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# OUTPUT, POLITICAL UNCERTAINTY, AND STOCK MARKET FLUCTUATIONS: GERMANY, 1890 - 1940

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## Abstract

The sources of stock volatility and especially higher volatility in recessions have puzzled financial economists. One explanation emerges from recent theoretical work that points to political and regulatory uncertainty as a source of output fluctuations. Since political uncertainty can also generate stock price volatility, its joint effects on stock prices and output may explain why stock volatility is correlated with output declines. Evidence from a particularly instructive natural experiment, the transition from Imperial to Weimar Germany, supports the view that stock price volatility reflects an uncertain political climate. Statistically, stock price volatility and the ultimate factors it represents play a major role in explaining the post-World-War-I collapse of the German economy and subsequent output fluctuations. A doubling of stock volatility implies a decline of output of -6 to -15 percent.

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Business leaders and economists often contend that political uncertainty depresses economic activity. Though widely voiced, the idea has never became part of mainstream macroeconomics. However, recent theoretical work on uncertainty and irreversible investment has given it new life. In the relevant models, firms do not face the choice between investing and not investing, but rather between investing now and investing later when new states of the world are realized. Greater uncertainty, especially a higher probability of "bad news," generates incentives to wait rather than invest. For example, uncertainty over price controls, environmental regulation, the integrity of the monetary standard, forced restructuring of major industries or – in the extreme case – expropriation or nationalization may deter investment even for projects with positive expected net present values. Intriguing as this line of thought may be, it has generated little empirical work.[1]

The lack of empirical research no doubt stems in part from the difficulty of measuring political uncertainty. One serviceable proxy may be the volatility of stock prices. Rapidly changing or diffuse opinions about future economic policy should be reflected in fluctuating share prices. Moreover, stock prices are available for a variety of countries and time periods, unlike other measures of political uncertainty which are likely to depend on the institutional setting. Some of the stylized facts about stock volatility are also encouraging. For example, political struggles usually extend over several weeks or months, which could explain why volatile returns tend to cluster. In addition, and suggestive for the view that uncertainty affects output, a number of researchers have found that the volatility of stock prices, and not just their level, can explain or forecast real output. Though the pattern shows up in other periods, the high volatility during the Great

[1] The effect of political uncertainty was noted by Mitchell (1913) for the turn of the century, and by Roose (1954) and Friedman and Schwartz (1963, pp. 495-496) for the 1930s. Theoretical work on uncertainty and irreversible investment includes Cukierman (1980) and Bernanke (1983). Dixit and Pindyck (1994) provide a recent summary and synthesis, as well as illustrations of the effect of policy uncertainty. Pindyck (1991b, p. 1141) also discusses the possible effects of regulatory and political instability on investment.

Depression is the obvious example. Conceivably, the depth of the Great Depression and slow revival from it were a consequence of uncertainty about future economic policy, and not just the result of mechanical monetary and fiscal factors.[2]

Still, in the absence of direct measures of policy uncertainty it is possible that some other neglected factor and not political uncertainty is the ultimate mover. Stock volatility and output fluctuations are clearly both endogenous. One way of advancing the discussion is to focus on a natural experiment, an instance in which a major political upheaval is presumptively the cause of a major increase in stock price volatility.

That sort of natural experiment occurred in 1918 in Germany with the transition from Imperial rule to the Weimar republic. Germany up to 1914 was comparatively stable and marked by a limited economic role for the state. In contrast, the period from 1918 to 1933, and perhaps several years beyond, was marked by political instability, including revolution, the loss of overseas colonies and important territories in Europe, a struggle with World War I victors over war reparations, foreign occupation of the Rhineland, hyperinflation, political violence, an increased economic role for the state, and increased political influence of parties advocating an even greater role for the state. The shift to a less stable and more interventionist political regime no doubt explains at least part of the observed increase in stock price volatility after the First World War. The standard deviation of monthly German stock returns increased from 2 percent for 1890-1914 to 13 percent for 1920-1940. To be sure, some political events were the consequence of economic conditions. Even politics is ultimately endogenous. However, the fundamental

