W397.

### 4.3. Aggregated GDP

By adding the value-added series for the different industries, we are able to conclude with annual GDP series for Norway 1816-2019 in current base values calculated by the production side approach, by adding net production taxes we reach at GDP in market prices as reported in chart 1.

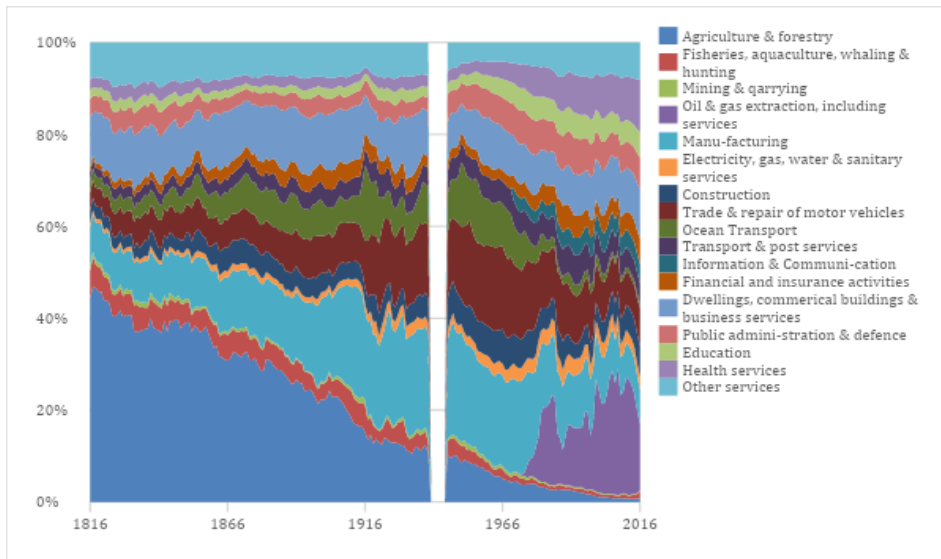
Chart 1. GDP from the production side in current mill NOK 1816-2019, semi-logarithmic scale.



Sources, See text.

Chart 2 reports the shares of GDP by industry in base values 1816-2019. The chart mirrors industrial development as we know it. It clearly shows the decline of primary production over time, the acceleration and decline of traditional manufacturing and the steady increase of service production, along with the rapid growth of oil and gas from the 1970s.

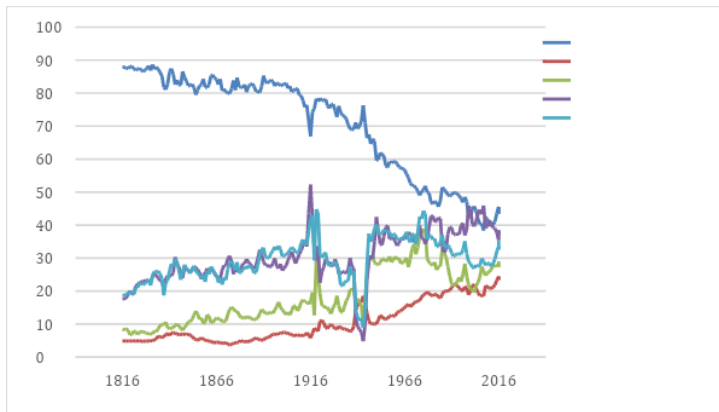
Chart 2. GDP in current base prices. Distribution by industry 1816-2019 in percent.



Sources, see text.

Chart 3 presents GDP by expenditure as shares of GDP in market prices. The development mirrors what we know from economic history research, and relative shares are in line with previous HNAs. We also see significant stability in private consumption and government consumption expenditures, when investments and foreign trade were more volatile, as is reasonable.

Chart 3. GDP in market prices. Distribution by expenditure 1816-2019 in percent.



Sources, see text.

## 5. Fixed price calculations

To reach at gross domestic product in fixed prices we offer a set of deflators for each parameter. By deflating the nominal figures by these, we obtain fixed price series.



