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New Measurement and Cliometric Analysis of Shocks

Jean-Luc DEMEULEMEESTER, Claude DIEBOLT ([1]) & Magali JAOUL-GRAMMARE

Abstract: Aggregate wage earnings are one of the key variables of the German economy. Paradoxically, it is also a little known variable, especially in the long term. Historians have never devoted a synthesis to the subject and, among all the economists who have centred their work on the study of economic growth, Walter Hoffmann (1965) is the only one to have addressed aggregate earnings over a long period. This article follows up his founding work and has two objectives. The first is to measure the movement of wages and wage earners over a long period and use this to make an original estimate of aggregate employment earnings in Germany from 1810 to 1989. Reconstituted sets of statistics are also used to put forward new hypotheses concerning the way is which wages, wage earners and aggregate employment earnings in Germany are linked to the socioeconomic development of the country in the nineteenth and twentieth centuries. It is also sought to detect the temporary and permanent shocks that have affected the German economy since the beginning of the nineteenth century. Our reflection is in two parts. The first defines the concept of wages, sets out the spatial scope and describes the methodological constraints. The second describes our cliometric results.

Keywords: Wages, wage-earners, aggregate earnings, retrospective national accounts, cliometrics, Germany.

JEL Classification: C22, C82, N33, N34.

Introduction

Wages play a fundamental role in the determination of economic equilibria. They form an essential component of household incomes and have a direct effect in the setting of final demand and savings. Determinants in company production costs, their movements affecting the behaviour of businesses in price setting, employment and investment. Their multiple effects on physical flows and on monetary magnitudes mean that wages and the way in which they are set are central to the short-term regulation and long-term evolution of developed capitalist economies.

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However, in Germany for example, although the statistics on wages and the occupations of workers are plentiful and varied, their heterogeneity and the gaps in them mean that it is not possible to obtain a rapid and accurate appraisal of the mass of wages distributed over a long period ([2]). The difficulties increase further when breakdowns that display a degree of aggregation are required for specific subgroups: occupational sectors, professional categories, regions, etc.

Taking up this point, this article has two purposes. It first aims at developing a new measurement of the long-term movements of wages and wage-earners and thus obtain an original estimate of aggregate wage earnings in Germany from 1810 to 1989. It is also aimed at using reconstituted sets of statistics to formulate new hypotheses concerning the way in which wages, the workforce and wage earnings are hinged with the socioeconomic development of Germany in the nineteenth and twentieth centuries. We also sought to detect the temporary and permanent shocks that have affected the German economy since the beginning of the nineteenth century.

The points are addressed in two parts. The first defines the concept of wages, presents the spatial field covered and describes the methodological constraints. The second shows our cliometric results.

I. Methodological aspects

Study of the evolution of wages, wage-earners and wage earnings in Germany in the nineteenth and twentieth centuries requires the assembly of new sets of statistics ([3]). As in our previous work ([4]), we used a procedure inspired by cliometrics (cf. www.cliometrie.org).

([2]) Homogeneous information on wages in Germany only appeared in December 1935. "*Von einer nennenswerten und brauchbaren amtlichen Lohnstatistik kann in Deutschland erst seit Dezember 1935 gesprochen werden.*" Hohls, R.: *Arbeit und Verdienst. Entwicklung und Struktur der Arbeitseinkommen im Deutschen Reich und in der Bundesrepublik*, Doctoral Thesis in History, Free University of Berlin, 11 February 1992, p. 10.

([3]) See especially the article by K.H. Kaufhold on the state of knowledge (since 1930) in historical research on wages in Germany. Kaufhold, K.H.: "Forschungen zur deutschen Preis- und Lohngeschichte (seit 1930)", in: Kellenbenz, H.; Pohl, H. (eds.): *Historia Socialis et Oeconomica. Festschrift für Wolfgang Zorn zum 65. Geburtstag*, Special issue of the journal Vierteljahrschrift für Sozial- und Wirtschaftsgeschichte, No. 84, 1987, pp. 81-101. Interested readers can also see Schulz, G.: Résultats, débats et nouveaux champs de travail: Nouvelles recherches sur l'histoire économique du XIXème et XXème siècles en Allemagne, in: *Revue historique*, 118ème année, Tome CCXC/1, 1994, pp. 191-206.

([4]) See in particular Diebolt, C.: *L'évolution de longue période du système éducatif allemand: 19ème et 20ème siècles*, special issue of the journal Economies et Sociétés, Cahiers de l'ISMEA, Série AF, No. 23, 1997. We suggest that interested readers should also visit the website http://www.histat.gesis.org.

1. Wages

The wages concept gave rise to complex problems throughout the nineteenth century. Very general definitions hide fundamental differences. The main uses of the term in everyday life, in political controversies or in scientific writing do not reflect an even approximate single reality. Two major viewpoints make wages either a purchasing power index that is fairly closely defined in relation to well specified material goods or, more broadly, a purely subjective index of well-being.

In the first notion, wages are the sum of the income of a person during a certain period of time. The second notion is much broader and covers monetary and non-monetary income. Thus a wage that has been defined is complemented by a whole series of services whose inclusion is not automatic in the first notion. This definition of wage refers to the notion of standard of living. In a broad sense it is seen as the counterpart of well-being. It is very interesting but, unfortunately, has a major disadvantage when it is applied as there is a two-fold difficulty. Firstly, that of the limit of the list of items to be included in the practical measurement of well-being and secondly the question of how to evaluate these items. A choice between the two concepts of wages must therefore be made.

For reasons of effectiveness, reference is made in this article to the traditional notion of wages as in the first concept, that is to say income drawn directly from a production-related occupation. However, we are aware that there is no single concept that can be used to match all the points of view. Indeed, the statistical definitions of the notion of wages are different in the various concepts. Moving on from there, we define the average wage of a population ensemble made up of several categories (e.g. occupational categories: managers, office workers, labourers, etc.) as being the sum of the average wages of each category weighted by the numbers in each category. Then movement of the average wage of the population depends not only on the movements of the average wage in each category but also on the changes in the proportion of managers, office workers, labourers, etc. The latter feature is referred to as the structure effect and depends in turn on the choice of categories, that is to say the way in which the population is assembled. The quality of historical reconstruction depends in turn on

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This database (Online-Datenbank Historische Statistik) displays the main statistics produced by Claude Diebolt for Germany in the nineteenth and twentieth centuries.

the availability of homogeneous, reliable statistics. However, this is far from being certain for the long period ([5]).

2. Reference territory

For the pre-1945 period, our work is based on the states that formed the German Empire as proclaimed in Versailles on 18 January 1871 and whose territorial cover dates back to the Congress of Vienna, and more precisely to the setting up of the German Confederation, whose Final Act was signed on 8 June 1815. Particular attention is paid to the state of Prussia that first played a guiding role in the economic development of Germany and then turned German unity to its benefit.

