

The Debt-Inflation Channel of the German Hyperinflation

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Abstract

Unexpected inflation can redistribute wealth from creditors to debtors. In the presence of financing frictions, such redistribution can impact the allocation of real activity. We use the German inflation of 1919-1923 to study how a large inflationary shock is transmitted to the real economy via a *debt-inflation* channel. In line with inflation reducing real debt burdens and relaxing financial constraints, we document a tight negative and convex relation between firm bankruptcies and inflation in aggregate data. Using newly digitized firm-level data, we further document a significant decline in leverage and interest expenses during the inflation. We show that firms that have more nominal liabilities at the onset of the inflation become more valuable in the stock market, face lower interest payments, and increase their overall employment once the inflation starts. The results are consistent with substantial real effects of inflation through a financial channel that operates even when prices and wages are fully flexible.

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“The Germany of the inflation was paradise for anyone who owed money.”

– Frederick Taylor, *The Downfall of Money* (2013).

1 Introduction

The German inflation of 1919-1923 is a key event in monetary history (Bresciani-Turrone, 1937; Cagan, 1956; Sargent, 1982). From a value of 4.2 marks per dollar on the eve of World War I, the mark depreciated to 4.2 *trillion* marks per dollar by November 1923. Generations of researchers have examined this episode to understand the fundamental causes of inflation, as well as its macroeconomic, distributional, and broader societal effects.

In this paper, we use the German inflation as a laboratory to study how a large inflationary shock is transmitted to the real economy through a *debt-inflation* channel. With long-term nominal debt contracts, unexpected inflation can redistribute wealth from creditors to debtors (Keynes, 1923). If firms are financially constrained, such wealth redistribution can affect *real* economic activity and potentially have aggregate effects, even when prices and wages are fully flexible (Fisher, 1933; Gomes et al., 2016). The German hyperinflation provides an appealing setting to study this financial channel because the enormous unexpected increase in the price level puts the effects of inflation on balance sheets into sharp relief. Further, we compare the debt-inflation channel with the traditional New Keynesian channel based on nominal rigidities by presenting new evidence on price and wage setting during the inflation.

We begin by describing the macroeconomic environment surrounding the German inflation, revisiting existing evidence and providing novel facts from newly digitized data.¹ The post-war German inflation can be divided into two broad phases. The first phase occurs from the end of WWI in November 1918 to June 1922.² In this phase, the price level increased by a factor of 30, and economic growth was strong. Inflation was unexpected based on forward exchange premium data as well as anecdotal evidence of foreign speculators betting on an appreciation of

¹Throughout the paper, we refer to the entire post-war inflation from November 1918 to November 1923 as the “German inflation.” As we discuss below, we reserve term “hyperinflation” for the phase from July 1922 to November 1923 when monthly inflation exceeded 50%.

²Inflation begins with the outset of WWI following the abandonment of the gold standard. The price level in Germany increased by a factor of 2.4 during WWI. We focus mainly on the post-WWI period because inflation was higher during this period and economic activity and inflation during the war was heavily influenced by wartime policies and controls.

the German mark. The root cause of the inflation was deficit-financed war spending, massive WWI reparations, and a lack of political will to adjust to the burden of higher debt through reduced spending and increased taxation in an attempt to maintain social peace (Graham, 1931; Sargent, 1982; Kindleberger, 1985; Feldman, 1993). Moreover, there was no central bank policy response to high inflation; instead, the Reichsbank accommodated large deficits by discounting government securities.

The second phase of the post-war inflation is the hyperinflation from July 1922 to the stabilization in November 1923. This phase begins after the assassination of foreign minister Rathenau and concurrent political turmoil over WWI reparations. In this phase, the price level spirals out of control. In line with inflation expectations becoming unanchored and a flight from the mark, the forward exchange premium turns to a large discount from July 1922 onward. The hyperinflation coincides with deteriorating economic conditions and rising unemployment, which is exacerbated by the invasion of the Ruhr and resulting collapse in industrial production.

What are the macro-financial implications of the inflation? Using time-series variation, we find a striking negative relation between inflation and firm bankruptcies. Bankruptcies consistently declined with rising inflation and remained at historically low levels even with the economic tumult of 1923. Moreover, the relation is convex. For low to moderate inflation, additional inflation is associated with sharply lower firm bankruptcies. At levels of annual inflation above 500%, additional inflation only weakly reduced bankruptcies. Intuitively, once the price level has doubled several times over within a few years, debts have already been wiped out, making bankruptcy increasingly unlikely.

To better understand the negative relation between inflation and bankruptcies, we document that inflation is associated with a massive fall in leverage. We find that the ratio of nominal liabilities to assets falls by around 25 percentage points for the average firm, representing a 50% decline. Interest expenses as a share of total expenses also fall by 6 percentage points, representing a 60% decline from 1918 through 1923. On the other hand, salaries as a share of total firm expenses remain constant. These trends are consistent with the longer maturity of financial liabilities relative to wage liabilities. As inflation accelerates, nominal financial liabilities such as long-term debt and pensions are wiped out, while wages become increasingly flexible and race to keep up with inflation. Indeed, we show that the frequency of price and wage adjustment rises with

inflation, consistent with menu cost models. We find that while wages are adjusted on average every 9 months for lower levels of inflation, they are adjusted every 60 days or less once inflation exceeds 100% and every 30 days or less once inflation becomes hyper. Further, we find that once inflation exceeds 50%, retail prices are reset at least every 30 days, and when inflation becomes hyper, retail prices adjusted every 7 days or less. Financial frictions thus potentially matter more than nominal rigidities in understanding the transmission of large inflationary shocks to the real economy.

The aggregate decline in bankruptcies during the inflation raises several intriguing questions. What is the extent of redistribution toward leveraged firms from the inflation? How much do equity-holders benefit from leverage and how is this reflected in equity prices? Does the erosion of the real value of nominal debt have real effects in terms of firms' employment?

To answer these questions and provide a more convincing identification of the debt-inflation channel, we examine the impact of inflation in the cross-section of firms. We construct a new firm-level database by digitizing a financial manual with firm-level information on balance sheets, income statements, employment, and outstanding bonds for about 700 joint-stock firms in Germany. We merge these data with newly digitized monthly stock prices. Information on employment and stock prices is particularly valuable, as accounting statements potentially provide a distorted representation of firm financial conditions during the hyperinflation phase, especially in 1923.³

The debt-inflation channel has real effects in the cross-section of firms. We estimate a difference-in-differences specification, sorting firms by their leverage at the onset of the inflation. Firms with higher initial leverage have significantly stronger employment growth relative to firms with lower leverage. In terms of magnitudes, a 10 percentage point increase in leverage is associated with a 3.5% higher employment during the inflation. Abstracting from general equilibrium effects, the debt-inflation channel accounts for a 17% increase in employment, which is similar to the overall employment increase in this phase of the inflation. The expansionary effect on employment occurs throughout the inflation, but is strongest in the first phase of inflation up to 1922. The hyperinflationary phase of 1922-23 has limited additional stimulative real effects on high leverage

³Accounting statements become more reliable again starting in January 1924, when firms were required to draw up revalued "Goldmark" balance sheets, as we discuss in section 3.

firms, consistent with the convex relation between bankruptcies and inflation in the aggregate.