[2] Huang and Kracaw (1984) find that the variance of S&P 500 returns "Granger causes" changes in real GNP; Schwert (1989a, 1989b) shows that monthly and daily stock returns are higher during recessions; and Pindyck (1991a) reports that lagged quarterly stock return variance explains the growth of real investment, especially non-residential investment and equipment. Although Pindyck links these results with the uncertainty literature, he uses stock prices as a proxy for volatile product markets, and not as a proxy for political uncertainty. Romer (1990) finds that increased stock price volatility precedes declines in consumer durables purchases. I discuss these last two papers at greater length below.



change in Germany – from ascendant empire before 1914 to beleaguered republic after 1918 – was unanticipated and exogenous.

The aim in the statistical work below will be to see if after controlling for other factors predicting or affecting output – the level of stock prices, population and price level changes – stock price volatility helps explain output. Depending on the specification, a doubling of stock price volatility results in a decline of output of -6.3 to -15.1 percent. Since I use annual output data spanning half a century, and since the specification works well in original levels (rather than, say, with first or quasi-differences), this estimate captures the full effects of the factors measured by stock volatility.

## I. Output, Uncertainty and Stock Price Fluctuations

Why does the volatility of stock prices change? As Schwert's (1989) exhaustive survey of U.S. experience shows, aggregate stock return volatility increases with leverage, is correlated with interest rate and bond volatility, increases with higher trading volume, and increases during recessions. Stock volatility was particularly high during the Great Depression. However, measurable factors explain only a small fraction of observed volatility. Some authors have in fact inferred "excess" volatility. Schwert, in contrast, explains the high volatility of the Depression by pointing to a "peso problem," a substantial but unrealized probability of a major political upheaval. On that interpretation, high volatility is the consequence of an appreciable, though fluctuating probability of financial disaster.

For the U.S. the possible connection between political uncertainty, on the one hand, and either stock price volatility or output declines, on the other, has been discussed since at

least the turn of the century. For example, business cycle pioneer Wesley Clair Mitchell (1913) credited early antitrust initiatives and the resulting uncertainty over the legal status of early corporations for the low investment and volatile financial markets of 1911-12. In a study of New Deal economic policies, Roose (1954, ch. 4) attributed the slow revival from the Great Depression to an array of social and political factors, including securities and labor legislation, Roosevelt's attempt to restructure the Supreme Court, and the New Deal's shifts in monopoly policy. Friedman and Schwartz (1963) offer a similar explanation for the slow emergence from the Depression.

Theoretical work pioneered by Cukierman (1980) and Bernanke (1983) offers a mechanism that may link uncertainty, in particular policy uncertainty, with fluctuations in output. In Cukierman's model, increased uncertainty creates incentives for agents to delay investment even under risk neutrality. In comments relevant for the case at hand, he notes (p. 474) that "stable economic policies will be growth promoting because they shorten the period of information gathering before investment decisions are reached. . . . There is, therefore, a trade-off between the democratic discussion of issues and the number of investment projects undertaken within a period of time."

Bernanke (1983) emphasizes the importance of irreversibility, the option-like quality of the ability to delay investment, and the implication that unfavorable future outcomes influence the decision to invest or wait – the "bad news principle." He also lists a number of "macro-level factors" that may increase uncertainty and influence the decision to invest now or wait: wars, oil price instability, governmental regulation, and the introduction of new technology. Pindyck's (1991) review of the literature on uncertainty and irreversible investment also notes that political uncertainty may depress investment, and Dixit and Pindyck (1994) argue that the failure to account for uncertainty may explain the poor performance of empirical models of investment.