For the period running from after World War 2 until the fall of the Berlin Wall on 9 November 1989, marking the end of the study, attention is paid solely to the Federal Republic of Germany (FRG), founded on 8 May 1949. This takes into consideration the structural phenomena reflecting territorial and institutional changes, evolution of behaviour and economic changes. It therefore has fragile components that make the extension of the old trends delicate. However, given the importance of the changes that have affected the German socioeconomic system since 1945, understanding the contemporary system requires information about its post-war developments.

3. Calculation of wages series

Quantitative study of the movements of wages over a long period concerns wage-earners only. Numerous factors cause changes in this population: total population, the proportion of workers and the proportion of wage-earners. In fact, the switch from working population to wage-earning population was not immediate as employment structures differed in the various German states throughout the nineteenth century ([6]). Furthermore, the proportions of agriculture, industry and services varied according to the reference area ([7]). This being so, reliable estimates of the evolution of the wage-

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([5]) See in particular Scholliers, P.; Zamagni, V. (eds.): *Real Wages in the Nineteenth and Twentieth Centuries*, 11th International Economic History Congress, Università Bocconi, Milan, 1994.

([6]) See Hohls, R.; Kaelble, H.: *Die regionale Erwerbsstruktur im Deutschen Reich und in der Bundesrepublik 1895-1970*, Scripta Mercaturae Verlag, St. Katharinen, 1989.

([7]) See Grumbach, F.; König, H.: "Beschäftigung und Löhne der deutschen Industriewirtschaft 1888-1954", in: *Weltwirtschaftliches Archiv*, vol. 79, No. 1, 1957, pp. 125-155.

earning population and hence the employment earnings ([8]), only really started with the founding of the German Empire ([9]).

The nominal wages series is completely original. As far as we know, it is the longest series drawn up to date on the annual movements of wages in Germany:

- 1810 to 1870: it is constructed using statistical information available for Prussia and is based on the preliminary estimates made by Gömmel ([10]), Hoffmann ([11]) and Kuczynski ([12]);

- 1871 to 1945: data from German Empire records and from our work on the invalidity and old age system ([13]); this discusses and deepens the publications of Bry ([14]), Desai ([15]) and Hohls ([16]);

- after 1945: annual data were compiled from Hohls' doctoral thesis ([17]) and the GFR National Statistics Office yearbooks ([18]).

([8]) Wage earnings (at constant prices) are calculated using the following formula:

$$WE = NWE \times (AAW/P)$$

in which:

- WE = wage earnings;
- NWE = number of wage earners;
- AAW = average annual wage;
- P = price index.

([9]) See Kaiserlich Statistiches Amt, Abteilung für Arbeiterstatistik (ed.): "Deutsches Reich", in: *Beiträge zur Arbeiterstatistik Nr. 1. Die Fortschritte der amtlichen Arbeitsstatistik in den wichtigsten Staaten. Erster Teil: Vereinigte Staaten von Amerika, Großbritannien und Irland, Frankreich, Belgien, Österreich, Deutsches Reich*, C. Heymanns Verlag, Berlin, 1904, p. 176.

([10]) See Gömmel, R.: *Realeinkommen in Deutschland. Ein internationaler Vergleich*, Aku-Fotodruck GmbH, Nürnberg, 1979.

([11]) See Hoffmann, W.G.; Müller, J.H. unter Mitarbeit von H. König; K. Döring; J. Dohmen; R. Goldschmidt; F. Grumbach; A. Hölling; A. Hülden: *Das Deutsche Volkseinkommen 1851-1957*, J.C.B. Mohr, Tübingen, 1959. Hoffmann, W.G. *et al.*: *Das Wachstum der deutschen Wirtschaft seit der Mitte des 19. Jahrhunderts*, Springer-Verlag, Berlin, 1965.

([12]) See Kuczynski, J.: *Die Geschichte der Lage der Arbeiter unter dem Kapitalismus*, 38 Vol., Part 1: *Die Geschichte der Lage der Arbeiter in Deutschland von 1789 bis zur Gegenwart*, 21 Vol., Akademie-Verlag, Berlin, 1961-1972.

([13]) See Diebolt, C.: "Le système d'invalidité et de vieillesse en Allemagne avant la Première Guerre mondiale", in: *Economies et Sociétés*, Série AF, No. 26, 2000, pp. 135-155.

([14]) See Bry, G. assisted by C. Boschan: *Wages in Germany 1871-1945*, N.B.E.R., Princeton, 1960.

([15]) See Desai, A.V.: *Real Wages in Germany 1871-1913*, At the Clarendon Press, Oxford, 1968. A.V. Desai's statistical series are considered by the international community as being those most representative of the movement of wages in Germany before 1914. "*Einzig Desais Lohnreihen aus dem Jahre 1968 [...] wurden aber bisher von der Literatur als am repräsentativsten für das kaiserliche Deutschland angesehen.*" Hohls, R.: *Arbeit und Verdienst. Entwicklung und Struktur der Arbeitseinkommen im Deutschen Reich und in der Bundesrepublik*, op. cit., p. 87.

([16]) See Hohls, R.: *Arbeit und Verdienst. Entwicklung und Struktur der Arbeitseinkommen im Deutschen Reich und in der Bundesrepublik*, op. cit., 683 pp.

II. Results

As our estimation of a new series of statistics for wage earnings has a central position in our research in quantitative history, it seemed opportune to compare the series with other series, and especially those compiled by Hoffmann (1959 and above all 1965). It is seen clearly that our evaluation gives much the same results as that of Hoffmann (see figure below) as the shapes of the curves are practically identical.

However, our estimation covers a much longer period, totalling 180 years against the 118 examined by Hoffmann. The log scale used also allows better display of the slight differences between the two chronological series. It can be seen in particular that Hoffmann's evaluations for the period following World War 2 are doubtless overestimated ([19]) in comparison with the more recent figures produced by the *Statistisches Bundesamt*.

Hardly any differences in rate can be seen between the two statistical series. This is easily explained by the fact that the sources we use are mainly the same as those available in Hoffmann's time. The major interest of our estimate therefore lies in the putting into perspective of a number of breaks that are absent in Hoffmann's founding work. The rest of the article is devoted to these breaks.