We provide several pieces of evidence to support the interpretation that the real effects on employment are driven by the debt-inflation channel. First, high leverage firms see larger reductions in the share of interest expenses to total expenses. At the same time, these firms increase the share of salary and material expenses. This is consistent with inflation lowering real debt payments, relaxing liquidity constraints, and thereby allowing firms to increase spending on production inputs.

Second, the debt-inflation channel should especially benefit firms with a higher proportion of long-term debt. Around 50% of the non-financial firms in our sample have a long-term bond outstanding as of 1919. All bonds were fixed rate. The majority of these bonds were issued before WWI, and the median remaining maturity is 20 years. Exploiting these additional details on the maturity structure of firms' liabilities, we apply a triple difference-in-differences specification and show that the decline in interest expenses and the increase in employment is strongest for highly levered firms with a high proportion of long-term debt to total debt.

Third, we show that high-leverage firms see a larger increase in their book equity and a larger decline in book leverage. Finally, these firms experience relatively higher stock market returns, especially in the hyperinflation phase of 1922-23 when erosion of real debt was most salient to investors. On average, high leverage firms have 10-13% higher annual risk-adjusted returns relative to low leverage firms during the inflation. Overall, firm-level evidence suggests that the largely unexpected inflation thus redistributed wealth from debtholders to shareholders of levered firms, relaxing financing constraints and allowing these firms to expand employment and production.

We reinforce these results and rule out several potentially confounding explanations with a series of robustness tests. Higher employment growth for highly levered firms is unlikely to be explained by differential exposure to wage rigidity. Wages were mostly set at the industry level by union bargaining, and all the results are robust to the inclusion of detailed industry-by-time fixed effects. Thus, the debt-inflation channel appears to matter, above and beyond, the New Keynesian nominal rigidity channel, especially since prices and wages are essentially flexible once inflation surpasses 100%. The estimates are also robust to the inclusion of other firm-level controls such as initial size, the share of fixed assets, and profitability. In addition, while credit availability

tightened especially in the later phase of the inflation, the results are robust to controlling for proxies of credit supply. Furthermore, firms with high leverage at the onset of the inflation do not have higher business cycle exposure in other periods.

Our paper contributes to the large literature on the German inflation and big inflations more broadly.⁴ Few episodes have attracted as much attention from economists. The extensive work on the German hyperinflation, however, has almost entirely relied on aggregate time series data.⁵ We provide several new insights based on novel industry- and firm-level data. Previous studies have discussed that inflation eroded public debt (Dornbusch, 1985) and private debt (Graham, 1931), but we are the first to document that the fall in bankruptcies lines up closely with the preceding rise in the price level. Moreover, we are the first to quantify the impact of the debt-inflation channel of the inflation on firm balance sheets, stock market valuations, and real firm-level outcomes.

We also contribute to studies on the impact of inflation on the performance of firms with high and low leverage. Prior research has primarily focused on the 1970s Great Inflation in the U.S and finds mixed evidence for the hypothesis that equity valuation of firms with leverage benefit from inflation (see, for example, Summers, 1981; French et al., 1983; Ritter and Warr, 2002).⁶ While inflation during the 1970s was high by U.S. historical standards, it was orders of magnitudes lower than the German inflation, even before the hyperinflation stage. Therefore, studying the German inflation allows us to identify a channel that has been challenging to isolate during episodes of moderate inflation when other shocks may obscure the balance sheet effects of inflation. Moreover, the absence of a central bank policy response allows us to examine the impact of an unexpected inflationary shock that was not met with a large increase in interest rates.

Our findings on the frequency of price and wage adjustments also inform the literature on price setting. The evidence that the frequency of price and wage adjustment rises with inflation is consistent with the early accounts of Pazos (1972) and Simonsen (1983). More recently, Alvarez et al. (2019) show theoretically and empirically that higher levels of inflation increase the frequency

⁴Prominent studies of the German inflation include Schacht (1927), Bresciani-Turroni (1937), Graham (1931), Holtfrerich (1986), and Feldman (1993). Important studies of hyperinflations, including Weimar Germany's inflation, include Cagan (1956), Sargent (1982), and Dornbusch and Fischer (1986). Section 4 and Appendix A.1 provide an overview of the historical context and reviews existing historical studies on Germany's inflation.

⁵A recent exception is Braggion et al. (2022), who analyze security holdings of clients of a major bank. They find that investors exposed to higher local inflation have lower demand for stocks, likely due to money illusion.

⁶These papers do not examine whether inflation has real effects on firm investment or employment. Focusing on the U.S. during the Great Depression, Hausman et al. (2019) document that the departure from the Gold Standard in 1933 led to an increase in crop prices, which boosted income and spending in areas with high farm mortgage debt.

of price changes and lead to a wider price dispersion, but only in high-inflation regimes (see also Gagnon 2009; Nakamura et al. 2018). Alvarez et al. (2019) also calibrate large welfare losses in hyperinflations due to high dispersion in relative prices. There is less evidence on wage adjustment during high and hyperinflation, but existing work focusing on times with low and moderate inflation finds that wage contract lengths shorten with higher inflation (Cecchetti, 1987; Card and Hyslop, 1997).⁷

The remainder of the paper is structured as follows. Section 2 provides a conceptual framework to motivate the empirical analysis. Section 3 describes our newly digitized macro and firm-level data. Section 4 presents aggregate evidence on the debt-inflation and nominal rigidity channels of inflation. Section 5 presents evidence of the financial channel in the cross-section of firms, and section 6 concludes.

2 Conceptual Framework

This section lays out a conceptual framework summarizing our hypotheses for how a large inflation can affect the real economy. The discussion in this section is based on intuition from a simple model laid out in Appendix A.2. Since the mechanisms are intuitive, we leave the formal model for the appendix.

In theory, the equity owners of a firm with nominal debt will benefit from unanticipated inflation, as inflation reduces real debt burdens. This should increase net worth and the market value of equity for more levered firms, especially when debt is of longer maturity and at a fixed interest rate. In the absence of financing frictions or costs of financial distress, the reduction in real debt burdens benefits equity owners but does not change employment, investment, or production.

If firms face financing frictions and/or costs of financial distress, inflation can boost real activity through what we refer to as the *debt-inflation* channel of inflation. The debt-inflation channel is the inverse case of Irving Fisher's famous debt-deflation channel (Fisher, 1933). Our model highlights that the debt-inflation channel can operate through two mechanisms. First, the reduction in real debt burdens reduces the likelihood that a firm will default and go into bankruptcy. This mechanism is at the heart of the models in Bhamra et al. (2011) and Gomes et al.

