Observations from New Historical National Accounts for Sweden

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Sweden has a long tradition in constructing historical national accounts. Recently, the fifth reconstruction was completed after a long period of time[1] which means that there are comprehensive accounts for the 19th and 20th centuries. Thereby, well founded analyses of long-term patterns of change and transformation can be carried out.

In this paper such an analysis is made. First, a short overview is provided of earlier efforts to construct historical national accounts and comparisons are made between the new series and some previous ones. After that, effects of the deflation techniques, i.e. double deflation, are analysed. The new deflators are compared with those resulting from single deflation, i.e. output deflators. A periodisation of the Swedish economic change is then analysed using modern time series analysis.

Previous work on Swedish historical national accounts

The first construction of Swedish historical national product series was initiated by Gösta Bagge, professor of economics in Stockholm, and published in the 1930s. The work on national income was performed by a team headed by Erik Lindahl, also professor of economics. Lindahl elaborated the theoretical framework and wrote the theoretical parts of the volumes, where the outcome of the project was published. The empirical work was, to a large extent, performed by Einar Dahlgren, a very diligent statistician. Karin Kock, later professor

[1] Krantz, Olle and Schön, Lennart (2007, *Swedish Historical National Accounts 1800-2000,* Lund Studies in Economic History 41, Almqvist & Wiksell International 2007. See also *http://www.ehl.lu.se/database/LU-MADD/National%20Accounts/default.htm*.

of economics in Stockholm, was employed to write some parts of the work and to bring the project to a conclusion, which she made in very energetic and competent way.[2]

The outcome of the project was two books on the Swedish national income 1861-1930. In one of them the main series are presented and analysed, while the other volume, contains a great number of appendices with detailed accounts of the data and sources. The series were estimated in current prices only, and no systematic calculations in constant prices were made. The only deflation carried out was made with the help of a cost of living index,[3] the explicit aim being to provide a welfare view.

The next work on Swedish historical national accounts was carried out by Olof Lindahl in the early 1950s and his main contribution concerned the period 1930-1950.[4] A revision was then made by Östen Johansson.[5] They both relied heavily on Lindahl/Dahlgren/Kock's series. Johansson's work had to do with Simon Kuznets' attempts to form an international network in order to create series for as many countries as possible. The Swedish part of the project was headed by Erik Lindahl. In a previous work Johansson had estimated completely new figures for building and construction[6] and these figures were integrated in his work on Sweden's historical national product. Furthermore, Johansson made a volume calculation. He assigned deflators for the gross output of the various industries. The sector totals were, however, not aggregated to form a GDP series in constant prices. Instead, the total GDP volume as well as the sector totals were computed using a cost of living index. Thus, as to deflation, Johansson did not go any further than Lindahl/Dahlgren/Kock and Olof Lindahl.

The next estimate of Swedish historical national accounts was made in the first half of the 1970s by Olle Krantz and CarlAxel Nilsson.[7] The current value series were obtained from Östen Johansson's book, but revisions, mostly minor, were made. The emphasis was laid on constant price calculations, and, thus, the deflators were new and more elaborated than in

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2 Lindahl, Erik, Dahlgren, Einar and Kock, Karin (1937), *National Income of Sweden 1861-1930,* I-II, Stockholm and London. The National Income project with all its problems is described in Carlson, Benny (1982), Bagge, Lindahl och nationalinkomsten. Om National Income of Sweden 1861-1930 (Bagge, Lindahl and National Income. On National Income of Sweden 1861-1930), *Meddelande från Ekonomisk-historiska institutionen, Lunds universitet,* Nr 27..

3 Myrdal, Gunnar (1933), *The cost of living in Sweden 1830-1930,* Stockholm.

4 Lindahl, Olof (1956), Sveriges Nationalprodukt 1861-1951 (Swedish National Product 1861-1951), *Meddelanden från Konjunkturinstitutet,* Serie B:20, Stockholm.

5 Johansson, Östen (1967), *The Gross Domestic Product of Sweden and its Composition 1861-1955,* Uppsala.

6 Johansson, Östen (1958), *Byggnads- och anläggningsverksamheten i Sverige 1861-1955,(Building and Construction in Sweden1861-1955)* Mimeo, Uppsala.

7 Krantz, Olle/Nilsson, Carl-Axel (1975), *Swedish National Product 1861-1970. New Aspects on methods and Measurement*, Lund.

earlier computations. This is primarily true for the period up to and including 1950 when all series both for current values and deflators were linked to data taken from Statistics Sweden but reweighted. The study was to a great extent preliminary and the intentions were two-fold; to raise some methodological questions, and to come to terms with the most serious inadequacy in the earlier works, deflation. It was, thus, clear and explicitly stated that Krantz/Nilsson's new volume series had short-comings. The new deflators were for instance estimated only for the expenditure side of the accounts and were then used for the production side as well. It was made clear that studies on economic growth et cetera should be made using the expenditure series and the series on the production side were only aimed for analyses of structural change. However, this fact has not been observed by various scholars who have used the series and criticised them for not being what they were not intended to be.[8]