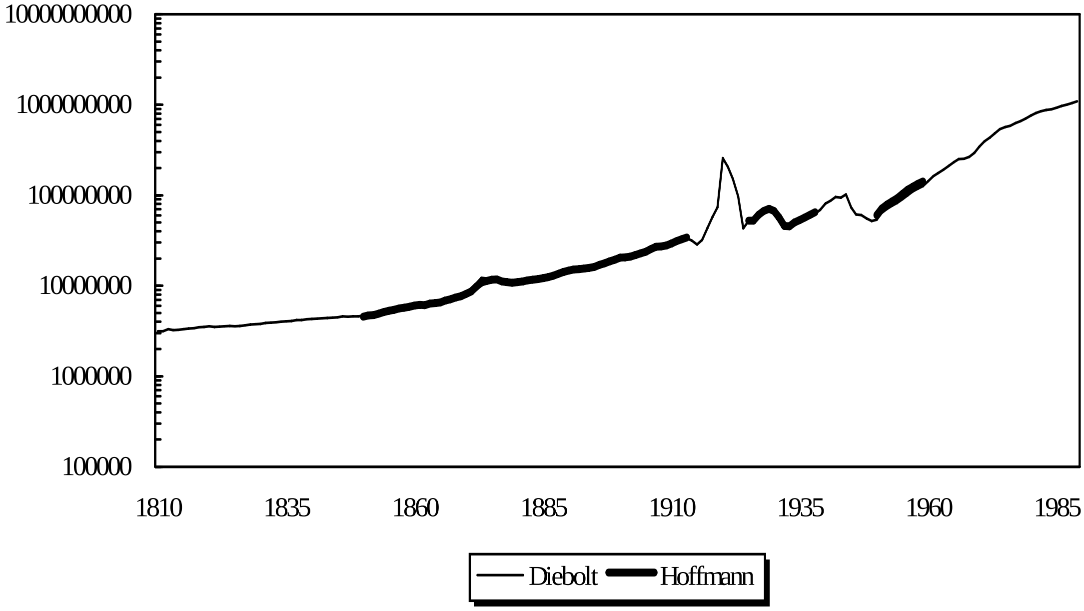
We aim here to show that rare events can have varied effects on time series. A movement of social unrest will thus usually have a temporary effect on the series observed. Conversely, the effects of financial slumps or changes in the choice of economic policy will be qualified respectively as temporary and permanent.

([17]) See Hohls, R.: *Arbeit und Verdienst. Entwicklung und Struktur der Arbeitseinkommen im Deutschen Reich und in der Bundesrepublik*, op. cit., 683 pp.

([18]) See Statistisches Bundesamt (ed.): *Bevölkerung und Wirtschaft. Langfristige Reihen 1871 bis 1957 für das Deutsche Reich und die Bundesrepublik Deutschland*, W. Kohlhammer, Stuttgart, 1958, Statistisches Bundesamt (ed.): *Bevölkerung und Wirtschaft 1872-1972 (Herausgegeben anläßlich des 100jährigen Bestehens der zentralen amtlichen Statistik*, W. Kohlhammer, Stuttgart, Mainz, 1972, Statistisches Bundesamt (ed.): *Statistisches Jahrbuch 1990 für die Bundesrepublik Deutschland*, Metzler-Poeschel, Stuttgart, 1990, Statistisches Bundesamt (ed.): *Volkswirtschaftliche Gesamtrechnungen, Fachserie 18, Reihe 1.1: Konten und Standardtabellen*, éd. 1990: *Erste Ergebnisse der Sozialproduktsberechnung*, Metzler-Poeschel, Stuttgart, 1991, and Statistisches Bundesamt (ed.): *Volkswirtschaftliche Gesamtrechnungen, Fachserie 18, Reihe S.7: Lange Reihen 1950 bis 1984*, W. Kohlhammer, Mainz, Stuttgart, 1985.

([19]) Concerning the overestimation question see also Ritschl, A.; Spoerer, M.: "Das Bruttosozialprodukt in Deutschland nach den amtlichen Volkseinkommens- und Sozialproduktsstatistiken 1901-1995", in: *Jahrbuch fürWirtschaftsgeschichte*, n°2, 1997, pp. 27-54.

Aggregate Wage Earnings in Germany, 1810-1989



In contrast with the founding theoretical work of Box and Tiao in 1975 who initiated analysis by using a deductive approach, we opted for a more inductive procedure here. In other words, we seek to detect the possible existence of atypical observations in the growth of wages and wage-earners in Germany, or the search for outliers. Much work has been devoted to the effects of outliers in the estimation of underlying processes. All the authors agree to show that not taking such values into account leads to bias in traditional tests, the estimation of models and forecasting.

More generally, two econometric methods can be envisaged in approaches in economic history to the analysis of shocks. Either, as in the traditional approach, shocks are studied in the form of impulsional response functions. In this case, analysis is based on the estimation of a VAR model and is essentially an analytical, forecasting approach as the shocks envisaged are simulated and hence fictitious. Or, as in the most recent work in econometric history, shocks are analysed in the form of atypical points referred to as outliers. In this case, analysis of shocks is part of an analytical and historical approach as they were actual shocks.

Our paper refers to this outliers methodology ([20]).

Consider a univariate time series y_t^* which can be described by the ARIMA(p, d, q) model:

$$\alpha(B)\phi(B)y_t^* = \theta(B)a_t \quad (1)$$

where B is the lag operator, a_t is a white noise process, $\alpha(B), \phi(B), \theta(B)$ are the lagged polynomials with orders *d, p, q,* respectively. The outliers can be modelled by regression polynomials as follows:

$$y_t = y_t^* + \sum_I \omega_i \nu_i(B) I_t(\tau) \quad (2)$$

where y_t^* is an ARIMA process, $\nu_i(B)$ is the polynomial characterizing the outlier occuring at time t = τ, ω_i represents its impact on the series and $I_t(\tau)$ is an indicator function with the value 1 at time t = τ and 0 otherwise.

In this paper, four main outliers are classified as:

– Additive Outliers (AO) that affect only a single observation at some points in time series and not its future values. In terms of regression polynomials, this type can be modelled by setting: $\nu_1(B) = 1$.

– Innovational Outliers (IO) that affect temporarily the time series with the same dynamics as an innovation. The polynomial is then $\nu_i(B) = \theta(B)/\phi(B)$.

– Level Shifts (LS) that increase or decrease all the observations from a certain time point onward by some constant amount. In this case, the polynomial: $\nu_i(B) = 1/(1-B)$.

– Temporary Changes (TC) that allow an abrupt increase or decrease in the level of a series which then returns to its previous level exponentially rapidly. Their speeds of decay depend on the parameter $\nu_i(B) = 1/(1-\delta B)$, where 0<δ<1.

([20]) Readers interested in other cliometric applications or a full mathematical and statistical presentation of outlier methodology should see Darné and Diebolt, 2004, 2006, Diebolt, 2007.

It is considered that AOs and IOs are outliers which are related to an exogenous and endogenous change in the series, respectively, and that TCs and LSs are more in the nature of structural changes. TCs represent ephemeral shifts in a series whereas LSs are more the reflection of permanent shocks. However, IOs will have a relatively persistent effect on the level of the series.