⁷See Taylor (2016) for an overview of research on price and wage setting.

(2016), where unanticipated inflation reduces leverage, alleviates debt overhang, and reduces the share of firms in costly bankruptcy, thereby increasing output. This effect is particularly strong when debt is long-term.

Hypothesis I: Inflation and Firm Bankruptcies. *When firms have nominal debt and can default, unexpected inflation increases firms' net worth, leading to a decline in bankruptcy rates.*

Second, the reduction in real debt burdens increases a firm's liquidity and net worth. This allows a financially constrained firm to expand employment, investment, and production. For example, if a firm's debt is limited to be a fixed proportion of assets (e.g., Kiyotaki and Moore, 1997) or cash flows (e.g., Lian and Ma, 2021), a one-time episode of unexpected inflation will relax this financing constraint. The inflation thus generates a boom in employment, investment, and production, especially for more levered firms. We illustrate this mechanism in our model in appendix A.2. Along similar lines, Cordoba and Ripoll (2004) consider a variant of the Kiyotaki and Moore (1997) model with money and nominal debt. In that model, unexpected inflation leads to redistribution toward constrained productive agents, which increases their net worth, relaxes financing constraints, and boosts production.

Hypothesis II: The Debt-Inflation Channel and Firm Activity. *If firms are financing-constrained, unexpected inflation relaxes financing constraints and leads to an increase in employment and output. The debt-inflation channel is stronger for firms with higher initial leverage.*

Several caveats to this financial channel are worth noting. Inflation has real effects through a debt-inflation channel if firms are financing-constrained and if debt contracts are nominal and long-term with fixed interest rate. If instead debt is floating, indexed to inflation, or denominated in foreign currency, then inflation does not necessarily increase firms' net worth or output. At the same time, unanticipated inflation results in a loss for the holders of nominal debt. If the holders of the debt are households, then this can lead to an increase in labor supply through a wealth effect, leading to a further increase in employment and output (see Appendix A.2). On the other hand, if inflation reduces the net worth of banks exposed to duration mismatch, then the reduction in credit supply can depress firm activity.⁸

The debt-inflation channel of the inflation is relevant in absence of nominal rigidities, tradition-

⁸While our main focus is on the debt-inflation channel operating through nonfinancial firms' balance sheets, we discuss the impact of inflation on bank credit supply in section 5. For recent evidence that inflation can impair the intermediation of credit, see Drechsler et al. (2022) and Agarwal and Baron (2022).

ally assumed in macroeconomic models of inflation (e.g. Galí, 2015). In our model in appendix A.2, we introduce a nominal rigidity by assuming a fixed cost of wage adjustment. With this assumption, moderate inflation leads to a fall in real wages, boosting labor demand, employment, and output. This *nominal rigidity channel* and the debt-inflation channel both work together to boost employment output. However, at high levels of inflation, wage setters pay the fixed menu cost of updating wages, and wages become flexible. Thus, for high levels of inflation, inflation only has real effects through the debt-inflation channel. Golosov and Lucas (2007) emphasize that menu costs imply small real effects of money-induced inflation, yet inflation could nonetheless have substantial real effects through the debt-inflation channel. The German inflation provides an appealing setting to test these hypotheses, as the high level of inflation led prices and wages to become highly flexible.

***Hypothesis III: The Nominal Rigidity Channel of Inflation.** If workers face a menu cost in adjusting wages, small increases in inflation have a large effect on output by reducing real wages. The nominal rigidity channel thus complements the debt-inflation channel. However, for high inflation, wages become flexible, and inflation only has an expansionary effect through the debt-inflation channel.*

3 Data

3.1 Aggregate, Industry-level, and Regional Data

We obtain aggregate, industry-level, and regional data by digitizing contemporary publications of various government agencies. Our main source is a publication from the government agency for statistical analysis, the *Reichsamt für Statistik*, which is called *Zahlen zur Geldentwertung in Deutschland von 1914 bis 1923* and was published in 1925. This publication provides data on the daily exchange rate of the mark to the dollar, cost-of-living and wholesale prices indexes by month, wages by industry, weekly prices for consumption goods in Berlin during 1923, as well as stock market indices by broad industry categories.⁹ Additional data on wages by industry and monthly prices for consumption goods at the city level are obtained from the contemporary publication *Wirtschaft and Statistik*, which was published at a monthly frequency starting in January 1921, and at a bi-monthly frequency from January 1922 onwards. Further, we obtain information

⁹These data are in part digitally available at <https://histat.gesis.org/>.

on firm bankruptcies and liquidations by industry and prices for wholesale goods from the *Vierteljahrshefte zur Statistik des Deutschen Reichs Herausgegeben vom Statistischen Reichsamt* and the annual *Statistisches Jahrbuch für das deutsche Reich*, which were published through 1919-1923 at the quarterly and annual frequency, respectively. Finally, we digitize parts of the appendix of the *Reichsarbeitsblatt*, published by the ministry of labor (*Reichsarbeitsministerium*) and which contains information on monthly industry-level and regional unemployment.

3.2 Firm-Level Data

We construct a firm-level dataset with annual information on balance sheets and income statements from *Saling's Börsenjahrbuch*, an investor manual.¹⁰ Figure 1a provides an example of the balance sheet and income statement from the 1920 issue of *Saling's* for Siemens & Halske AG, a large electrical engineering firm. We digitize these financial statements using optical character recognition (OCR), applying the methods discussed in Correia and Luck (2023), and then hand-check the OCR output, with particular attention to cases where accounting identities fail to hold. Further, the source also provides loan terms for long-term bonds which we hand-collect for selected years. The data are available for over 700 nonfinancial firms and 60 banks each year for the period 1915 to 1933. In this paper, we focus on the sample of nonfinancial firms and exclude banks and insurance companies. Table 1 provides summary statistics for key firm-level variables. Appendix Figure A.3.1 plots the number of firms reporting balance sheets by quarter and currency of reporting from 1918 to 1927.

An important point to note when using data from *Saling's Börsenjahrbuch* is that balance sheets can provide a misleading account of firms' financial situations during hyperinflation.¹¹ "Inflation accounting" did not exist at the time, and dealing with inflation was a major challenge for firms, especially in 1922-23. For example, the 1923 financial report of Darmstädter und Nationalbank stated that "the figures in our balance sheet and profit- and-loss statement are, as in those of all German companies, unfit for any serious scrutiny, and to examine them in detail is folly."¹²

¹⁰The *Saling's* documents are made available by the University of Mannheim. See <https://digi.bib.uni-mannheim.de> for the scanned originals.

¹¹Income statements can also be distorted due to the addition of nominal values at different price levels, but the distortions are most severe for balance sheets. For income statements, we rely on ratios such as the share of interest expenses to total expenses, which are less likely to be distorted by inflation as long as different expenses occur at similar times in the year.