Only two studies invoke uncertainty to explain the statistical correlation between stock price volatility with output fluctuations. Romer (1990) argues by analogy to the case of uncertainty and investment – increased uncertainty should also cause a decline in *consumer* durables purchases. She advances the 1929 stock crash as the cause of the 1930 decline in consumer durables, and finds in fact that increases in volatility explain declines in durables purchases, both in the decades before the crash and for 1949-1986. Her results are consistent with Schwert's (1989) findings. Romer takes stock market volatility as given, but it bears emphasis that much work addressing the ultimate causes of the 1929 crash and other major market movements has implicated government action. In the case of the 1929 crash, possible causes or precipitating factors include Fed discount rate increases, the Smoot-Hawley Tariff, or the shift in antitrust policy from Coolidge to Hoover.[3]

Pindyck (1986, 1991a) shows that the growth of quarterly investment is predicted by the lagged variance of the NYSE index. Though the evidence is similar to Romer's, Pindyck provides a different rationale, namely that stock prices will become more volatile when product markets become more volatile. As does Romer, he leaves open the question of the ultimate sources of stock and commodity price volatility. He does mention the increased stock volatility that preceded the 1975 and 1980 recessions, which both came on the heels of energy price shocks, and, I would add, an accompanying political reaction in the form of crude oil allocation, energy price controls and windfall profits taxes. In other words, stock price variance may capture both the uncertainty over future energy prices and uncertainty over future energy policies.

[3] Bierman (1991) emphasizes Fed policy, Wanniski (1979) the Smoot-Hawley Tariff, and Bittlingmayer (1992) the attorney general's October 25, 1929 announcement that the Hoover administration was reversing Coolidge-era antitrust policy. Along similar lines, Mitchell and Netter (1989) argue that an antitakeover amendment was responsible for some of the volatility before and after the 1987 crash, and could have served as a triggering mechanism for the crash, and Bittlingmayer (1993) implicates "trust-busting" under Theodore Roosevelt and William Howard Taft in the Panic of 1907 and the unsettled market of 1911-12.

## II. Politics, Stock Prices and Output in Germany, 1890-1940

Experience from Germany may offer extra insight on the connection between political uncertainty and stock price volatility, and the ultimate effect of uncertainty on output. My findings below confirm for Germany what Huang and Kracaw, Schwert, Pindyck and Romer found for the U.S.: increased stock price volatility is associated with declines in output. However, the real significance of this result comes from the historical context. The presumption that political factors played a role in episodes of high stock price volatility is much stronger for Germany in the teens and twenties than for the typical period in the U.S.

The political changes that occurred in Germany during and after World War I represent an unusual turn of events for a major industrialized country. The war itself strained Germany's resources, and it was unable to remobilize after the 1918 armistice. The war and its immediate consequences upset a stable political and economic order. A series of economic and political crises followed.

Figure 1 shows that real output followed a remarkably steady upward trend until 1913. It declined during and especially after the war and fluctuated below pre-war levels until the late 1920s, and then declined again from 1929 to 1933. At the same time, stock prices declined and stock volatility increased. Interestingly, a recent study of "excess" volatility of German stock returns by De Long and Becht (1992) finds low volatility for 1870-1914, excess volatility after World War II, but excludes 1914-1950 because of "peso problems." For the purpose at hand, however, political instability giving rise to peso problems is likely to illuminate the connection between political uncertainty, stock volatility and output.