An ARIMA model is fitted to y_t^* in (1) and the residuals are obtained:

$$\hat{a}_t = \pi(B) Y_t, (3)$$

where $\pi(B) = \frac{\alpha(B)\phi(B)}{\theta(B)} = 1 - \pi_1 B - \pi_2 B^2 - ...$

For the three types of outliers in (2), the equation in (3) becomes:

AO: $\hat{a}_t = a_t + \omega_1 \pi(B) I_t(\tau)$

IO: $\hat{a}_t = a_t + \omega_2 I_t(\tau)$

LS: $\hat{a}_t = a_t + \omega_3 \left[\frac{\pi(B)}{(1-B)} \right] I_t(\tau)$

TC: $\hat{a}_t = a_t + \omega_2 \left[\frac{\pi(B)}{(1-\delta B)} \right] I_t(\tau)$

These expressions can then be viewed as a regression model for $\hat{a}_t$, i.e.,

$$\hat{a}_t = \omega_i x_{i,t} + a_t$$

With:

for all i and $t < \tau$: $x_{i,t} = 0$

for all i and $t = \tau$: $x_{i,t} = 1$

$$
\text{for } t > \tau \text{ and } k \geq 1: \quad
\begin{aligned}
x_{1,t+k} &= -\pi_k && \text{(AO);} \\
x_{2,t+k} &= 0 && \text{(IO);} \\
x_{3,t+k} &= 1 - \sum_{j=1}^{k} \pi_j && \text{(LS);} \\
x_{4,t+k} &= \delta^k - \sum_{j=1}^{k-1} \delta^{k-j} \pi_j - \pi_k && \text{(TC).}
\end{aligned}
$$

The test statistics for the types of outliers are given by:

$$\text{AO: } \hat{\tau}_1(\tau) = \left[\hat{\omega}_1(\tau)/\hat{\sigma}_a\right] \Big/ \left(\sum_{t=\tau}^{n} x_{1,y}^2 \right)^{1/2}$$

$$\text{IO: } \hat{\tau}_2(\tau) = \hat{\omega}_2(\tau) / \hat{\sigma}_a$$

$$\text{LS: } \hat{\tau}_3(\tau) = \left[\hat{\omega}_3(\tau)/\hat{\sigma}_a\right] \Big/ \left(\sum_{t=\tau}^{n} x_{3,t}^2 \right)^{1/2}$$

$$\text{TC: } \hat{\tau}_4(\tau) = \left[\hat{\omega}_4(\tau)/\hat{\sigma}_a\right] \Big/ \left(\sum_{t=\tau}^{n} x_{4,t}^2 \right)^{1/2}$$

$$\hat{\omega}_i(\tau) = \sum_{t=\tau}^{n} \hat{a}_t x_{i,t} \Big/ \sum_{t=\tau}^{n} x_{i,y}^2 \quad \text{for } i = 1,3,4.$$

and $\hat{\omega}_2(\tau) = \hat{a}_t$

where $\hat{\omega}_i(\tau)(i = 1 - 4)$ denotes the estimation of the outlier impact at time $t = \tau$, and $\hat{\sigma}_a$ is an estimate of the variance of the residual process.

An outlier is identified at time $t = \tau$ when the test statistics $\hat{\tau}_i(\tau)$ exceeds a critical value. In TRAMO (Time Series Regression with ARIMA Noise, Missing Observations, and Outliers) the critical value is determined by the number of observations in the series based on simulation experiments. The different test statistics at time $t = \tau$ are compared in order to identify the type of outlier. The one chosen has the greatest significance such as $\hat{\tau}_{max} = \max\left|\hat{\tau}_i(\tau)\right|$.

When an outlier is detected, we can adjust the observation Y_t at time $t = \tau$ to obtain the corrected Y_t^* via (2) using the $\hat{\omega}_i$, i.e. $Y_t^* = Y_t - \hat{\omega}_i v_i I_t(\tau)$. Finally, the procedure is repeated until no outlier is detected. A multiple regression on Y_t^* is performed on the various outliers detected to identify spurious outliers.

We now examine the nature of the shocks on the annual series of nominal and real wages, wage earnings and the working population.

The tables below display the results of outlier identification. All detected outliers are given by series, with their timing, type, value and *t*-statistic. The 'Value' represents the estimated outlier effects by which the series of the first differences can be adjusted. The last column presents one possible economic, financial, political etc. explanation of outlier occurring. In a general manner, outliers are detected in all the series.

Statistically, figures in the Appendix display the original series (in full line) and the outlier corrected series (in dotted line). They clearly show the presence of outliers in each original series and their correction from the outlier identification procedure. A comparison of the first differences with the adjusted series demonstrates the extent of the adjustment. In other words, the outlier effects can also be demonstrated by subtracting the adjusted series from the unadjusted series. The main advantage of such a representation is that it is directly open to scientific interpretation.

Nominal Wages

Years	Type	Value	T-Stat	Events
1872	IO	0,18	4,92	2nd Reich
1917	IO	0,19	5,4	1st World War
1920	TC	1,09	40,29	Economic Crisis
1922	IO	-0,13	-3,6	Premises of the Great Inflation
1923	IO	-0,24	-6,46	Inflation
1924	TC	-0,63	-24,4	Consequences of the Great Inflation
1932	IO	-0,13	-3,61	Nationalist push
1942	AO	9,60E-02	5,63	2nd World War
1945	IO	-0,32	-8,68	2nd World War

Real Wages

Years	Type	Value	T-Stat	Events
1817	AO	-0,29	-6,65	Economic Crisis
1919	IO	0,65	7,84	Weimar Republic
1920	TC	0,66	10,01	Premises of the Great Inflation
1923	IO	-0,42	-5,03	Inflation
1924	LS	-1,03	-13,89	Consequences of the Great Inflation
1945	IO	-0,37	-4,44	2nd World War

Aggregate Nominal Wage Earnings

Years	Type	Value	T-Stat	Events
1872	IO	0,18	4,61	2nd Reich
1915	TC	-0,13	-4,31	1st World War
1917	IO	0,23	5,67	1st World War
1919	IO	0,15	3,87	Weimar Republic
1920	TC	1,07	35,92	Economic Crisis
1923	IO	-0,25	-6,22	Inflation
1924	TC	-0,64	-21,13	Consequences of the Great Inflation
1926	AO	-9,80E-02	-4,98	Economic Expansion
1931	IO	-0,18	-4,56	Financial Krach
1932	IO	-0,17	-4,33	Nationalist Push
1945	IO	-0,42	-10,49	2nd World War

Aggregate Real Wage Earnings

Years	Type	Value	T-Stat	Events
1817	AO	-0,29	-6,49	Economic Crisis
1915	TC	-0,24	-3,65	1st Word War
1919	IO	0,73	8,63	Weimar Republic
1920	TC	0,67	9,84	Economic Crisis
1923	IO	-0,43	-4,97	Inflation
1924	LS	-1,07	-13,98	Consequences of the Great Inflation
1945	IO	-0,42	-5	2nd World War