¹²See Sweeney (1934) for a detailed discussion of how inflation distorted balance sheets during the 1920s hyperinfla-

Figure 1: Example of Newly Digitized Firm-Level Data from Saling’s Börsenjahrbuch and Berliner Börsen Zeitung.

(a) Siemens & Halske AG’s financial statement from Saling’s, 1920.

(b) Stock prices of industrial firms from Berliner Börsen Zeitung, 1922.

Nummer 118. Kurszettel der „Berliner Börsen-Zeitung“ vom 30. Juni 1922. 3

Aktien von industriellen und Bergwerks-Gesellschaften.

Die Dividenden laufen für 1920 u. 1921 resp. für 1919, 1920 u. 1922, außer den Geschäftsjahr nach dem 31. XII. 21, aber vor dem 1. VI. 22 endete, in anderen Fällen für 1920, 1919 u. 1920-21 bedeutet, dass die Dividenden vorgezogen, der Termin der Ausschüttung aber noch nicht bestimmt ist.
*) hinter dem Kurs bedeutet, daß bei Ausübung von Kauf- oder Verkaufsaufträgen im nächsten Verkehr die Reparatur stiftungsbenehm.

Aktiva			Passiva		
Stückzahl	Kurs	Wert	Stückzahl	Kurs	Wert
14 100 000	1000	14 100 000	100 000 000	1000	100 000 000
12 500 000	1000	12 500 000	100 000 000	1000	100 000 000
10 000 000	1000	10 000 000	100 000 000	1000	100 000 000
8 000 000	1000	8 000 000	100 000 000	1000	100 000 000
6 000 000	1000	6 000 000	100 000 000	1000	100 000 000
4 000 000	1000	4 000 000	100 000 000	1000	100 000 000
2 000 000	1000	2 000 000	100 000 000	1000	100 000 000
1 000 000	1000	1 000 000	100 000 000	1000	100 000 000
500 000	1000	500 000	100 000 000	1000	100 000 000
250 000	1000	250 000	100 000 000	1000	100 000 000
125 000	1000	125 000	100 000 000	1000	100 000 000
62 500	1000	62 500	100 000 000	1000	100 000 000
31 250	1000	31 250	100 000 000	1000	100 000 000
15 625	1000	15 625	100 000 000	1000	100 000 000
7 812 500	1000	7 812 500	100 000 000	1000	100 000 000
3 906 250	1000	3 906 250	100 000 000	1000	100 000 000
1 953 125	1000	1 953 125	100 000 000	1000	100 000 000
976 562 500	1000	976 562 500	100 000 000	1000	100 000 000

Notes: Panel (a) shows an example of financial statements for the firm Siemens & Halske AG from the 1920 issue of Saling’s Börsenjahrbuch. Panel (b) shows an excerpt of stock prices and dividends from Berliner Börsen Zeitung.

Similarly, Hoffmann and Walker (2020) provide examples of firms noting that the calculation of balance sheets and income in paper marks “lost its economic meaning” and that firms only reported financial statements out of legal obligation. We are therefore cautious in drawing inferences based on financial statements from 1922 and especially 1923. Figure A.3.2 shows that violations of the balance sheet accounting identity spikes to about 40% in 1923, from around 5% in other years.¹³

In response to the distortion of paper mark balance sheets caused by the hyperinflation, the

tions in Europe.

¹³Specifically, we test whether the sum of all assets equals the sum of all liabilities and equity, as well as whether these sums equal total assets (reported separately). Failure of accounting identities to hold for 5% of balance sheets outside of the hyperinflation is likely due to clerical errors or cases where firms do not report small balance sheet items.

regulation on Goldmark accounts (Verordnung über Goldbilanzen) was passed in December 1923. It required firms to prepare new opening balance sheets for financial years beginning on or after January 1, 1924 in Goldmarks.¹⁴ This preparation required a full revaluation of all assets and liabilities (see, e.g., Sommerfeld, 1924).

Treating the Goldmark balance sheets as correct, we can compare the changes in balance sheet items before and after the introduction of Goldmark balance sheets to understand how hyperinflation distorted accounting.¹⁵ Accounting distortions caused by inflation are not symmetric across the balance sheet items. Instead, the revalued Goldmark balance sheets reveal that “real” positions such as fixed assets, inventories, and book equity are systematically more likely to be undervalued than “nominal” items such as cash, other short-term assets, and debt.¹⁶ Figure A.3.3 illustrates that the introduction of Goldmark balance sheets leads to large positive revaluations of fixed assets, inventories, and book equity. An implication is that the level of leverage (liabilities-to-assets) is significantly overstated by balance sheets during the hyperinflation.

Our analysis uses two approaches to overcome the inflation-induced measurement challenge. First, we primarily rely on accounting variables before the hyperinflation (before 1922) and after the Goldmark balance sheets (usually from January 1, 1924), avoiding use of the 1923 balance sheet values. This allows us to see what happened to key balance sheet variables from before to after the inflation, but has the obvious drawback of not being informative about the timing of the effects.

Second, we examine variables that are not subject to accounting issues throughout the inflation: employment and stock prices. Employment is self-reported by firms in *Saling* for about one-third of the firms in the sample. Aggregating employment growth across firms in *Saling* captures the aggregate fluctuations in employment reasonably well. Figure A.3.5 compares average employment growth in *Saling* with the change in the aggregate unemployment rate (on an inverted scale). The two variables co-move reasonably closely. Employment growth among firms in *Saling* captures

¹⁴The Goldmark was not an actual currency in circulation but used for accounting purposes and equivalent to the new Rentenmark which had an exchange rate of 4.2 per U.S. dollar.

¹⁵Sweeney (1934) uses the Goldmark balance sheets as the “truth” to illustrate the misleading nature of the paper mark balance sheets during the hyperinflation. However, it should be noted that even the revalued Goldmark balance sheets likely undervalue real assets, as uncertainty about the costs of stabilization and whether it would succeed led to conservative valuations (Graham, 1931, p. 242).

¹⁶Sweeney (1934) also notes that current assets and current liabilities more likely to be correct in a case study comparing paper mark and revalued gold mark balance sheet for one firm. Measurement error is most severe for less liquid, long-term assets, such as fixed assets and book equity.

the boom in the 1920-1922 period, the slowdown in 1923 and after the stabilization in 1924, the boom in the latter part of the 1920s, and the collapse after 1929.

Finally, monthly stock and bond prices for nonfinancial firms and banks are hand-collected from *Berliner Börsen Zeitung* (BBZ), a financial newspaper. We also collect dividends to construct total returns. Figure 1b provides an example of data from *Berliner Börsen Zeitung*. Figure A.3.20 shows that equal-weighted stock price indexes constructed from the BBZ data closely track corresponding indexes published by *Wirtschaft und Statistik*, providing a reassuring validation of our hand-collected stock market data.