The present project

The methods adopted in Krantz/Nilsson's study formed one of the starting points for the research project *Structural Change in the Swedish Economy 1800-1980. Construction and Analysis of National Product Series,* conducted at the Department of Economic History, Lund University. The project was carried out in the 1980s and early 1990s but for various reasons it was not accomplished until 2007. The intention was to calculate completely new series for the 19th century up to 1861 and partly new, partly revised series for the period thereafter up to 1950. For the time span after 1950 the project was to rely on data in the contemporary national accounts computed by Statistics Sweden.[9] Current values as well as data used for constant price calculations were published in nine volumes all with the main title *Historiska nationalräkenskaper för Sverige (Historical National Accounts for Sweden, HNS)*.[10]

[8] One example is found in Edvinsson, Rodney (2005), *Growth, Accumulation, Crisis: with new Macroeconomic Data for Sweden 1800-2000*, Stockholm: Almqvist & Wksell International, where a comparison is made of Swedish cycles according to various GDP estimates. He reports the following percentage figures for the change of GDP 1920-21: Östen Johansson -11.9, Krantz/Nilsson 3.1, Krantz, Olle (2001), *Swedish Historical National Accounts – Aggregated Output Series*, Preliminary version, Mimeo, Umeå, -5.0, Edvinsson -8.1-9.8. However, the appropriate figure (Gross Domestic Supply) from Krantz/Nilsson (1975) is -10.5! It can be added that according to the present estimate the figure is - 4.9 per cent.

[9] The background, method, and empirical approach of project are described in Krantz/Schön (2007).

[10] The volumes are 1) Schön. Lennart, Jordbruk med binäringar 1800-1980 (Agriculture and Ancillaries), Lund 1995; 2) Schön, Lennart Industri och hantverk 1800-1980 (Manufacturing Industry and Handicrafts 1800-1980) Lund 1988; 3) Pettersson, Lars, Byggnads- och anläggningsverksamhet 1800-1980 (Building and construction 1800-1980), Lund 1987; 4) Krantz, Olle, Transporter och kommunikationer 1800-1980 (Transports and Communications 1800-1980), Lund 1986; 5) Krantz, Olle, Privata tjänster 1800-1980 (Private Services 1800-1980) Lund 1991; 6) Krantz, Olle, Husligt arbete 1800-1980 (Domestic Work 1800-1980), Lund 1987;7) Krantz,

For the general design of the HNA it was decided to estimate gross output for the various industrial sectors and branches and allocate it to different uses. Then appropriate parts could be summed up to form aggregated series. Generally speaking, the procedure means that a crude input-output approach is employed. Its origin is found in Lindahl/Dahlgren/Kock´s work.

One issue that perhaps by some scholars will be conceived as inadequate and, thus, criticised is that methods, arrangements, and terminology of the modern national accounts developed in several editions of System of National Accounts (SNA) are not used in the new Swedish HNA. The last edition of SNA is from 1993[11] and, thus, it appeared a long time after the design of the present project. It would of course have been possible to transform the data to comply with the modern principles but it was decided not to do so. Instead the original design was employed for the present HNA.

The method of deflation opted for was chain indices with yearly links of a Paasche type as deflators. Furthermore, all value added series in constant prices are calculated by means of double deflation. Thus, output from and input to all branches are deflated separately by their respective set of price series. Value added in constant prices then appears as deflated output minus deflated input. It was possible to follow this procedure for all sectors back to 1800 thanks to the price material and the input and output data collected in the sector volumes. [12]

As mentioned, the project was not finished until 2007 and the following analyses are based on the new series.[13]

Olle, Offentlig verksamhet 1800-1980 (Public Services 1800-1980), Lund 1987;8) Schön, Lennart, Utrikeshandel 1800-1870 (Foreign Trade 1800-1870), Mimeo 1984; 9) Ljungberg, Jonas, Deflatorer för industriproduktionen 1888-1955, (Deflators for Industrial Production 1888-1955) Lund 1988.

11 The previous edition was from 1968.

12 The basic data from the present project have been used in works by Kander (2002) and Vikström (2002). They have also been utilized by Edvinsson, (2005), where he, however, uses other methods and principles than in the present project.

13 In a review article, Bohlin (2003) has dealt with the present project. It is an odd article since it treats a semi-finished project from which, at the time when the article was written, mainly unpublished and preliminary aggregated series existed. Maybe, this is the first review article ever in a well-known refereed journal to lay great stress on non-published preliminary reports. The article is strange also in the sense that it does not at all deal with the basic methodology of the project, the plans for it and how it was carried out.

Some comparisons with other series

As mentioned, a number of HNA constructions for Sweden have been made and here some comparisons between the new series and the most frequently used of the earlier ones, Johansson's and Krantz/Nilsson's, will be made.

As seen in table A, there are some differences between the old series and the new ones. According to the latter, the GDP growth in the second half of the 19th century is slower and the same is true in the 1930s and 40s, particularly in relation to Johansson. Then, however, the new series show a higher growth rate than the old one, in this case, Krantz/Nilsson.

Table A. Annual growth rates of GDP per capita in constant prices according to Johansson, Krantz/Nilsson and the new series respectively, 1861-1970.

	The new series	Krantz/Nilsson	Johansson
1861-1890	1.3	1.7	1.8
1890-1910	2.6	2.5	2.6
1910-1930	1.9	1.9	1.7
1930-1950	2.6	2.8	3.6
1950-1970	3.8	3.2	-
1861-1950	2.0	1.9	2.2
1861-1970	2.3	2.1	-

Table B. Annual growth rates of sector output and GDP in constant prices according to Johansson (ÖJ), Krantz/Nilsson (KN) and the new series 1861-1970.