Working Population

Years	Type	Value	T-Stat	Events
1900	AO	6,97E-02	3,17	Emigration
1914	IO	-8,55E-02	-17,17	1st World War
1915	IO	-0,11	-21,71	1st World War
1916	IO	4,94E-02	9,91	1st World War
1917	IO	-8,01E-02	-1,61	1st World War
1918	IO	1,49E-02	3	1st World War
1919	IO	7,84E-02	15,74	Weimar Republic
1925	IO	3,72E-02	7,47	Economic expansion
1926	AO	-6,76E-02	-30,07	Economic Expansion
1930	IO	-4,01E-02	-7,94	Elections & Economic Crisis
1931	IO	-6,79E-02	-13,56	Financial Krach
1932	TC	-5,37E-02	-14,65	Nationalist Push
1934	LS	2,16E-02	5,11	National-Socialismus
1942	AO	-1,97E-02	-7,51	2nd World War
1944	IO	-2,99E-02	-5,34	2nd World War
1945	LS	-5,97E-02	-11,44	2nd World War
1946	IO	-8,27E-02	-14,16	Migration
1947	IO	-3,83E-02	-7,23	Migration
1948	IO	-7,20E-02	-14,09	Migration
1949	IO	-5,96E-02	-11,86	The Two Germanies
1950	TC	-7,82E-02	-22,59	Emigration RDA→RFA
1955	IO	2,03E-02	4,06	Emigration RDA→RFA
1958	AO	-1,14E-02	-4,96	Emigration RDA→RFA
1961	AO	1,05E-02	4,55	Construction of the Berlin Wall
1967	IO	-2,32E-02	-4,66	Demographic Explosion

1923, the inhuman year, the year in which Germany experienced the most total inflation—this, with the dates of political breaks, is the major outlier that emerges from our econometric processing and from observation of the time series for wages and wage earnings.

In fact, the mark lost value from the end of World War 1 onwards. During the war, the floating debt in Germany increased from 2 billion to 51 billion marks and currency in circulation quadrupled. However, inflation reached catastrophic proportions in 1923. The exchange rate on 1 November was 8 million marks to 1 dollar! A record. In fact, the period of hyperinflation lasted from the end of 1922 to the end of 1923.

The depreciation of the mark resulted in a simultaneous continuous increase in the price of all goods (it is reminded that prices in 1918 prices were some three times as high as they had been in 1914). Wages had difficulty in keeping up. In fact, the central trade union council considered in 1920 that wages should have been doubled to keep up with rising prices. In spite of a slight improvement in 1921, prices rocketed in 1923. Devaluation was so fast in November that a day's wages could only buy two-thirds or even half of the goods that they would have bought the previous day.

At the same time, and in spite of the country's bankruptcy, German inflation was also seen, as described by G. Badia (1962), firstly as a vast legal swindle, a kind of large-scale operation for the recovery of advantages lost in 1918 (industrialists and owners of land and buildings cleared their debts and mortgages cheaply), and secondly as an opening to the fascist explosion!

In our estimation of the growth of the working population, the outliers detected show pertinently that population growth, economic slumps, migration and changes in territory associated mainly with political break-points undeniably exerted substantial if not crucial influence on the German labour market and its evolution over a long period.

Conclusion

For the measurement of economic growth, the raw material of retrospective national accounting is a regular quantity of information and a sufficiently homogeneous sum of items for making comparisons in time and space. The drawing up of statistical series on the long-term evolution of wages, wage-earners and wage earnings in Germany in the nineteenth and twentieth centuries is part of this process of contributing new information. Indeed, a long period is an excellent observation window because it facilitates—in its own way—the understanding of contemporary economic growth.

Moving on from there, the studies of the presence of infrequent temporary and permanent shocks in the time series gives a major result. It shows that persistence in time series is more linked to infrequent but significant economic events (wars, financial slumps, changes in political regime and above all the 1923 crash) than to major innovations period by period (as would be implied by the stochastic trend of random walks).

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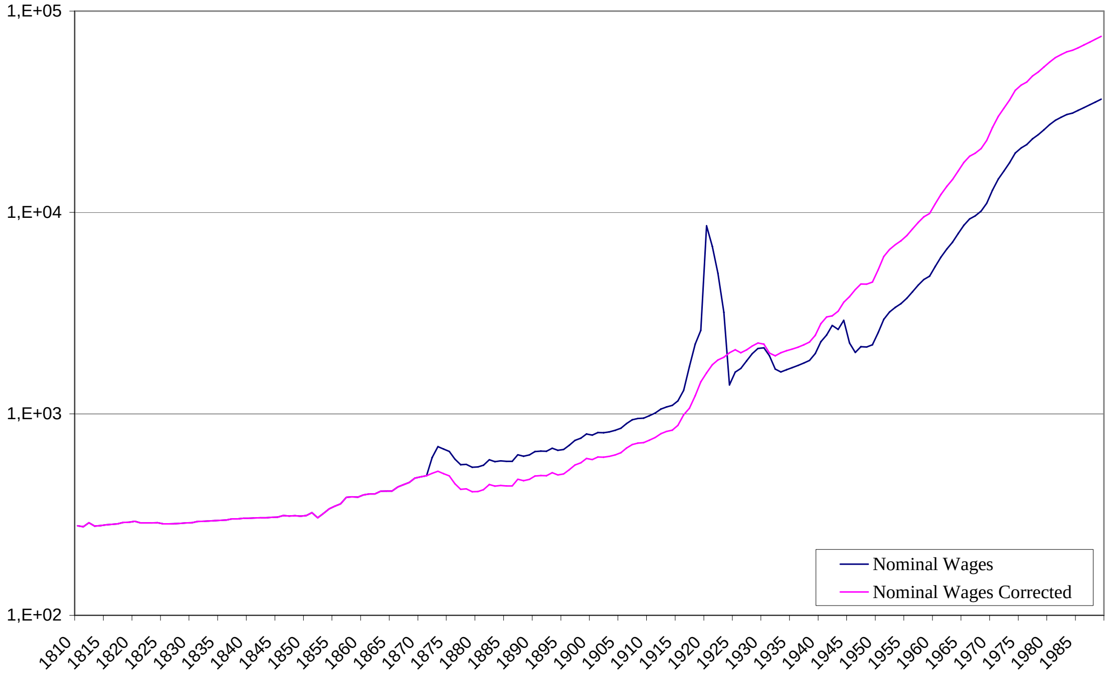
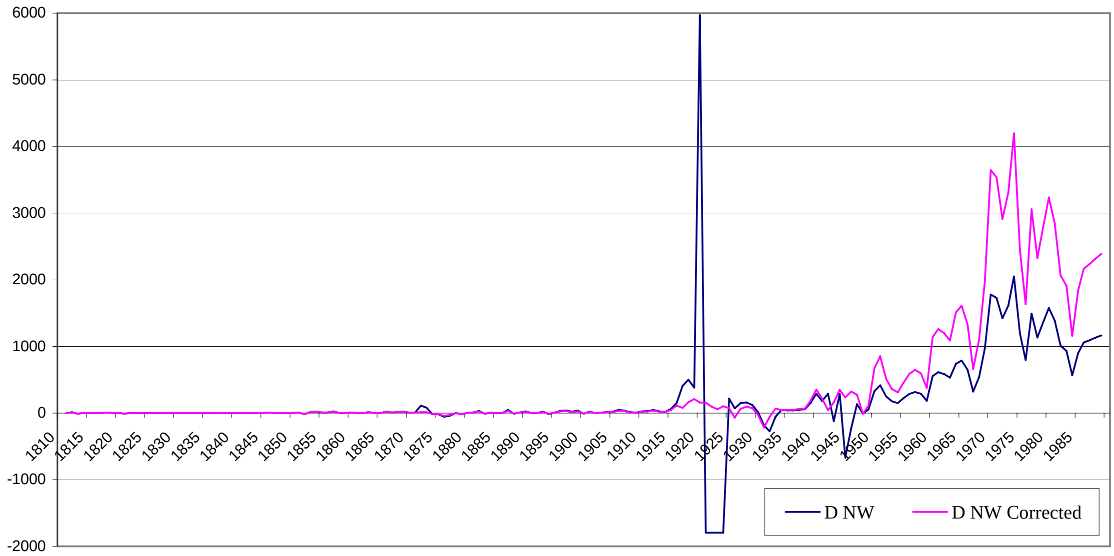
Appendix