Table 1: Summary Statistics: Firm-Level Dataset.

	N	Mean	Std. dev.	10th	90th
Liabilities/Assets $_{i,1918-1919}$	795	0.47	0.18	0.23	0.68
$\Delta_{1919-1924}$ Liabilities/Assets $_i$	656	-0.25	0.20	-0.47	0.00
Debt/Assets $_{i,1918-1919}$	799	0.37	0.18	0.13	0.59
$\ln(\text{Assets})_{i,1918-1919}$	800	15.01	1.26	13.48	16.77
Fixed Assets/Assets $_{i,1918-1919}$	800	0.36	0.24	0.08	0.74
ROA $_{i,1918-1919}$	744	0.10	0.06	0.03	0.18
EBIT margin $_{i,1918-1919}$	758	0.36	0.22	0.10	0.68
Employment $_{i,1919}$	240	4,151.54	9,307.68	400.00	9,959.50
$\Delta \ln(\text{Employment})_{i,t}$	1,358	3.50	21.90	-2.90	19.24

Notes: This table reports summary statistics for the firm-level dataset based on *Saling's Boersenjahrbuch*. Variables with "1918 – 1919" subscripts are averaged over 1918 and 1919. $\Delta \ln(\text{Employment})$ is the change in log firm employment (times 100) from 1919 through 1923.

4 Aggregate Evidence on the Debt-Inflation Channel

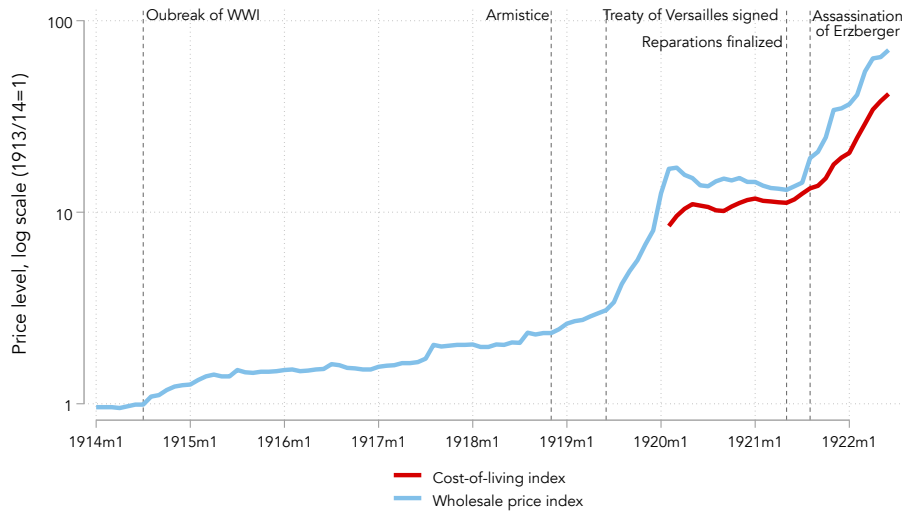
4.1 Background and Aggregate Evidence on Weimar Germany's Inflation

We start with a brief overview of Weimar Germany's inflation. Appendix A.1 provides further details on the historical background and a chronology of critical events.

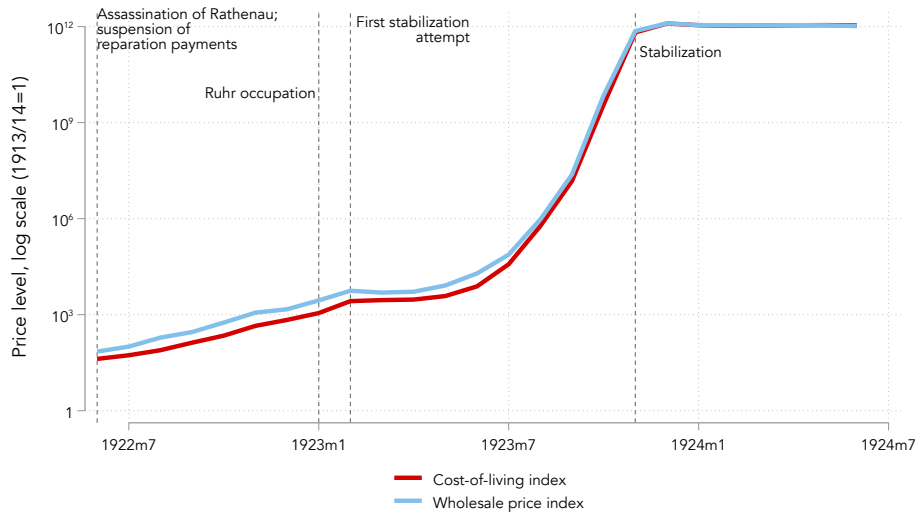
Two phases of the inflation. Figure 2 plots the time series of the wholesale price index and the cost-of-living index. Germany's inflation has its roots in WWI, when the gold standard was abandoned and the government increasingly financed the deficit by discounting government securities at the Reichsbank (Feldman, 1993). During WWI, the wholesale price index increased by

Figure 2: The Price Level during Germany's Inflation.

(a) Wartime inflation and first phase of the post-war inflation, January 1914 to June 1922.



(b) Second phase of the inflation and the post-stabilization period, June 1922 to December 1924.



Notes: The source for the wholesale price index (Gesamtindex der Grosshandelspreise) and cost-of-living index (Lebenshaltung insgesamt) is *Zahlen zur Geldentwertung in Deutschland von 1914 bis 1923*.

a factor of 2.45. This rate of inflation was slightly higher than in the U.K., where prices increased by a factor of 2.3, and lower than in France, where wholesale prices increased by a factor of 3.3. At the end of the war, German inflation and public finances were not in significantly worse condition than France's (Graham, 1931).