Commentary on the economic consequences of the First World War and the Weimar republic has focused on classic "static" incentive issues such as taxes and the role of the state. Borchardt (1985) emphasizes three major changes: an increase in the percentage of national product spent by the state, transfer of control of finances from the state to the federal level, and attainment of control of economic policy by the parliament. Similarly, James (1986, p.1) regards "the politicisation of the economy and the creation of a commitedly interventionist state" as the major changes stemming from the First World War. Stolper, Häuser and Borchardt (1967) note that war itself was accompanied by inflation, price controls and greater state control of industry. Moreover, they also claim that "the war broke down whatever limitations the nineteenth century had built around state power." (p. 10) As a quid pro quo to labor for its sacrifices and to the Social Democrats for their support of the war effort, works councils were established in 1916. These survived the war. In addition, the enhanced political power of organized labor led, according to one view, to excessively high wages in the 1920s and early 1930s. The Revolution of 1918 and the Weimar Constitution of August 1919 also raised the possibility of nationalization of major industries - mining, iron and steel, and electric utilities. Though first steps were taken in mining and iron and steel, the efforts ultimately failed. In other sectors, notably housing, banking, transportation and utilities, the state's role grew appreciably. Stolper et al. estimate that the "proportion of national income determined by the state may will have been as high as 50 percent" by 1932. While a larger role of the state may be good or bad, it does represent one *possible* explanation for the marked decline of output after 1918 from the pre-war trend.[4]

Aside from the static effects of taxation and government regulation, the continuing political struggle arguably had other effects on domestic business and foreign investors if

[4] Liefmann (1930) and Stucken (1953) also contain assessments that are critical of 1920's policies.

that struggle increased uncertainty about future outcomes. Evidence of political instability with potentially disastrous financial implications can easily be marshaled. The period from the 1918 armistice to the 1933 Nazi takeover was punctuated by a series of intertwined political and economic crises: worker rebellion (1919), hyperinflation (1922-23), National Socialist gains which stimulated capital flight (1930), bank closures (1931), deflation (1930-32), and the National Socialist takeover (1933).

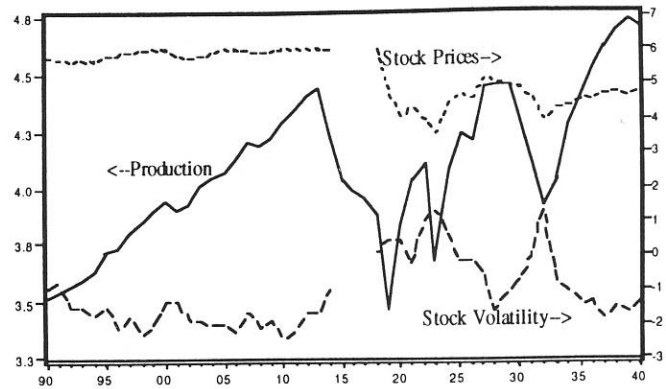
This capsule summary of post-World War I developments offers an obvious explanation for the history of stock prices and stock return volatility shown in Figure 1. Stock prices, shown for April of each year, are relatively stable through 1914, and are still at pre-war levels in April of 1918. This is consistent with the historical accounts, according to which the war was viewed as a stalemate in early 1918. A sharp decline set in after 1918, and the figure shows that stock prices roughly followed output fluctuations, reaching a peak in 1927, declining into the Great Depression, reviving slightly after 1933, but never achieving their 1920s peak in the 1930s.

Stock volatility shows a roughly inverse pattern, increasing immediately after the war from pre-war levels, peaking during the 1923 hyperinflation, and reaching its lowest level in 1928. Volatility reaches a second peak in 1933 and then declines. Output also becomes more volatile as stock volatility increases, consistent with Schwert's findings for the U.S.



**Figure 1**

Log of Industrial Production, Log of Stock Prices and Log of Stock Volatility, 1890 - 1940




Sources: See Appendix.

## III. Specification and Empirical Results

Table 1 has regressions of the natural log of annual German industrial production on the log volatility of stock prices and other factors that are likely to influence output for the period 1890-1940. This period covers over two decades of Imperial rule and ends at the beginning of the Second World War. (Stock prices fell under governmental price control starting 1941). The regressions exclude 1915-1917 because of missing stock price data. A brief description of the variables used and rationale follow. The appendix has the sources.

*Industrial production.* I use annual industrial production data out of necessity. Investment data or quarterly or monthly production data covering 1890-1940 do not exist. While the effects of uncertainty are most likely to fall on investment, actual investment data cover only tangible physical investment. Consequently, output may

be preferable in practice since it includes intangible investment as well as consumer durables. Moreover, since investment is volatile, a large fraction of the variation in industrial production will in fact reflect variation in investment.