Nominal Wages



Nominal Wages (1st differences)



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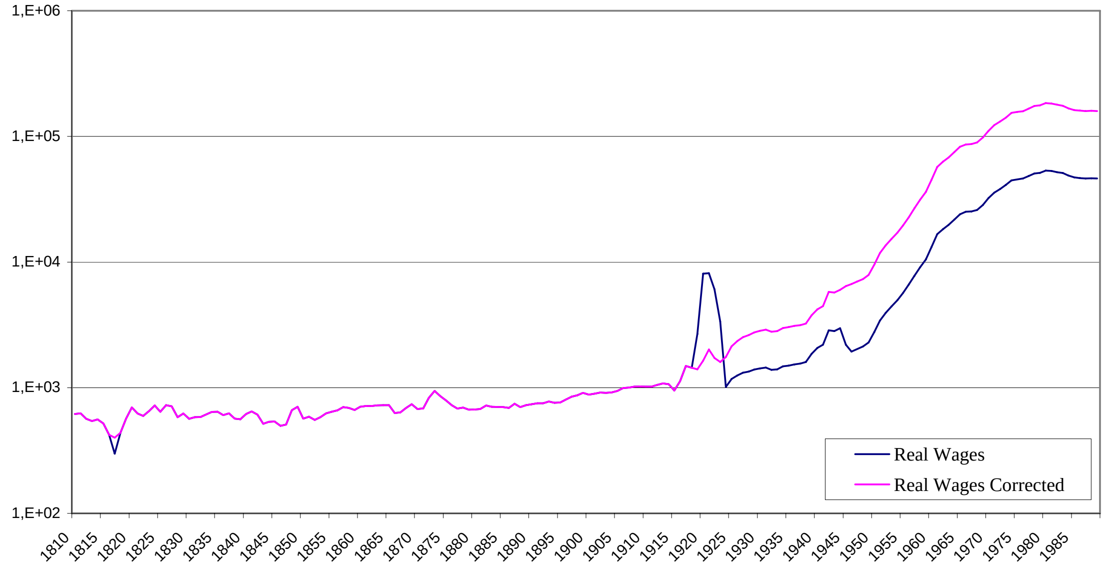

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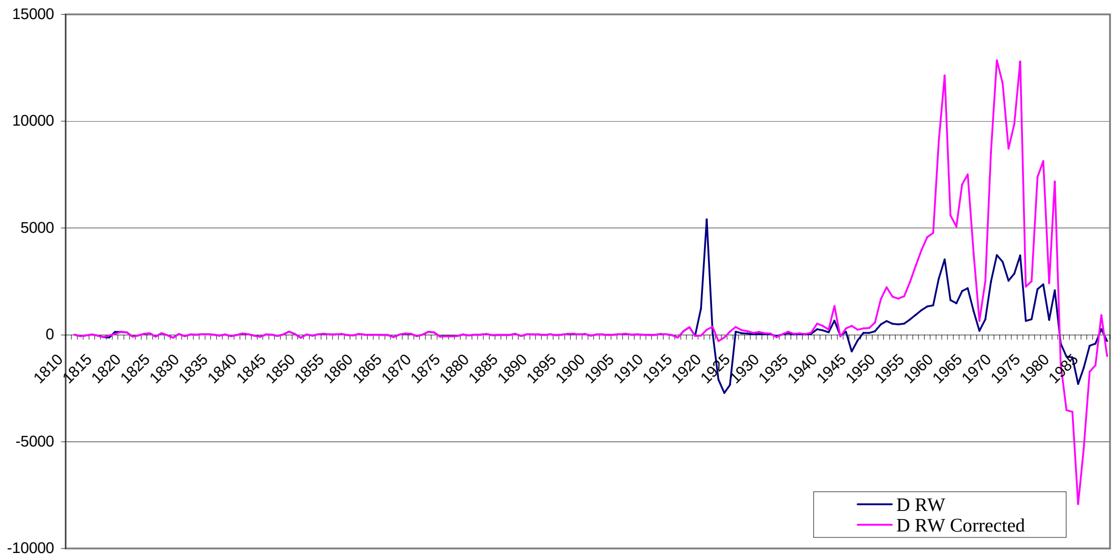

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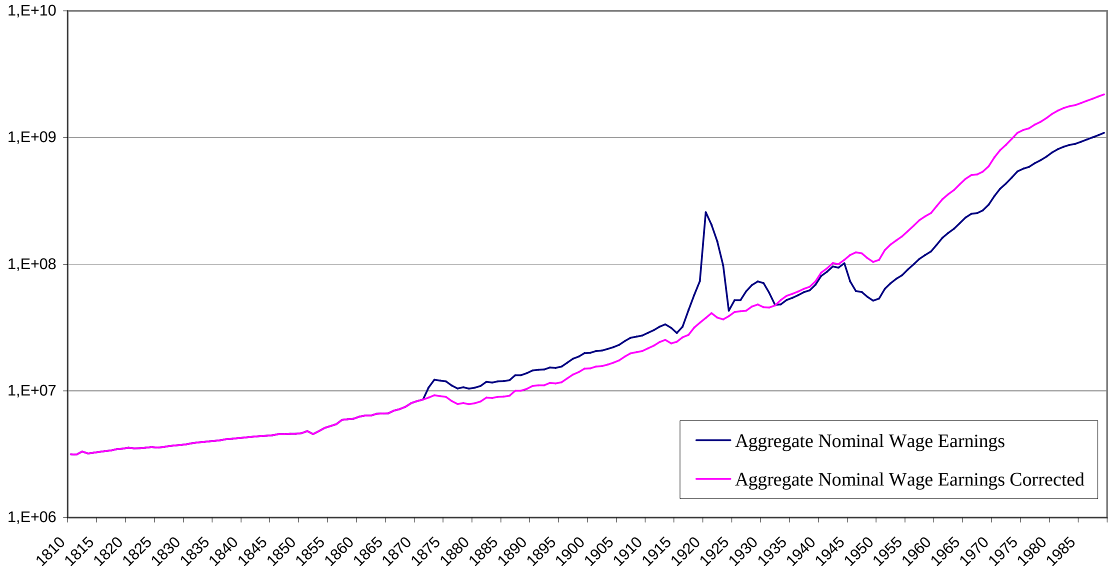