In the post-war period, there are two broad phases of the inflation. The first phase is from

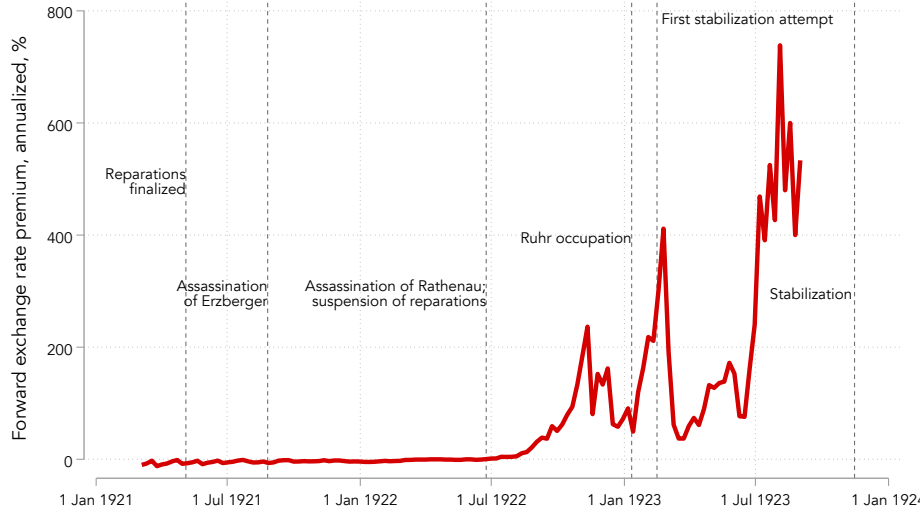
the WWI Armistice in November 1918 to the summer of 1922. Panel (a) of Figure 2 shows that inflation accelerated in the second half of 1919, after the signing of the Treaty of Versailles in June 1919. The Treaty assigned sole blame for the war on the Central Powers (the “War Guilt Clause”) and imposed large and uncertain reparations on Germany. From the end of 1918 to end of 1919, the wholesale price index increased by a factor of 3.3. The price level stabilized during 1920 with the Ezberger fiscal reforms and the successful suppression of the “Kapp Putsch,” a right-wing coup attempt, in March 1920. The price level then rose again in May 1921 after the Reparations Commission determined Germany’s exact reparations bill and imposed an ultimatum of a substantial upfront payment in 1921.

The second phase of the inflation runs from July 1922 to stabilization in November 1923, shown in panel (b) of Figure 2. This phase was ushered in by several events that further undermined confidence in Germany’s ability to meet reparations. In early June 1922, the French government insisted on the original reparations schedule, rather than a reduced schedule—in part as a response to the upset of the Treaty of Rapallo in which Germany entered into diplomatic relations with the Soviet Union. Hopes of an international loan to stabilize the mark were disappointed by the Reparations Commissions Banker’s Committee. On June 24, the foreign minister Walther Rathenau was assassinated by an ultra-nationalist terrorist group. That day the mark depreciated by 7% against the dollar. Moreover, Germany suspended and formally demanded a 2.5 year postponement of reparations in July 1922. From July 1922, monthly inflation exceeded 50%, marking the start of the hyperinflation phase.

Inflation expectations. During the first phase of the inflation, many agents, including foreign speculators, believed that the depreciation of the mark would be temporary and that the mark would recover. Narrative evidence suggests inflation expectations were anchored in the first phase of the inflation (Kindleberger, 1985).¹⁷ Expectations of inflation then shifted decisively and became unanchored in the summer of 1922, as expectations of further depreciation became widespread (Feldman, 1993).

¹⁷Ferguson (1995) reports that Keynes lost £20,000 speculating on the mark (about £500,000 today). He was later reported to have said that “everyone in Europe and American bought mark notes... the argument has been the same... Germany is a great and strong country; some day she will recover; when that happens the mark will recover also, which will bring a very large profit. So little do bankers and servant girls understand of history and economics.”

Figure 3: Inflation Expectations Implied by Forward Exchange Rates.



Notes: Forward and spot exchange rate data are from Einzig (1937), which records the data from the weekly circular of the Anglo-Portuguese Colonial and Overseas Bank, Ltd. The annualized forward premium is based on one-month forward contracts and is calculated as $12 \frac{F_t - S_t}{S_t}$, where S_t is the spot exchange rate in marks per sterling and F_t is the forward exchange rate. A higher value implies that the forward price of sterling (in terms of marks) is at a premium compared to the spot price.

This narrative is supported by the behavior of the forward exchange rate. Figure 3 plots the annualized mark/sterling forward premium based on one-month forward contracts.¹⁸ From covered-interest parity and abstracting from a risk-premium, the forward premium is given by $\frac{F_t}{S_t} = \frac{1+i_t}{1+i_t^*}$, where i_t is the mark interest rate and i_t^* is the pound sterling interest rate. Taking an approximation and applying the Fisher equation yields $\frac{F_t - S_t}{S_t} \approx i_t - i_t^* = \mathbb{E}_t \pi_{t+1} - \mathbb{E}_t \pi_{t+1}^* + r_t - r_t^*$, where π_t is the rate of inflation and r_t the real interest rate. Assuming that most variation in interest rates is due to expectations about inflation in Germany ($\mathbb{E}_t \pi_{t+1}$), the forward premium provides a proxy of inflation expectations.¹⁹

Before June 1922, the mark forward rate was at a premium relative to the spot rate, suggesting that the forward market anticipated lower inflation in Germany up to summer of 1922. Therefore, high inflation came as a surprise relative to expectations in the first phase of the inflation.²⁰

¹⁸The annualized forward premium is calculated as $\frac{12(F_t - S_t)}{S_t}$, where S_t is the spot exchange rate in marks per sterling and F_t is the forward exchange rate.

¹⁹Frenkel (1977) also makes this assumption and uses the same forward-premium data to construct a measure of inflation expectations to estimate money demand during the German hyperinflation.

²⁰Another piece of evidence for anchored inflation expectations is that firms were able to issue long-term fixed rate bonds in 1919-20, as we discuss below (see Figure A.3.22). Moreover, in 1922 many borrowers repaid loans early to take advantage of the depreciated mark because they (wrongly) expected the mark to strengthen again (Hughes, 1988).

While this is perhaps surprising *ex post*, an important point is that inflation had been low from Germany's unification until WWI, at an average rate of 0.7% per year. The last hyperinflation occurred over a century earlier during the French revolution.

The forward price of sterling moves decisively from a discount to a premium the week of Rathenau's assassination in late June 1922, suggesting that inflation expectations became unanchored (Holtfrerich, 1986). After the political turmoil during the summer of 1922, the forward trades at a larger and larger premium. Inflation expectations and realized inflation rose further after the invasion of the Ruhr by France and Belgium in January 1923 in response to arrears on the delivery of reparations in kind. The occupation was met with passive resistance, which the government financed by discounting treasury bills. This led to a large increase in money printing, which further fuelled inflation.

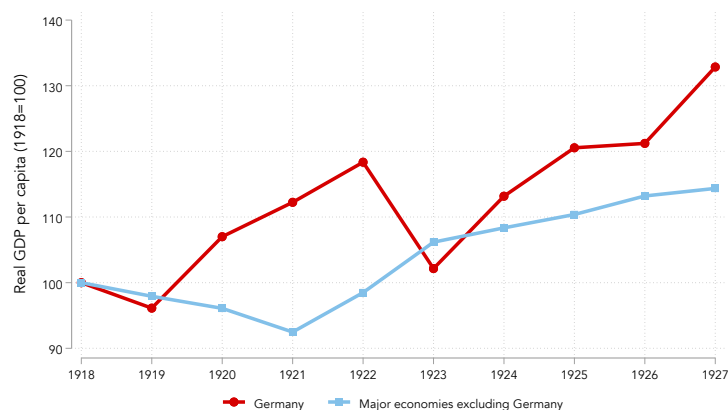
Stabilization. Inflation was stabilized in November 1923. The stabilization had several key ingredients. First, a monetary reform led to the introduction of the Rentenbank, backed by "fictitious" claims on industry and land. The Rentenbank would issue a new currency, the Rentenmark, at an exchange rate of one trillion paper marks per Rentenmark. Second, the reform imposed limits on the Rentenbank and Reichsbank's ability to discount government bills. Third, the Rentenmark exchange rate was stabilized at 4.2 Rentenmarks per dollar. Fourth, the stabilization was associated with a massive fiscal reform, including large reduction in public servants. Sargent (1982) argues the fiscal reform was crucial for ending the inflation, while Dornbusch (1985) also emphasizes the important role of the exchange rate stabilization.