	Agriculture and ancillaries						Manufacturing industry and handicrafts					
	ÖJ		KN		New		ÖJ		KN		New	
	%	R^2	%	R^2	%	R^2	%	R^2	%	R^2	%	R^2
1861-1890	1.8	0.82	1.9	0.86	1.6	0.77	2.6	0.76	4.0	0.95	3.9	0.97
1890-1910	1.6	0.79	1.0	0.51	0.9	0.46	6.3	0.93	6.6	0.97	6.3	0.98
1910-1930	-1.0	0.19	0.2	0.04	0.7	0.24	3.0	0.53	4.4	0.73	1.8	0.43
1930-1950	2.3	0.71	-0.4	0.06	-1.8	0.67	5.8	0.94	5.1	0.87	5.0	0.93
1950-1970	--	--	-0.3	0.17	0.2	0.18	--	--	4.7	0.98	5.4	0.98
1861-1950	1.1	0.82	1.2	0.89	0.8	0.95	4.3	0.97	4.7	0.99	4.3	0.98
1861-1970	--	--	1.0	0.85	0.6	0.61	--	--	4.6	0.99	4.3	0.99
1861-1950 average	1.3	--	0.8	--	0.5	--	4,2	--	4.9	--	4.2	--
1861-1970 average	--	--	0.6	--	0.4	--	--	--	4.9	--	4.4	--

	Building and construction						Transport and communication					
	ÖJ		KN		New		ÖJ		KN		New	
	%	R^2	%	R^2	%	R^2	%	R^2	%	R^2	%	R^2
1861-1890	3.7	0.48	2.1	0.52	2.0	0.51	6.0	0.96	6.5	0.96	4.4	0.91
1890-1910	2.9	0.57	2.5	0.58	3.1	0.59	4.4	0.99	6.1	0.98	5.2	0.97
1910-1930	4.0	0.57	2.2	0.29	-1.7	0.29	3.3	0.85	4.7	0.60	4.0	0.77
1930-1950	2.9	0.55	2.7	0.55	4.1	0.81	3.7	0.96	3.8	0.82	6.2	0.96
1950-1970	--	--	3.7	0.93	4.7	0.99	--	--	4.0	0.99	4.2	0.99
1861-1950	2.6	0.87	1.7	0.85	1.1	0.66	4.1	0.98	4.9	0.98	4.4	0.99
1861-1970	--	--	2.1	0.91	1.8	0.78	--	--	4.8	0.99	4.6	0.99
1861-1950 average	3.4	--	2.3	--	1.9	--	4.5	--	5.4	--	4.9	--
1861-1970 average	--	--	2.6	--	2.4	--	--	--	5.2	--	4.8	--

	Private services						Public services					
	ÖJ		KN		New		ÖJ		KN		New	
	%	R^2	%	R^2	%	R^2	%	R^2	%	R^2	%	R^2
1861-1890	2.4	0.93	2.6	0,99	2.1	0.95	3.6	0.95	1.9	0.94	0.2	0.05
1890-1910	3.3	0.98	3.4	0.99	3.8	0.95	2.6	0.94	1.3	0.98	1.8	0.76
1910-1930	2.1	0.82	3.3	0.97	3.0	0.93	4.8	0.86	2.9	0.89	0.6	0.04
1930-1950	3.7	0.96	1.2	0.78	1.6	0.34	5.8	0.92	3.3	0.97	5.4	0.66
1950-1970	--	--	3.9	0.99	4.5	0.99	--	--	3.8	0.99	3.9	0.99
1861-1950	2.8	0.99	2.9	0.99	2.6	0.99	3.7	0.97	1.7	0.93	1.5	0.78
1861-1970	--	--	2.9	0.99	2.8	0.98	--	--	2.0	0.94	1.9	0.87
1861-1950 average	2.8	--	2.6	--	2.6	--	4.1	--	2.3	--	1.8	--
1861-1970 average	--	--	2.9	--	2.9	--	--	--	2.6	--	2.2	--

	GDP					
	ÖJ		KN		New	
	%	R^2	%	R^2	%	R^2
1861-1890	2.4	0.93	2.3	0.94	2.0	0.91
1890-1910	3.4	0.98	3.2	0.98	3.3	0.98
1910-1930	2.2	0.74	2.5	0.82	2.4	0.89
1930-1950	4.1	0.66	3.4	0.90	3.2	0.93
1950-1970	--	--	3.7	0.99	4.5	0.98
1861-1950	2.8	0.99	2.5	0.99	2.7	0.99
1861-1970	--	--	2.8	0.99	2.9	0.99
1861-1950 average	3.0	--	2.8	--	2.6	--
1861-1970 average	--	--	3.0	--	3.0	--

In table B, a comparison is made between the growth of the output of the sectors according to the three HNA constructions. There are clear differences, the most spectacular being between Johansson on one hand and on the other Krantz/Nilsson and the new series. This is to a large extent due to the fact that Johansson throughout has used a cost of living index as deflator while in the other two HNA estimates sectors and branches are deflated separately. This is for instance noticeable in agriculture 1930-50 where the growth rate according to Johansson's series is 2.3 per cent while it was negative according to the other two data sets. Also for public services this effect is clear since in Krantz/Nilsson's and the new series the common technique of deflating a large part of the sub-sectors with remuneration of labour is used.