## 5.1. Method

We use the standard Paasche price index ( $P_P$ ) to calculate the deflators, where  $p$  denotes price,  $q$  denotes volume,  $i$  denotes industry or sub-industry,  $t$  denotes time in period, where  $t=0$  is the base year:

$$(6) \quad P_P = \frac{\sum(p_{i,t}) * (q_{i,t})}{\sum(p_{i,t=0}) * q(q_{i,t})}$$

### 5.1.2. Deflation from the production side

Using a double deflation technique, i.e. deflating both the input and output series, gives value added ( $y$ ) in fixed prices ( $f$ ) for agriculture, forestry, fishing, whaling, mining, construction, manufacturing and trade:

$$(7) \quad y^f_{i,t} = \{q_{i,t} / [\sum(p_{i,t}) * (q_{i,t}) / \sum(p_{i,t=0}) * q(q_{i,t})] - h_{i,t} / [\sum(p_{i,t}) * (q_{i,t}) / \sum(p_{i,t=0}) * q(q_{i,t})]\}$$

For the rest of the service industries, we apply a single deflation technique, i.e. deflating the value-added series only:

$$(8) \quad y^f_{i,t} = [(q_{i,t} - h_{i,t}) / [\sum(p_{i,t}) * (q_{i,t}) / \sum(p_{i,t=0}) * q(q_{i,t})]]$$

Adding the sub-industry series, we reach at value added per key industry ( $y$ ) in fixed prices ( $f$ ). Adding these again, leads us to national GDP in fixed prices ( $Y^F$ ). By dividing GDP in nominal prices ( $Y^N$ ) with GDP in fixed prices we find the implicit GDP deflator ( $P_D^Y$ ) at aggregated level:

$$(9) \quad P_D^Y = Y^N_t / Y^F_t = \frac{\sum(p_{i,t}) * (q_{i,t})}{\sum(p_{i,t=0}) * q(q_{i,t})}$$

The same principle is used for finding implicit deflators for aggregated industries.

### 5.1.3. Deflation from the expenditure side

Within a fixed price period we find GDP in fixed prices ( $Y^F$ ) from the expenditure side by deflating each post with their corresponding deflator ( $P_D^\mu$ ). For private

consumption expenditure we use an adjusted CPI in the historical series. This is constructed as a Laspeyres index ( $L_P$ ), according to the following equation:

$$(10) \quad L_P = \frac{\sum(p_{i,t}) * (q_{i,t=0})}{\sum(p_{i,t=0}) * q_{i,t=0}}$$

Thus, one arrives at a Laspeyres deflator for private consumption expenditures ( $L_D^C$ ). However, for modern data one is able to operate with annual weights of quantities by adopting t-1 calculations (annually spliced index). Hence, for this series until 1946 we use the following equation (10):

$$(11) \quad Y_t^F = C/L_D^C + G/P_D^G + I/P_D^I + X/P_D^X + M/P_D^M$$

## 5.2. Price data

Explicit deflators are calculated on basis of direct price observations. These are compiled from a wide range of sources and are well documented in existing research literature on the establishment of HNAs for Norway. (Grytten, 2000; 21-47, Grytten 2004b; 241-288, Brautaset 2002; 251-268, Bjørsvik, 2004; 293-310, Venneslan, 2007; 7-138). In addition, 19th and early 20<sup>th</sup> century price records kept in the Wedevang Archive serve as key data.<sup>12</sup> Some of these are already published as price indices by the Norwegian central bank (Klovland, 2018; 73-92, Grytten, 2020; 129-144). In principle the fixed price series are calculated by deflating the nominal series with Paasche price indices. However, for some periods it has been difficult to find annual volumes, and Laspeyres indices have been used.

Thus, fixed price periods have been set to 1816-1830 with 1825 as base year. 1830-1865 with 1850 as base year 1865-1890 with 1880 as base year 1890-1918 with 1910 as base year 1918-1940 with 1938 as base year, 1940-1945 with 1943 as base year. Thereafter we apply the Statistics Norway's figures. We use 2015 as the

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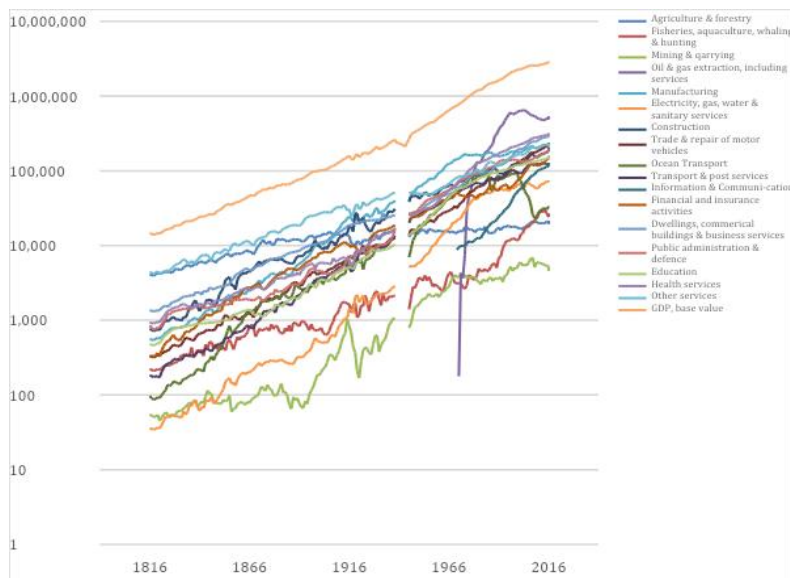
<sup>12</sup> Wedervang Archive, files W051, W128, W137, W138, W139, W140, W141, W142, W206, W207, W208, W209, W210, W213, W217, W218, W219, W220, W268, W269, W270, W271, W272, W273, W275, W276, W383, W386, W397 and W397.

reference year, meaning we present our fixed price calculations in values as of 2015 price level. Note that there is not additivity in the long run fixed price series.