Real activity during the inflation. The post-war inflation was associated with a booming economy through the third quarter of 1922, followed by a severe bust starting at the end of 1922.²¹ Figure 4 plots an index of real GDP per capita for Germany starting in 1918. For comparison, we also plot an index of weighted real GDP per capita growth for other major industrial economies. The figure shows that while the U.S., U.K., and other industrial economies underwent deflation and declining output to maintain or return to pre-war gold parities, Germany's real GDP per

²¹As emphasized by Graham (1931): "that business in Germany was booming during most of the inflation period is a universally admitted fact." Furthermore, Graham (1931) argued that inflation contributed to the boom: "domestic production [in Germany] seems, on the whole, to have been substantially greater than would presumably have been achieved under a stable monetary standard."

capita rose by 20% from 1919 to 1922. Further, unemployment was low from the end of WWI until the last months of 1922 (see Figure A.3.6). Germany’s inflationary boom slows with the hyperinflation in the second half of 1922 and decisively reverses in early 1923, following the invasion of the Ruhr and the resulting passive resistance. Starting in 1923, Germany saw a large fall in industrial production, and unemployment rose to nearly 30% at the height of the hyperinflation and in the run-up to the stabilization.

Figure 4: Real GDP in Germany and Other Major Economies, 1918-27.



Notes: This figure shows real GDP per capita for Germany and an index of other major economies. The series are indexed to 100 in 1918. The data are from Jordà et al. (2017) and Barro and Ursúa (2008). “Other major economies excluding Germany” is an index of average real GDP growth per capita, weighted by lagged nominal GDP in U.S. dollars. The index is constructed using 15 countries with continuous coverage in the Jordà et al. (2017) database between 1914 and 1927 (Australia, Belgium, Canada, Switzerland, Denmark, Spain, Finland, France, U.K., Italy, Japan, Norway, Portugal, Sweden, and the U.S.).

4.2 Aggregate Evidence on the Debt-Inflation Channel

Inflation and firm bankruptcies. Cagan (1956) argued that “hyperinflations provide a unique opportunity to study monetary phenomena. The astronomical increases in prices and money dwarf the changes in real income and other real factors. . . Relations between monetary factors can be studied, therefore, in what almost amounts to complete isolation from the real sector of the economy.”

While the increase in nominal quantities indeed dwarf the changes in real income, inflation may nevertheless have important real effects through redistributive financial channels (Fisher, 1933; Gomes et al., 2016). The equity holders of firms with nominal debt will benefit from unexpected

inflation. These redistributive effects can operate and affect real activity even when prices are fully flexible, breaking monetary neutrality. This contrasts with New Keynesian and classical monetary models without financial constraints, as discussed in section 2.

One implication of long-term nominal debt contracts is that unexpected inflation will tend to reduce the likelihood of bankruptcy for nonfinancial firms. To test this, Figure 5 plots the relation between the monthly number of firm bankruptcies and inflation. Figure 5 reveals a striking negative relation between inflation and firm bankruptcies. Bankruptcies fall with rising inflation in 1919, then rise with falling inflation in 1920, before falling as inflation rises from the second half of 1921. The relation is also convex. It is steep during the first phase of the postwar inflation for 1919Q1 to 1922Q2, but flatter in the hyperinflation phase from 1922Q3 to 1923Q4.²² Once annual inflation is high, further increases in inflation are not associated with additional defaults. It is worth noting that bankruptcies remained low even in 1923 when output declined significantly.

The pattern is robust to different ways of measuring bankruptcies and inflation. Figure A.3.8 confirms the above patterns for the bankruptcy rate, rather than the level of bankruptcies. The bankruptcy rate falls from 1.5% in 1920 to close to zero in 1923.²³ Further, while Figure 5 shows realized annual inflation on the x-axis, Figure A.3.7 in the Appendix reveals a similar pattern when using the “accelerationist” version that uses unexpected inflation, $\pi_t - E_{t-1}[\pi_t]$, where inflation expectations are assumed to be adaptive so that expected inflation is assumed to be last periods inflation, $E_{t-1}[\pi_t] = \pi_{t-1}$.

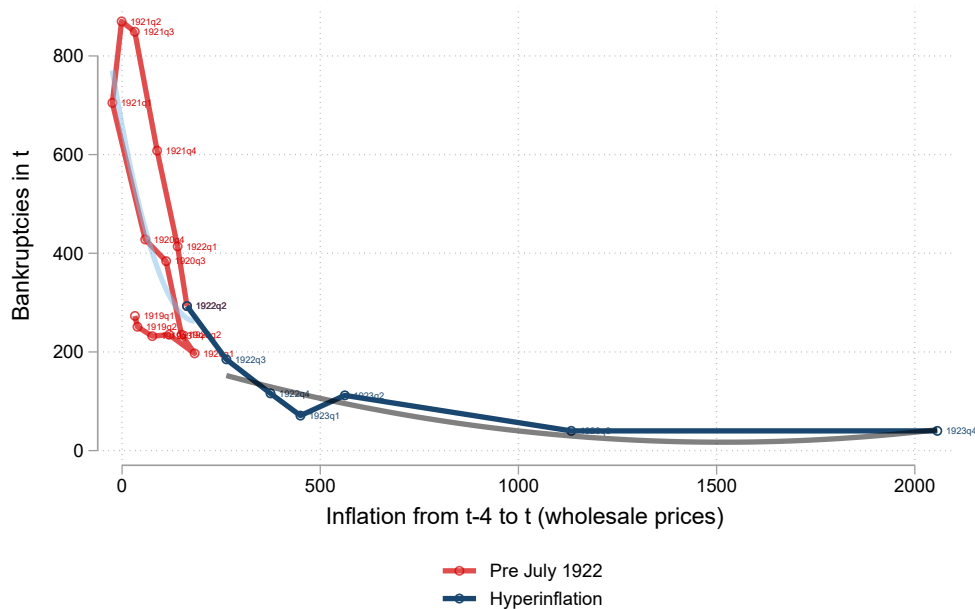
Inflation eroded real firm debt burdens. Our hypothesis is that the negative inflation-bankruptcy relation emerges because inflation erodes firms’ long-term nominal liabilities. Figure 6 provides direct evidence that the inflation reduced firm leverage. Panel (a) compares the distribution of firm book leverage in 1919 and 1924 in the *Saling’s* firm-level data. Book leverage is defined as liabilities-to-assets. We choose 1919 as the start year because it is likely to be less influenced by the end of the WWI than 1918. We choose 1924 as the endpoint to utilize the more reliable Goldmark balance sheets, which most firms reported in January 1924, shortly after the stabilization.