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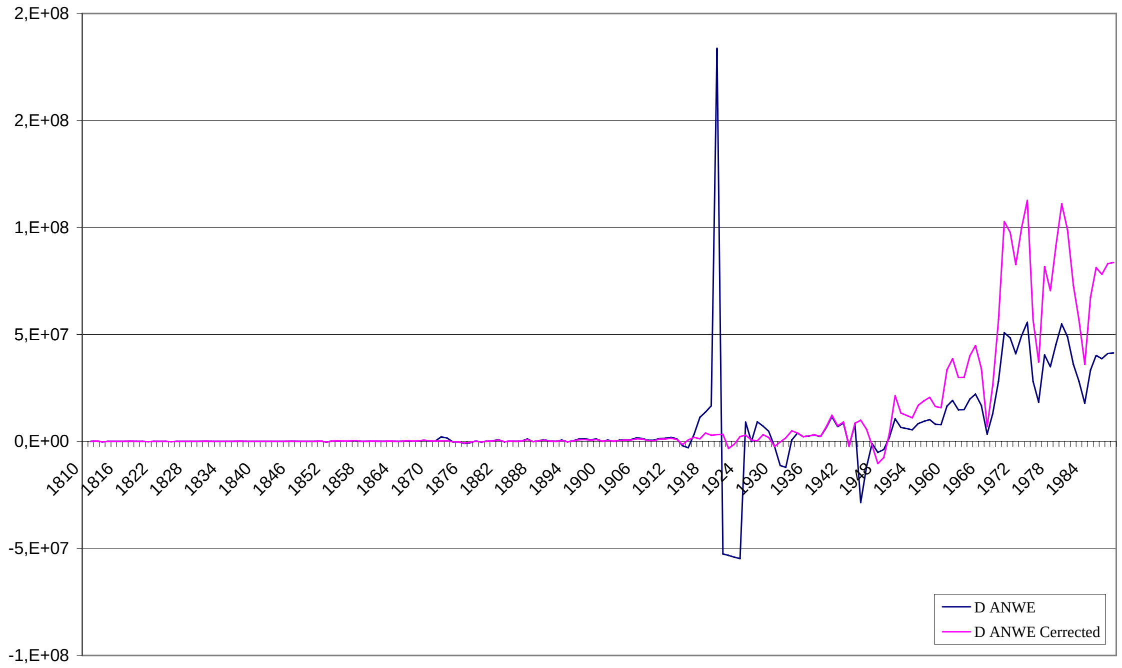

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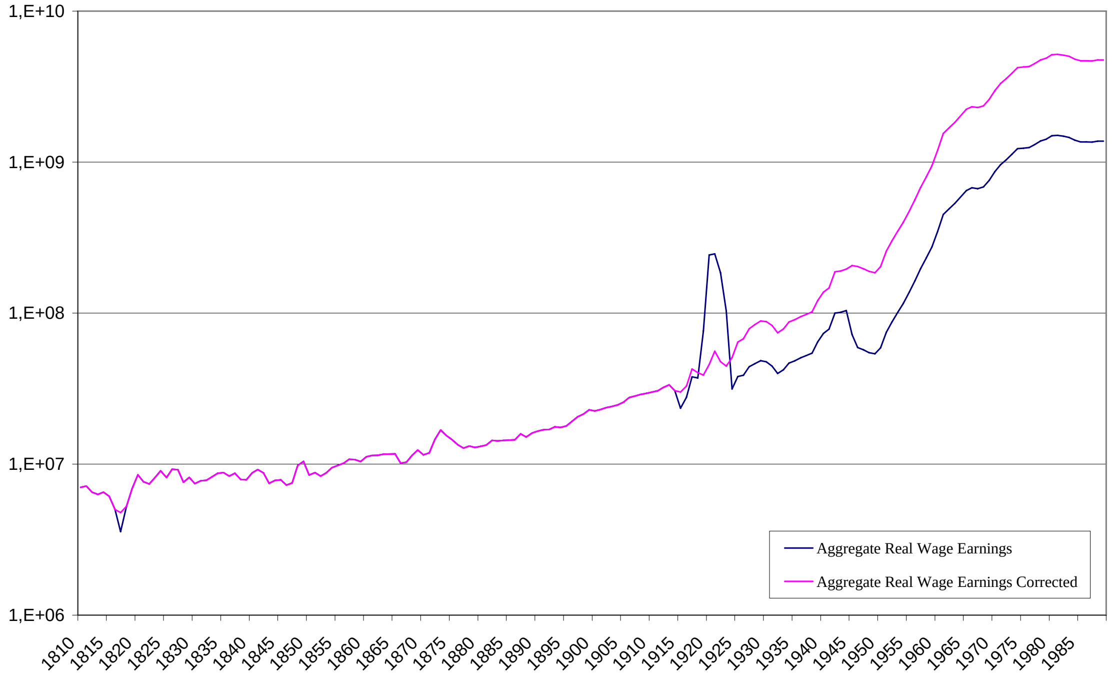