*Log volatility*. For each year's observation, I use the natural log of the sum of absolute values of stock returns for January through December. This sum measures the cumulative movement of stock prices. The natural log specification allows a simple interpretation of the results. Logs also yielded higher t-statistics than original levels. Volatility serves as a proxy for shifting expectations about future outcomes and is arguably generated or at least heavily influenced by political events.

*Log stock prices*. The level of stock prices has a long history as a leading predictor of real output, and the work here uses the stock index from April, a third of the way through the year. Stock prices reflect actual and expected earnings. However, since the level of stock prices also reflects risk, and since volatility measures based on monthly returns may be flawed as a measure of risk, the level of stock prices may also reflect uncertainty after controlling for measured volatility. In the case at hand, the sharp 1918-20 decline also reflects company assets lost abroad or in ceded territories as a result of the Versailles Treaty.

*Rates of Deflation and Inflation*. Monetary policy affects output, arguably through its effect on the price level. Experience in the U.S. and elsewhere suggests that deflation and inflation both lower output, but the effects are not symmetrical. Ten percent deflation is associated with a greater decline in output then 10 percent inflation. Experimentation showed that lagging deflation improved the fit.

*Population and Time Trend*. Other factors also affect output, notably population growth and technological progress. In Germany's case, the population variable also controls for the loss of population at the end of World War I. The population of Germany was 7 percent smaller in 1922 than in 1918. For lack of a



better variable, I used time trend as a measure of technological progress. Omission of this important factor would have biased the coefficient estimates.[5]

*Post-WWI and 1918-1920 Dummies*. I include a post-World-War-I dummy (1918-1940 = 1) to provide a formal test of the proposition that my other variables account for the remarkable output decline shown in Figure 1. I also include a dummy for 1918-1920 for two possible reasons. First, it controls for the fact that the aggregate production index is composed of only mining production in 1918 and only mining and producer goods in 1919. These are arguably cyclically sensitive components. Consumer goods reappear in the index in 1920. Second, it allows me to test whether the overall results are the consequence of the unusual events right after the war.

Estimate (1) in Table I regresses log of output on the log of population, time trend and the post-WWI dummy. It serves as a benchmark. Post-war production was lower by -52.6 percent, the coefficient on population is negative and the estimated rate of technical progress (the "effect" of time) is high, 3.3 percent. Plausible specifications should result in a post-war dummy equal to zero, a coefficient on log population close to 1.00, and a time trend coefficient below .020.

Estimates (2) through (6) add other variables: stock volatility, stock prices, deflation, inflation, and a dummy for 1918-1920. Regardless of specification, the log of stock volatility has a strong negative effect on output. A doubling of stock volatility lowers output by -6.3 and -15.1 percent. These results are consistent with work on the U.S. The level of stock prices is also related output, though not at usual significance levels in every case.

[5] The Dickey-Fuller test rejects the unit-root assumption for the residuals in Table 1's estimate (6).

The inclusion of the dummy for 1918-1920 cuts the estimated effect of log volatility by one half and roughly doubles the effect of the log of stock price level. In other words, measured output declined more over 1918-1920 than the historical negative association with volatility and the positive association with the level of stock prices at other times would have predicted. This may reflect spotty post-war data weighted toward cyclical industries, or some risk factor not adequately captured by the volatility of monthly stock prices or the level of stock prices in April of each year.

The effects of deflation appear large but are consistent with historical experience in the Great Depression. Across estimates (4) to (6), a 10 percent decline in the price level implied a decline of -24.9 to -40.8 percent in real output. This estimate is driven by 1931 and 1932, when the price level declined by -8 and -11 percent. The estimated effects of inflation are considerably smaller, by ten orders of magnitude. As Figure 1 shows, output declined less during the hyperinflation of 1922-1923 than during the deflation of the 1930s.