In one of the sectors, building and construction, there is an apparent peculiarity which should be commented on. The growth rates for the long periods, 1861-1950 and 1861-1970, are lower than could be expected from the rates for the various sub-periods. In other words, the average for these periods is higher than the rate calculated for the longer time-span. This has to do with the very great fluctuations in this sector's output, especially in the early part of the 20th century. This is clear from the R^2 coefficients.

In general, the determination coefficients for building and construction are lower than for manufacturing industry, transport and communication, and private services. The coefficient is particularly low for the period 1910-1930 in Krantz/Nilsson's series and in the new ones. This period comprises WWI and its aftermath when the price and output changes were great, not least for building and construction as will also be touched upon below. It should be added here that the estimates for this sector are generally uncertain for early periods due to scanty source material. This fact made for instance Lindahl/Dahlgren/Kock to leave out this sector completely.

For agriculture and public services the determination coefficients are also lower than for industry, transport and private services. In the case of agriculture this has to do with the fact that the output changes are lower, to a great extent following population changes in the long run at the same time as productivity rose. This means that instead of rising production there was an out-migration of labour to other sectors. For public services deflation, as mentioned, is to a great extent based on remuneration. Thus, productivity changes are implicitly assumed to be non-existent. However, this sector's output boosted during the two world wars with the effect that the growth figures in the table are uncertain. Furthermore, during the first sub-period, the growth of public services was practically non-existent in contrast to the other sectors, which probably had to do with how the services were performed. There was for instance a huge state railway building but this is visible in the building and transport sectors. In the next sub-period, however, public services grew which among other things had to do with changes in the military system from a standing army paid in kind to a system of conscription paid by taxes. These effects are not visible in the Krantz/Nilsson series and the differences are probably due to the different deflation methods.

Double deflation of value added

In the final set of aggregate HNA (Krantz/Schön 2007), all value added series in constant prices are calculated by means of double deflation. This means that output and input are deflated separately with deflators constructed from their respective set of products. Value added in constant prices then appears as deflated output minus deflated input. This is considered as the best procedure for value added deflation and it is followed in modern national accounts. In historical national accounts the procedure of double deflation is very unusual and it is a specific asset of our series. The reason is of course that for double deflation you need a very detailed set of annual inputs as well as annual prices. This has been accomplished both by the meticulous sector volumes containing material for the input structure and by the supply of historical price series. Such series has been obtained from Jörberg and Ljungberg[14] and has been complemented by price series constructed in the sector volumes by Krantz and Schön.

Usually when there is only single deflation, as is the case in the sector volumes of the present HNA, value added in constant prices are calculated by means of output deflators of the sub-branches which are aggregated to sector deflators or GDP deflators with their respective shares of value added in the base years as weights. This is a second best solution.

Every deflation is a calculation keeping certain factors constant. Whenever the same set of series in current prices is deflated with two different techniques, a new possibility of analysis appears. Differences in outcome measure the importance of such factors. The so called

[14] Jörberg, Lennart, *A History of Prices in Sweden 1732-1914*. Gleerups Lund 1972. Ljungberg, Jonas, *Priser och marknadskrafter I Sverige 1885-1969. En prishistorisk studie*. Skrifter utgivna av Ekonomisk-historiska föreningen, Lund 1990.

Gerschenkron effects from shifting base years in fixed price calculations - or shifting from Paasche to Laspeyre price indexes - is a well known means to identify changes in the price and quantity structure of production. Comparison of single and double deflation gives other possibilities. Basically a difference between the two deflators indicates the compound effect of input prices on output prices and on output volumes. Single deflation reflects influences on output prices and volumes both from input prices and from contributions of the factors in the production sector per se. Doubly deflated volumes give a more strictly defined value added volume by deducting the volume of inputs and hence a fixed price measure of the combined capital and labour contribution to the product value in each sector. Accordingly, it is a better basis for any productivity estimate.

Comparison between the two deflators gives, evidently, an estimate of the impact from all input factors at different levels of aggregation of the economy. If the value added deflator (i.e. from double deflation) increases in relation to the product value deflator (i.e. from single deflation), there is a relative price increase in labour and services performed within the sector, in relation to input prices, for a certain volume of goods. Thus, there is a positive contribution from input to the product based productivity measure and to the volume of value added. Hence, productivity decreases when this contribution is withdrawn in double deflation. If the value added deflator decreases in relation to the product based deflator, the effect runs of course in the opposite direction.

Table C. The ratio between double deflated value added price indices and product based value added price indices at sector level and GDP level 1800-1950. Ratio in annual percentages effect.

	1800-1875	1875-1950	1800-1950
Agriculture	0.00	0.22	0.07
Industry	0.58	0.05	0.18
Building	0.26	1.20	0.61
Transport	0.60	-0.37	0.16
Private services	-0.05	0.02	-0.04
Public services	-0.03	0.80	0.49
GDP	0.04	0.17	0.11

In the long run 1800-1950 the double deflated value added deflator at the GDP level has increased annually by 0.1 percent in relation to a product based value added deflator. This means basically that there has been a positive contribution to growth from imported inputs.

This effect was on the whole negligible before the 1870s but increased to close to 0.2 percent 1875-1950. This is a variant of positive terms of trade for Sweden in the period of industrialisation and expanding foreign trade. It is not directly terms of trade, though, since it involves not only the import and export sectors but the total price structure of the economy. There might, for instance, be input price effects on output prices in forward linkages that deviate from price effects of the internal production factors. This effect is clear at sector levels.