### 5.3. GDP in fixed prices

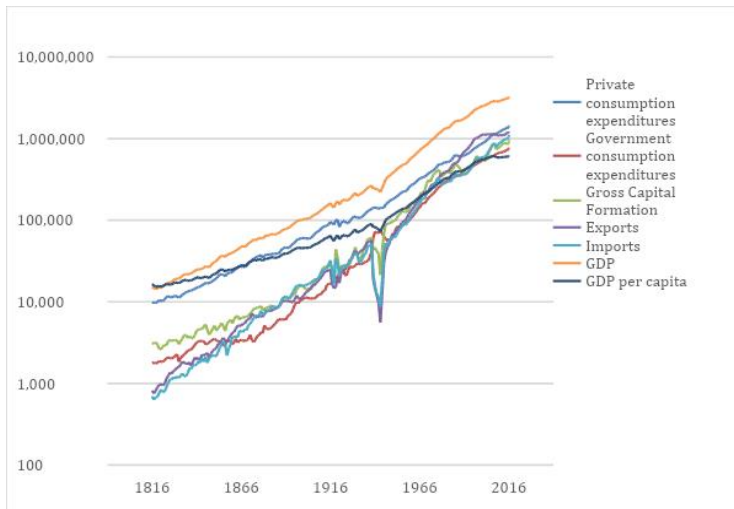
We are now in a position to calculate GDP by the production side and the expenditure side in fixed prices. Chart 4 maps gives the development of GDP by industry, when chart 5 reports GDP by expenditure, both in fixed prices.

Chart 4. GDP by industry in mill 2015 NOK base values (semi-logarithmic scale).



Source, see text.

Chart 5. GDP and components from expenditure side in mill 2015-NOK market values (semi-logarithmic scale).



Source, see text.

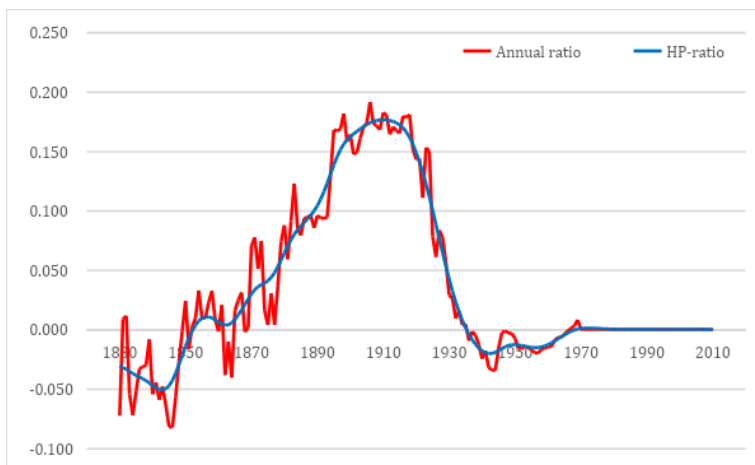
Both graphs seem to show a valid and reliable picture of the development as we know it from economic history research.

## 6. Comparisons

So, do the new historical GDP series show a different picture of the macro economic development than assumed hitherto? To answer the question, we compare the old ( $Y^{Old}$ ) series with the new ( $Y^{New}$ ) by calculating gaps ( $Y^G_t$ ). The differences are calculated as logs in chart 6:

$$(12) \quad \log Y^G_t = \log Y^{New}_t - \log Y^{Old}_t$$

Chart 6. Ratios between new and old fixed price GDP series 1830-2019.



Sources, New: see text. Old: Grytten (2004b; 241-288).

The graph drawn in chart 6 reveals it is necessary to rewrite parts of Norwegian economic history. In the first place, the country seemed to have started on a somewhat lower level in the 1830s than shown in the existing GDP series. This is quite marginal, around 4%.

However, from the 1840s onwards to the dawn of the 20<sup>th</sup> century the new series suggest significantly higher growth, in particular from 1865. During the two first decades of the 1900s the new series suggest GDP was around 17% higher than in the old. Then, in the 1920s the two series converge rapidly, suggesting considerably lower growth after World War I.