As other variables are added, the post-war dummy approaches zero and even becomes slightly positive in some cases. The estimated effect of population approaches unity, and the time trend variable also decreases. These movements offer additional evidence that the specification correctly captures the influences at work.

The last two columns assess the effects of volatility alone, uncontaminated by the level of stock prices, and the effects of the level of stock prices alone, uncontaminated by volatility. The volatility coefficient increases substantially when level is excluded, and the level coefficient decreases (becomes more negative) when volatility is excluded. These estimates suggest that the level of stock prices also contains information about uncertainty.



**Table 1**

Regressions of natural log of annual German industrial production, 1891-1914 and 1918-1940, on natural log of stock return volatility (log of sum of absolute values of percentage changes in average monthly prices, January through December), natural log of stock price in April (nominal values except for gold mark values, 1918-1924), lagged deflation rate, inflation rate, natural log of population, time trend, a post-World-War-I dummy (1919-1940), and a dummy for 1918-1920. Constant calculated but not shown, t-statistics in parentheses. Estimates using lagged deflation start in 1892.

Dependent Variable: Natural log of industrial production

| Variable | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) |
|---|---|---|---|---|---|---|---|---|
| $\ln(\text{Volatility}_t)$ | | -.114<br>(3.52) | -.141<br>(4.02) | -.151<br>(4.69) | -.079<br>(3.04) | -.063<br>(2.56) | -.115<br>(4.61) | |
| $\ln(\text{Stock Price}_t)$ | | .214<br>(2.52) | .190<br>(2.27) | .085<br>(1.06) | .168<br>(2.82) | .084<br>(1.34) | | .256<br>(4.43) |
| $\text{Deflation}_{t-1}$ | | | | 3.48<br>(3.65) | 2.49<br>(5.05) | 4.08<br>(6.09) | 4.14<br>(5.85) | 3.41<br>(4.49) |
| $\text{Inflation}_t$<br>$(X\ 10^{-10})$ | | | | | | -2.7<br>(2.81) | | |
| $\ln(\text{Population}_t)$ | -.356<br>(0.36) | | 1.35<br>(1.77) | 0.873<br>(1.18) | 1.18<br>(2.19) | 1.17<br>(2.35) | 1.29<br>(2.21) | 0.61<br>(1.09) |
| Time Trend | .033<br>(2.91) | .027<br>(8.65) | .012<br>(1.34) | .018<br>(2.65) | 0.16<br>(2.65) | .017<br>(3.03) | .016<br>(2.44) | .023<br>(3.81) |
| Post WWI | -.526<br>(2.60) | -.019<br>(0.12) | .219<br>(1.06) | -.005<br>(0.03) | .080<br>(0.56) | .059<br>(0.42) | -.125<br>(0.93) | -.016<br>(0.10) |
| 1918-1920 | | | | | -.373<br>(6.01) | -.410<br>(7.00) | -.333<br>(5.08) | -.459<br>(7.54) |
| $R^2$ | .65 | .84 | .85 | .87 | .94 | .95 | .92 | .92 |
| D-W | .51 | .99 | 1.17 | 1.49 | 2.59 | 2.37 | 2.03 | 2.03 |

## IV. Concluding Comments

Industrial output dropped dramatically in Germany after the First World War, remaining 29 to 62 percent below its 1913 level until 1924, and only barely reaching the pre-war peak in the late 1920s. Most accounts of the German business cycle of this period emphasize monetary factors – the hyperinflation of 1922-23 and the deflation of the early 1930s – or the restrictions on fiscal policy imposed by reparations. However, these factors do not explain the permanent downward shift in the trend of output of roughly 50 percent that occurred in the wake of the war.

Part of the decline in output may be attributable to the shift in the political and regulatory climate. A number of factors changed in a relatively short period of time, notably the balance of power between labor and employers, and the fiscal power and economic role of the state, especially the central government. These factors, extensively discussed in the older literature, provide one set of reasons for the decline in output, though separating the influence of individual policies would be difficult.