On sector level, the relationship between double and single deflators varied considerably. In the first period 1800-1875, there was a strong positive effect from input in industry and transportation. Thus, in industry annual output growth was 2.6 percent measured by products but only 2.0 percent measured as manufactured value added. A considerable part of early industrial growth depended upon imports of input material at falling prices. It is clearly so in the case of raw cotton and cotton yarn imported in increasing quantities. It goes also for tobacco and sugar and of course for coal.

Quite naturally the effect is about as equally as strong in transport and communication. Annual growth rates of this sector fall from 2.1 percent to 1.5 percent when going from the output price based deflator to the new value added deflator. Also in building the effect was considerable but in the case of constructions, the positive input effect came mainly from relatively falling prices of domestic input and transportation.

In agriculture and services the effect was negligible. One can also conclude that the two most expansive sectors in the Swedish economy 1800-1875 - transportation and industry - received the strongest positive contribution from international market integration and from technological change and industrial growth in other countries.

As indicated above, the overall positive influence increased considerably in the period 1875-1950. The sectoral composition of this influence changed however drastically. Now the effect of relatively decreasing input prices appeared in the typically domestic sectors of building and public services. In building the effect was particularly strong. Thus, while the product based volume output of building and construction increased by 2.2 percent annually, the value added of the sector grew by only 1.0 percent. The reason is clearly that new industrial input such as steel and cement became increasingly cheaper in relation to labour. Furthermore this effect came very dramatically in the 1920s. On one hand, raw material prices fell internationally after the First World War. By 1925, the price of steel and cement, for instance, hade fallen to ½ or 1/3 of the 1920 prices.[15] On the other hand, nominal wages for urban workers fell only by roughly 1/10 according to wage indexes,[16] so hourly real wages soared particularly after the new regulations of working hours in 1920. Thus, while industrial input prices in constructions had a downward influence on output prices, a handicraft production process with rising wages increased the price of the sectors compound value added. The same is basically true for public services although the effect was somewhat weaker - in all 0.8 percent annually.

In agriculture a similar effect becomes more pronounced from the 1930s. A new agricultural price and income policy raised the internal price level while there was a positive input effect from industry and transportation in the modernisation of the agricultural sector.

In both these cases - as well as in agriculture and on the GDP level - the slower growth of doubly deflated value added volume is particularly pronounced from the 1910s. Thus, for the period 1910-1950 we have the following relations between annual change in the doubly deflated value added indices and product based value added indices: GDP 0.28; agriculture 0.38; building 1.60; public services 1.01. Thus, the tensions grew between, on one hand, inputs from industry, transportation and imports at relatively falling prices and, on the other hand, labour in non-mechanised sectors at relatively rising prices.

Within the domestic sectors of industry and transportation technological development within each sector neutralises any positive effects from inputs. In transportation development actually reverts. There is an annual positive effect from internal sector value added formation of 0.4 percent upon growth that becomes particularly strong from the 1890s onwards. Thus, the downward pressure on prices came primarily from technological change and productivity increases through the sustained modernisation of the transportation and communication infrastructure and equipment.

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[15] Ljungberg (1990) a.a.

[16] Bagge Gösta et.al., *Wages in Sweden 1860-1930*,Vol I-II. Stockholm 1933, 1935. Krantz (1987) a.a.

Trend Growth in Aggregate Output 1800—2000. Stochastic Trends, Deterministic Trends and Structural Change

In this section growth trends in the new aggregate real GDP series are preliminary examined. The aim is to analyse the way in which primarily technological change have influenced the conditions for long-term growth of total output in Sweden between 1800 and 2000. Growth trends in real GDP are analysed in a "unit root" framework. A unit root test aims at separating trend stationary processes and difference stationary processes in the new macroeconomic time series. A trend stationary processes (or deterministic trend in a context of economic growth) in total production implies that the rate of technological change is constant and that deviations are temporary so that growth returns to the steady long-term trend. A difference stationary processes (or stochastic trend), on the other hand, implies that the impact of technological change on economic growth is discontinuous mainly because technological change itself is discontinuous, of varying magnitude and takes time to realize.[17]

The common economic interpretation of a difference stationary process is that economic fluctuations are caused by permanent random shocks that have persistent effects on the future path of the macroeconomic time series. Difference stationary processes in macroeconomic aggregates feels intuitively appealing in economic history in that it depict economic growth and fluctuations as a cumulative effect of mainly countless technological changes to productivity. In that sense it seems to be a more "realistic" representation of the complicated and irregular processes in economic development that lie beneath real macroeconomic aggregates, even though the "randomness" of shocks may be disputed as well as the idea that "shocks" mainly have "real" causes, as is emphasised in real business cycle theory. However, a number of other sources of shocks, obvious to economic historians, have been suggested to supplement technological change, ranging from fiscal shocks, changes in monetary policy, investment-specific technological change to, not least important in the Swedish case, international influences. Trend stationary processes, on the other hand, suggest that growth path of macroeconomic time series follow a deterministic linear trend and that chocks are