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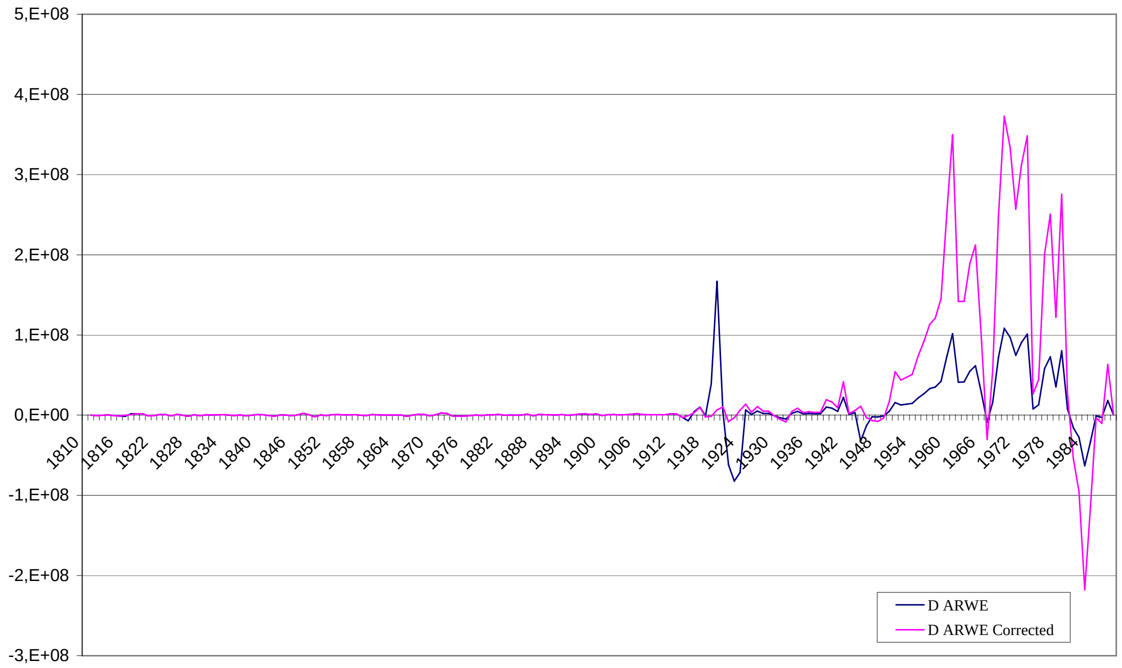

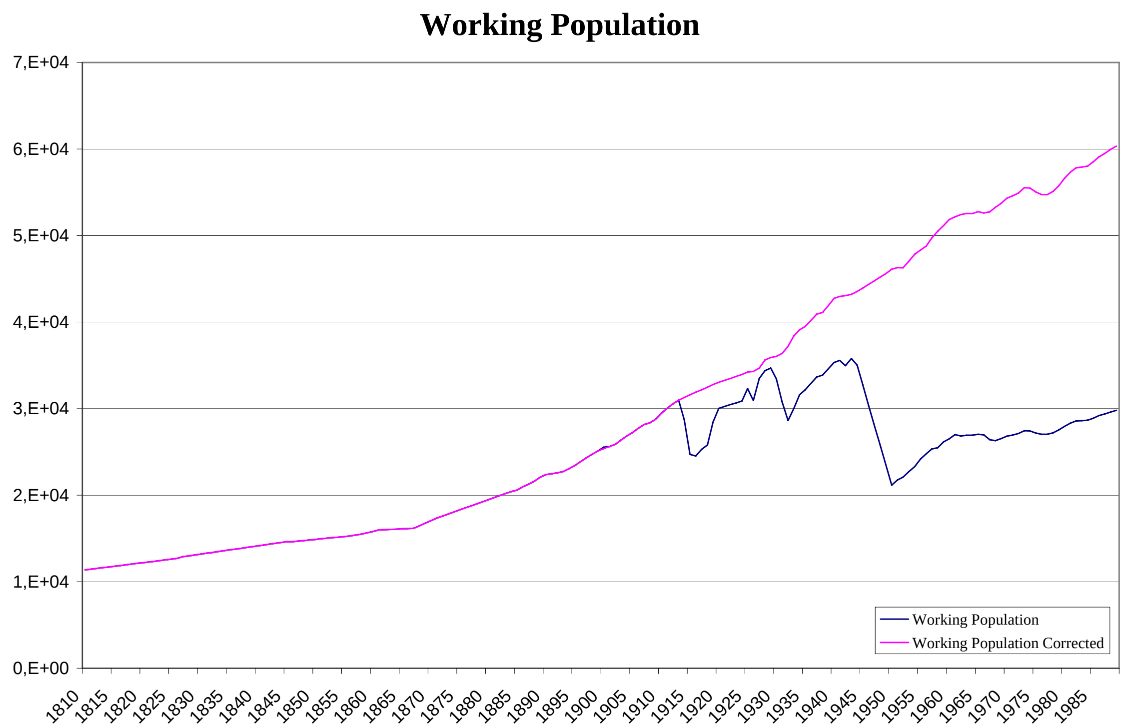
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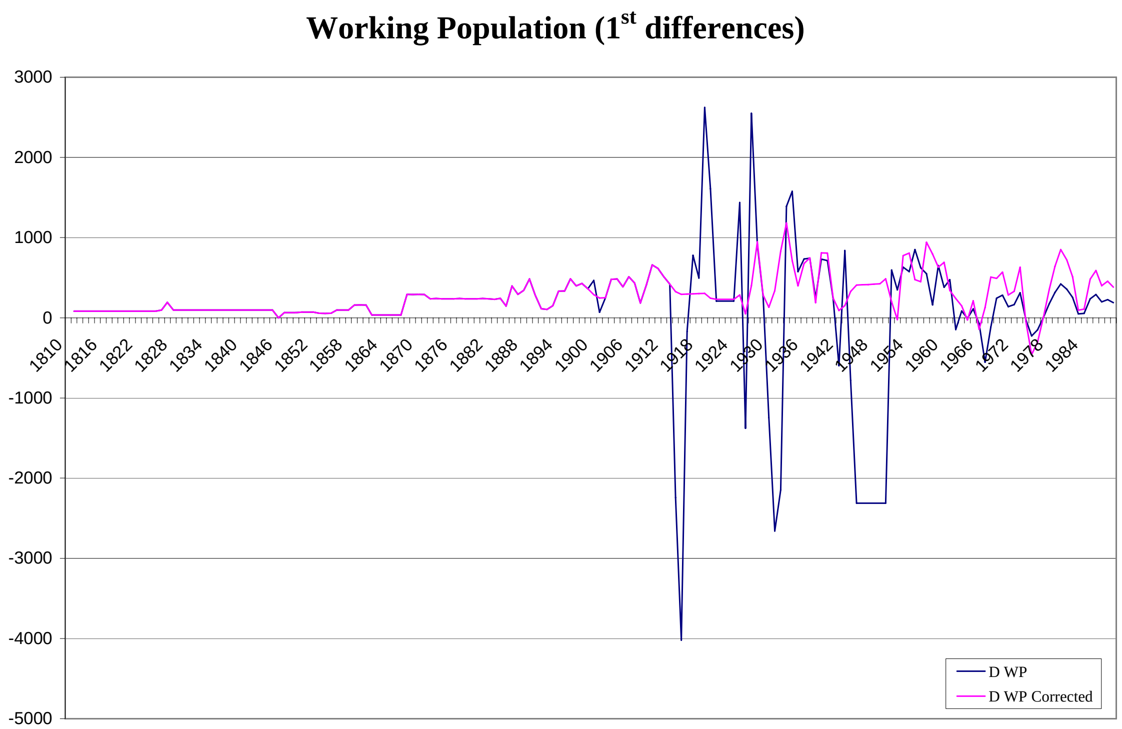
Working Population Corrected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