Of equal importance for an assessment of this period is the fact that political and economic changes after the war involved more than a simple shift to a more interventionist government with stable policies. The history of the late teens, twenties and early thirties suggests strongly that the direction and scope of future economic policy was in doubt at several crucial junctures. If businesses and consumers make irreversible commitments by investing in real assets, even temporary uncertainty about the wisdom of those investments will cause less investment in productive assets and durable goods. Hence increased uncertainty may also account for the decline in output.



Supporting evidence for the last proposition comes from the level and volatility of stock prices. If future outcomes are less certain, stock prices should fall and the volatility of stock prices should increase. In fact, both happened after 1917, and the level and volatility of stock prices moved inversely over the next two decades. According to the statistical results, the level and volatility of stock prices do in fact help explain the level of output. These results are consistent with findings for the U.S., but take on new meaning in the context of German experience.

Though suggestive, more work is clearly called for. At the simplest level, it would be desirable to estimate similar models using quarterly rather than annual data and extend the results to the post-World War II period. However, given the gaps in German data series, a study comparable to Schwert's (1989) study for the U.S. may be difficult to carry out. On another front, it also seems likely that it would be possible to confirm for Germany Romer's (1990) finding for the U.S. that the business press and other contemporary observers were uncertain about future economic conditions when the stock market turned volatile. Finally, it would be desirable to determine whether stock price movements can be linked with specific developments, particularly political developments. Though such a study would require assembly of daily stock price data, it could help confirm or refute what has been only a presumption here, namely that increased stock volatility after 1917 had its origins in or was seriously aggravated by political factors.

## Data Appendix

The production index appears in Mitchell [1992, Table D1, series (a)] and stems from Hoffman (1965, Table 76) for the years through 1913, and Petzina et al. (1978, Table 11, p. 61) for 1913-1940, who cite Wagenführ, *Industriewirtschaft*, p. 23 and p. 64 and Wagenführ, *Industrie im Kriege*, p. 166 and p. 191, and *Bevölkerung und Wirtschaft* (no author), p. 176, and *Statistisches Jahrbuch für das Deutsche Reich 1941/42*, p. 192. The Hoffmann series is based a variety of industries covering metals, metal working, chemicals, textiles, food, utilities and construction. The Petzina series is composed of three broad components – consumer goods, producer goods and mining. Nominally continuous through the First World War and the early 1920s, it is based on mining only for 1914-1918, and producer goods and mining in 1919. Since missing stock data already result in the loss of the years 1915-1917, the estimated regressions use a production index that excludes less cyclically sensitive consumer goods for the years 1918-1919.

The aggregrate stock index comes from Statistisches Bundesamt (1985, Table 2, pp. 189-193). It is based on nominal prices for 1890-1914 and 1924-1940. Since the price level was roughly constant, and since monthly price indices are likely to introduce new errors, I did not deflate. For the period of World War I inflation and early 1920s hyperinflation, I used the stock index quoted in gold marks – which was calculated by converting stock prices quoted in marks to dollars using the exchange rate and then dollars to gold. Because the index based on gold marks overlaps with the nominal series, it is possible to construct a continuous series for 1890-1914, interrupted only by missing data for 1915-1917. The monthly values are averages of daily values and exclude dividends. Since the index has no values for four months in 1914 and 1931 and three months in 1932, I extrapolote volatility for those years based on the remaining monthly values.



The consumer price index stems from Mitchell (1992, Table H2).

Population comes from Statistisches Bundesamt (1952, Table 2, p.13). Population excluded as the result of losses of territory are as follows: Alsace-Lorraine and Posen starting 1919 (reflected in a decline from 66.8 to 62.9 million); Memel province, Danzig and territories going to Poland, Czechoslovakia, Denmark and Belgium starting 1920 (62.9 to 61.7 million); and Upper Silesia starting 1922 (62.5 to 61.9 million).

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