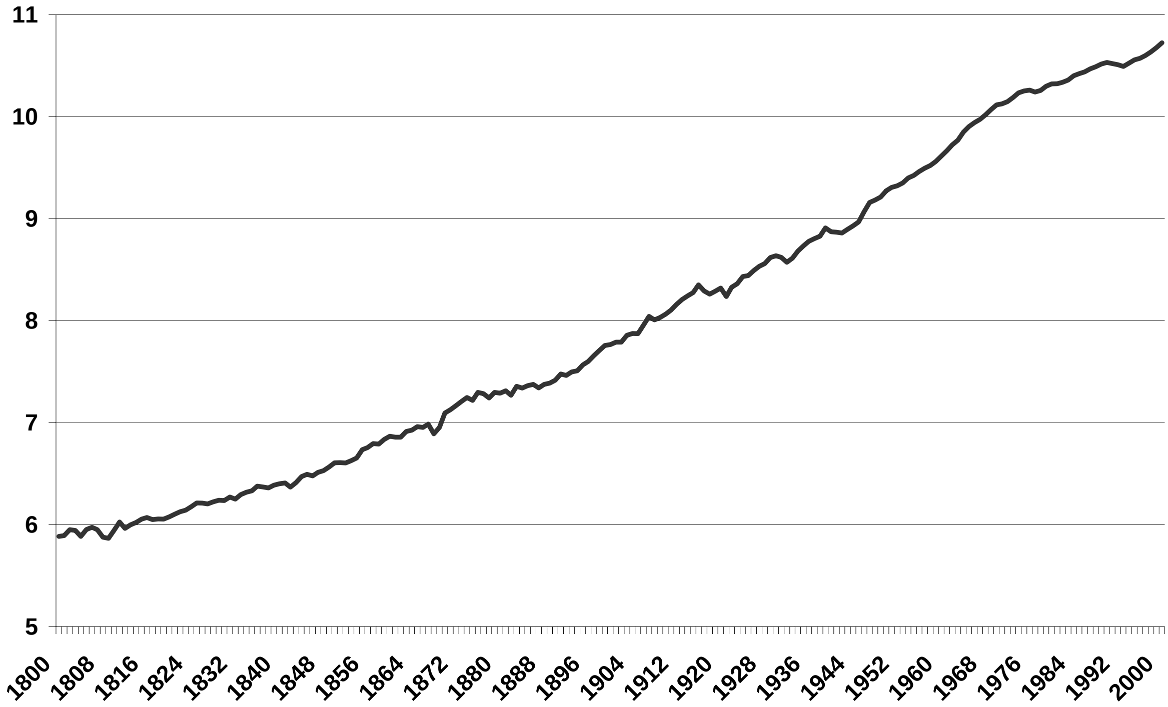
[17] There has been a large interest in analysing individual macroeconomic time series in this context since 1982 when Nelson and Plosser established that US output series contain unit roots, or are "difference stationary". The existence of unit roots and the failure to identify deterministic trends seemed to comply with a "Real Business Cycle" view of economic trends and cycles that emerged in the 1970s and represented by the well-known work of Kydland and Prescott. Until then it was commonly believed that macroeconomic time series are cyclical and typically reverts to a deterministic trend, or are "trend stationary". See Nelson and Plosser (1982), Kydland and Prescott (1982). See King and Rebelo (1999) or Rebelo (2005) for an overview.

transitory so that economic fluctuations tend to decay and return to a long term growth trend, consistent with the neoclassical Solow growth model and "Keynesian" business cycles. Obviously, such a representation of long term economic development does not seem plausible at all, but economic development divided into segments or broken trend stationary processes might well be. An analysis of the stochastic properties of GDP growth and trend brakes over this long period therefore might add to the well-known discussion of growth and change in Swedish economic development.[18]

It is easy to see that the new real GDP series in Figure 1 does not follow a linear deterministic trend over the whole sample 1800-2000. Nor is it expected since the Swedish economy were being subject to a number of fundamental economic changes that altered the path of output growth during this long period. Nevertheless, there is an obvious drift in the series.[19] Accordingly, the task in this section of the paper is to separate deterministic trends from stochastic trends (or random walks with drift) in real GDP and to examine how the trend growth-dynamics changed between different periods during the two hundred years covered by the new series.[20]

[18] See e.g. Schön (1994, 2000) or Krantz (2002).
[19] The difference between deterministic trends and random walks with drift is not altogether straightforward in a long run context. De Long and Summers and others have questioned the very idea that the "drift"-component of a "random walk with drift", typical process for a macroeconomic time series containing a unit root, should be very much different from a deterministic trend. De Long and Summers (1988).
[20] There are also statistical considerations that justify an analysis of the stochastic properties and segments of the new macroeconomic time series. It is well known, for instance, that regressions of detrended difference stationary variables against detrended trend stationary variables leads to spurious regressions. Moreover, detrending difference stationary series, i.e. a random walk with drift, by regressing it against time might result in spurious periodicity. See e.g. Maddala & Kim (1998) or Perron and Wada (2006).

Figure 1 **Natural Logarithms of Real GDP 1800-2000**



The analysis starts by testing for unit roots in the real GDP series to determine the dynamics and appropriate modelling of the time series processes that characterise the real output series. The standard Dickey-Fuller (DF) method is used to test the series for unit roots.[21] The DF-test is carried out on the whole sample and on sub-periods roughly divided by the accelerating industrialisation in the 1870s and by the two World Wars. The World Wars and a few following years are omitted from the sample periods. CUSUM of Squares and Rolling Regressions are employed to test the stability of the DF ordinary least square regressions.