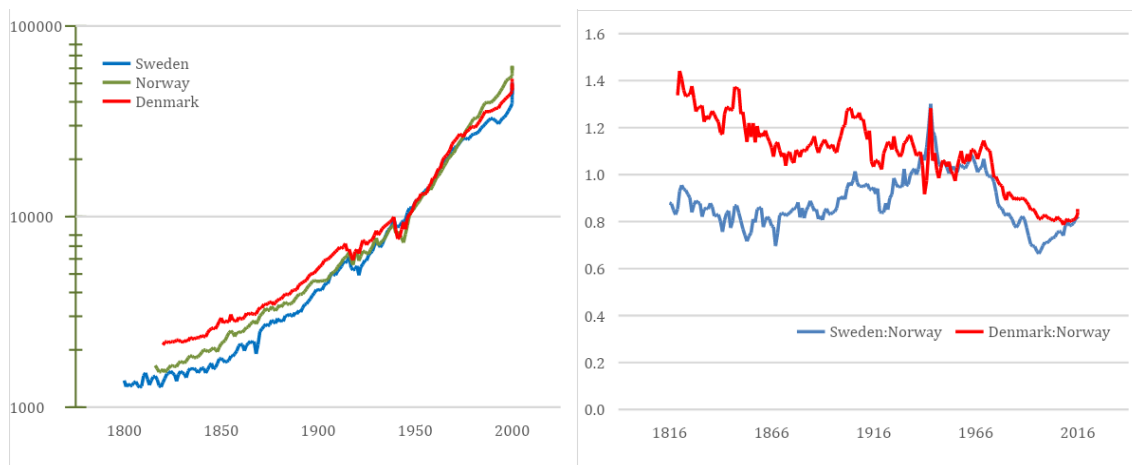
Looking more into short-term movements, one, with the exception of the crisis of 1848, finds the new series to reflect known upheavals and crises better than the old (Klovland, 1998a, 49-90, Klovland, 1998b; 309-344, Grytten and Hunnes, 2014; 25-57). The Crimean crisis towards the end of the 1850s, the start of the long depression in the mid 1870s and the Kristiania crisis 1900-1905 are better reflected in the new series. Additionally, the booms leading up to these crises have also become clearer. Lower growth in the 1920s, should better mirror the depression of the period. The same applies for the 1930s, but clearly to a lower extent.

It is of interest to compare the new series with those for Denmark (Hansen, 1983; 257-260) and the latest series for Sweden (Edvinsson, 2013; 1101-1126), which is more in line with the standards and definitions used for Norway than previous Swedish series (Krantz and Schön, 2007). We splice the series with present GDP in purchasing power parities of 2015 US reported by OECD.<sup>13</sup> Thus, historical GDP per capita series in fixed prices are showed in chart 7.

Chart 7. GDP per capita for Denmark, Norway and Sweden 1816-2019, 2015 US\$.

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<sup>13</sup> <https://stats.oecd.org/index.aspx?queryid=60702>



Sources, Denmark: Hansen (1983; 257-260). Norway: see text. Sweden: Edvisson (2010; 1101-1126).

The comparison confirms, like earlier versions of GDP, that Denmark still had the highest GDP per capita of the three Scandinavian countries during the 19<sup>th</sup> century, and Sweden the lowest. It also confirms a significant convergence from the early 1800s until World War II, when the discovery of oil and gas made Norway diverge from their neighbours from the 1970s. The new series confirm relative growth of the Norwegian economy until the 1870s, and thereafter relative stagnation. However, the relative stagnation is weaker than according to previous estimates.

Admittedly, the gaps during World War I seem very high. But still the results for the greater part of the new series are within the suggested margins of error in the old series (Bjerke, 1966; pp. 8-14).

## 9. Conclusions

The present paper offers new estimations of Norwegian gross domestic product from the production and the expenditure side 1816-2019. It sits on GDP by 17 industries and 78 sub-industries. The calculations are done on the basis of available sources on input, output volumes and prices. Fixed price calculations are done by adopting a double deflation technique where it is possible. The new series rest on a significantly larger amount of data than previous ones and are revised up to the most recent standards SNA10.

The new series are within the estimated errors of the old series. However, some significant differences exist. The new aggregated series show a somewhat lower level of GDP until the mid 1800s. From then on and until the turn of the century the new series show significantly higher growth rates than the old. When in the 1920s it shows lower growth rates. It is also more in line with international trends and business cycles than the old one. Thus, the new series on GDP by industry, presented in this paper seem fairly consistent, valid and reliable.

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