The first conclusion is that the real GDP series in both the full sample 1800—2000 and sub-periods, shown in table 2**,** are difference stationary. Second, the estimated Dickey-Fuller

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[21] A difference stationary autoregressive process with drift can be written as $y_t = \alpha t + \rho y_{t-1} + u_t$, where y_t is the variable of interest, αt is a time trend component, ρy_{t-1} is a first order autoregressive process and u_t is a random disturbance term. A unit root test tests if the autoregressive coefficient ρ=1. The Dickey-Fuller test uses unit root as null and tests an integrated version of the equation above:
$\Delta y_t = \alpha t + (1-\rho) y_{t-1} + u = \alpha t + \delta y_{t-1} + u_t$. If the coefficient δ is found not to be statistically different from zero, then it is assumed that ρ=1.

representation is not stable during the sample periods. Both CUSUM of Squares and Rolling Regression sequential tests indicates instability.

Table 2 Unit Root test results ln real GDP

Period	Deterministic Trend	Unit Root Test	5% level critical value	Test statistic	TS/ DS
1800-2000	na	DF	-3.4325	-2.3596	DS
1800-1870	na	DF	-3.475305	-2.499225	DS
1870-1914	na	DF	-3.513075	-1.424900	DS
1921-1939	na	DF	-3.658446	-2.802757	DS
1947-2000	na	DF	-3.495295	-1.063115	DS

However, Perron and others have demonstrated those unit root tests are very sensitive to structural change.[22] Perron argues that a small number structural breaks in macroeconomic time series, splitting a series into segments, may render unit root tests inconclusive or even flawed. Instead, long macroeconomic time series may consist of segments, or polynomial trends, of trend stationary processes. He found that US output growth in the periods both before and after the oil price chock in 1973 are trend stationary while many unit root tests tends to fail to reject the unit root null hypothesis.

Accordingly the analysis proceeds by identifying structural breaks in the data. It shall be emphasised that we are aware that this type of characterising and modelling the dynamics of the time series probably will attract criticism of “fishing” or “data mining” for breakpoints and periodicities. Perron, Crafts et al. and others argues convincingly that breakpoints must be established a priori.[23] Others, however, argue that purely statistically identified breakpoints might have a value and present a variety of methods, such as recursive, rolling or sequential

[22] See Perron (1989), Maddala & Kim (1998), Perron and Wada (2006) or Mill and Crafts (1996). Mills and Crafts argue that growth trends should be expected to vary in the long run. The basic reason is technological change appear to be irregular. Major inventions are followed by numbers of endogenous micro-inventions, which are subject to diminishing returns, and thus causing the rate of productivity growth to alternate between increase and decay in the long run. ((Mill and Crafts (1996))
[23] Perron (1989), Mills (1996) and Crafts et al. (1996).

tests for breakpoints.[24] Following these warnings, approximate breakpoints are established a priori, based on historical knowledge and then dated statistically more precise by using recursive unit root tests. The 1850s, the 1890s and the 1970s are chosen as decadal candidates for approximate breakpoints (the already small size of the samples is of course also a restriction). There is good reason to believe that there may be a breakpoint in the 1850s due to the major changes in transports and communications, financial institutions and the economic impact of the Crimean War. The 1890s might be chosen since it marked the end of the deflationary 1880s. We also know that growth slowed down in the 1970s and, as said before, Perron and others have shown that broken trend stationary process is a better representation of post-war GNP growth in the US case.

Figure XXa-c reports the results of breakpoint tests by recursive DF-tests which suggests that there are breakpoints present in the sub-samples, indicated at the dates when the test statistics are smaller than the critical values.[25] A breakpoint between two deterministic trends is detected if the test statistics of both samples indicate at the same date that the unit root null can be rejected. However, the tests do not suggest broken deterministic trends, but rather deterministic trends that are switching into stochastic trends. Accordingly, the last dates at which the tests indicates trend stationarity for the segments in each period are chosen as breakpoints in which trend stationary processes changes into difference stationary processes in 1853, 1896 and 1975. Test statistics for each segment are shown in Table XX.

[24] See e.g. Banerjee, A., Lumsdaine, R. and Stock, J. (1992), Crafts and Mills (1996).

[25] The tests are carried out by recursively adding one observation to the first part of the sample and at the same time recursively subtracting one observation from the second part of the sample and plot the test statistics and critical values for each of the sub-samples. However, as noted by Banerjee, et. al. (1992) and others, the ordinary probability distributions does not apply when structural breaks are statistically determined. It should be noted that that has not been done in the present work.

Figure XXa DF test statistics of recursive samples starting in 1800 and recursive samples ending in 1870.

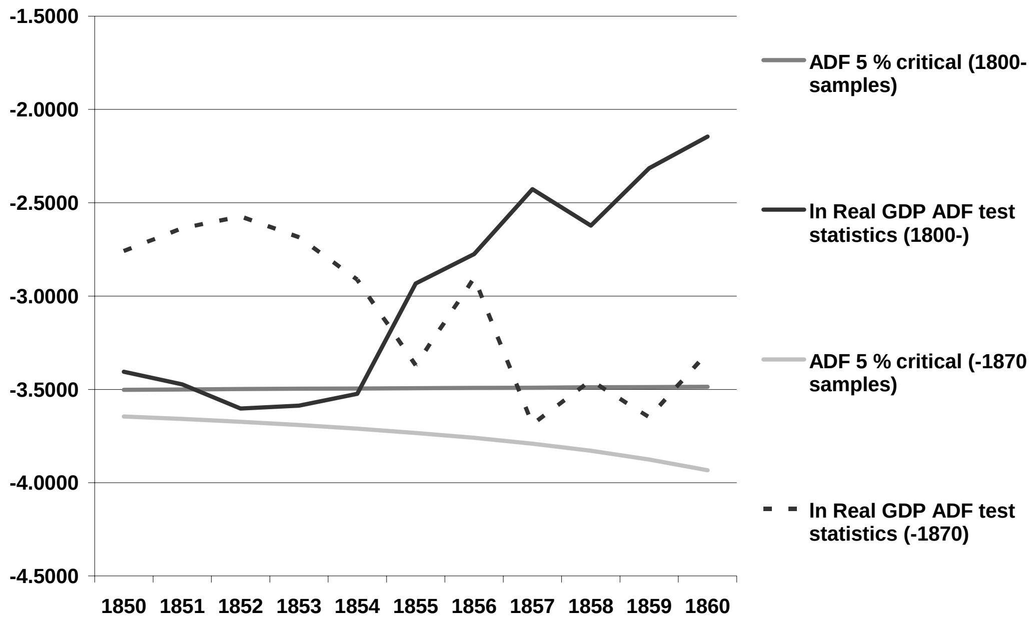

Figure XXb DF test statistics of recursive samples starting in 1870 and recursive samples ending in 1914.

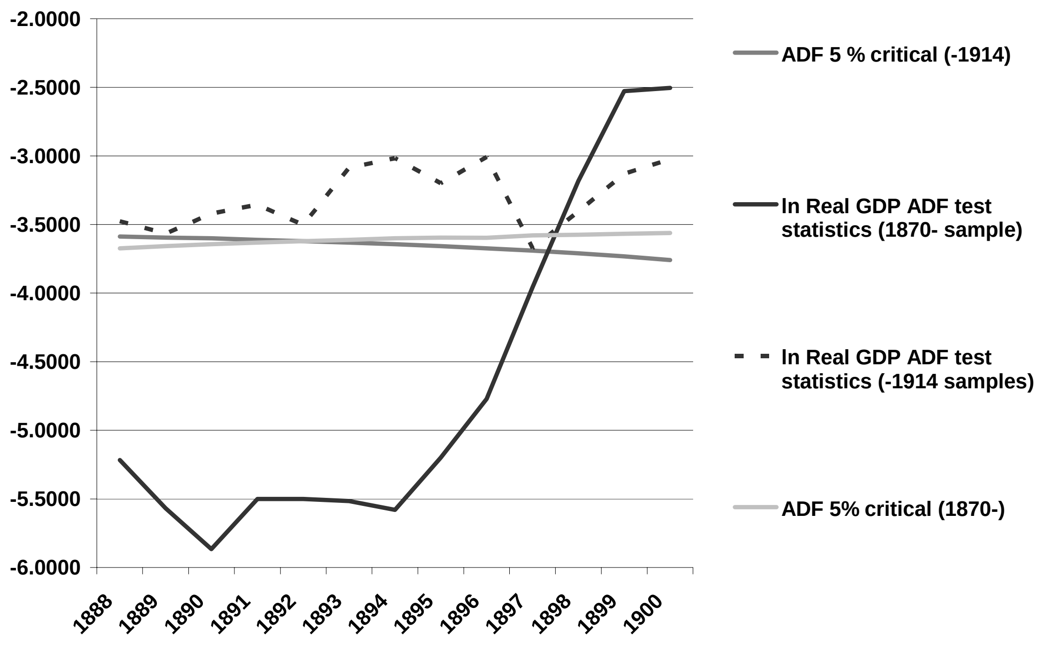

Figure XXc DF test statistics of recursive samples starting in 1947 and recursive samples ending in 2000.

Table XX Unit Root test results ln real GDP

Period	Deterministic Trend	Unit Root Test	5% level critical value	Test statistic	TS/ DS
1800-1853	0.014295	DF	-3.496960	-3.587108	TS
1853-1870	na	DF	-3.690814	-2.684919	DS
1870-1896	0.015416	DF	-3.587527	-4.771681	TS
1896-1914	na	DF	-3.673616	-3.008266	DS
1948-1975	0.041973	DF	-3.580623	-3.859930	TS
1975-2000	na	DF	-3.595026	-2.546433	DS

To conclude, the new historical national accounts provide new opportunities in the analysis of the long run economic development in Sweden. The results of this preliminary analysis of trend growth indicates that segments of Swedish real GDP growth can be modelled as alternating periods of trend stationary processes and difference stationary processes.

An economic interpretation of this pattern might be that periods of relative stable growth of aggregate real output, like the periods 1800-1853 (with some precaution), 1870-1896 and 1948-1975 were followed by periods of greater instability. Permanent chocks of different kinds during these periods – technological, institutional, or political, exogenous or endogenous – caused output to enter into new paths in a less predictable manner. This was the case from the 1850s, 1890s and 1970s. The result thus essentially corresponds with earlier findings of discontinuities in long term Swedish economic development with characterisations of structural periods from other criteria.[26] In contrast to these earlier findings and periodicity no such break point was established during the inter war period. This period however – particularly with the inclusion of the wars – showed weak trends and strong fluctuations over all. Hopefully this preliminary analysis will inspire further studies within this framework.

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