Figure 6(a) shows that the distribution of leverage shifts significantly to the left during the

²²See Table A.3.1 in the appendix for the corresponding regression estimates.

²³We plot the number of firms in bankruptcy in Figure 5, rather than the bankruptcy rate, because the total number of registered firms used in the denominator of the bankruptcy rate is only available annually.

Figure 5: Inflation and Firm Bankruptcies.



Notes: This figure plots the number of firm bankruptcies in quarter t against realized inflation over the past four quarters from $t - 4$ to t . Inflation is calculated as the log change (times 100). Quarterly counts of firm bankruptcies are obtained from the *Vierteljahrshefte zur Statistik des Deutschen Reichs Herausgegeben vom Statistischen Reichsamte*. Inflation of wholesale prices as reported in *Zahlen zur Geldentwertung*.

German inflation. The leverage ratio falls by 25 percentage points for the average firm in the sample. Figure A.3.4(a) in the Appendix plots the median of firm liabilities, deflated by wholesale prices, by quarter.²⁴ It shows that real debt declines sharply during the first inflation acceleration in 1919. Debt in real terms then falls again once inflation accelerates in 1921, before falling sharply from mid 1922, once hyperinflation takes hold. The large decline in debt from the summer of 1922 onward also suggests that firms were not able to take on new debt once expectations of inflation become unanchored.²⁵

Panel (b) of Figure 6 analyzes firm leverage from the perspective of interest expenses. Specifically, it shows the evolution of the share of interest expenses in firms' total non-depreciation expenses. We calculate the within-firm change using the estimated year fixed effects from a firm-level regression with firm and year fixed effects. Firms do not always break out interest

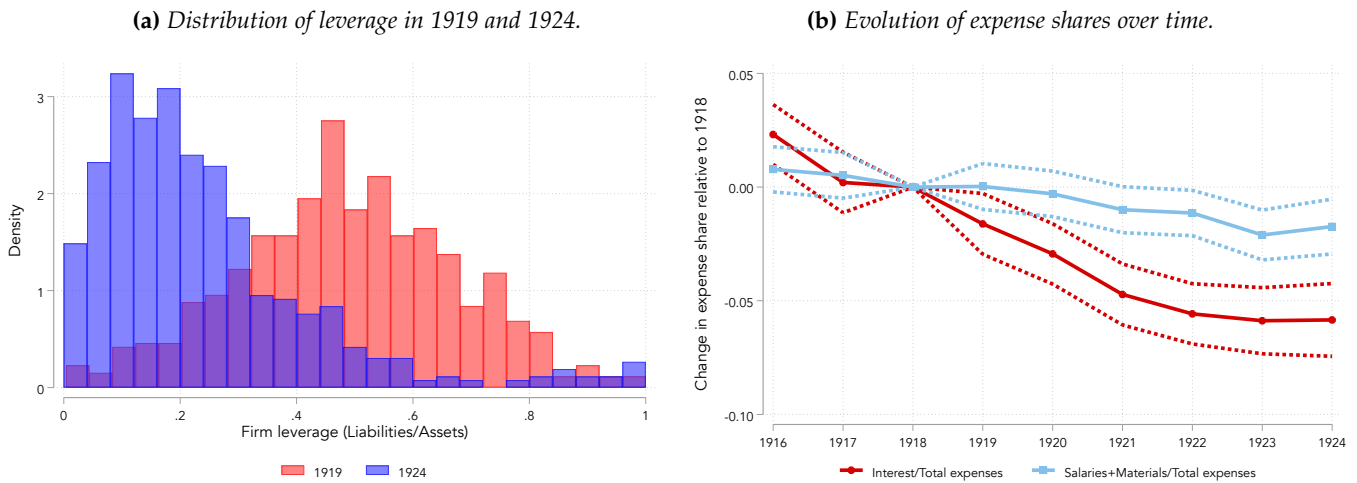
²⁴As discussed in section 3, systematic measurement error of balance sheet items during the hyperinflation is less of a concern for nominal items such as debt.

²⁵In July 1922, *The Economist* reported "an extreme shortness of money," as credit demand was high while credit supply was extremely limited (*The Economist*, July 8, 1922). See Appendix A.1 for a detailed discussion of credit conditions during the various stages of the inflation.

expenses from other expenses in the income statements reported in the *Saling* data, so this measure is a lower bound on interest expenses. Figure 6(b) shows a clear decline in the share of interest expenses to total expenses during the inflation. The interest expense share declines by about 6 percentage points. The erosion of real debt thus directly boosts firm’s interest coverage ratios and benefits their liquidity.

Figure 6(b) also plots the evolution of salaries and material expenses to total expenses. Salaries and material expenses as a share of total expenses essentially remain constant. This is consistent with wages becoming flexible and racing to keep up with inflation, as we document below, as well as with firms boosting employment and production. Wage liabilities are of shorter effective duration than nominal debt liabilities and hence adjust more quickly to rising inflation.²⁶

Figure 6: *Hyperinflation Led to Collapse in Leverage and Interest Expenses.*



Notes: Panel (a) shows the distribution of firm book leverage at the start of the post-war inflation in 1919 and in the aftermath of the hyperinflation in 1924. Leverage is defined as $\frac{Assets - Equity}{Assets}$. Panel (b) shows that interest expenses as a share of total expenses declined during the hyperinflation. Specifically, it plots the sequence of estimated year fixed effects from firm-level two-way fixed effects regression regression of the form:

$$expense\ share_{it} = \alpha_i + \gamma_t + \epsilon_{it}$$

for interest to total expenses and salaries to total expenses as the dependent variable. This regressions captures the change in the expense share within firm.

²⁶Consistent with our findings, Bresciani-Turroni (1937) documents that real wages declined in the first phase of the inflation up to 1922. From the latter half of 1922, real wages kept pace with inflation. As a result, Bresciani-Turroni (1937) discusses evidence from a survey of textile firms that the share of wages to total costs declined between 1913 and 1923. However, he does not provide annual evidence of when the decline in labor cost share occurred or compare it to the decline in interest expenses.

4.3 Price and Wage Flexibility during the Inflation

We next study the frequency at which prices and wages adjust throughout the inflation. These became increasingly flexible with rising inflation, and there was a reduction in the time elapsed between price adjustments as inflation accelerated.²⁷

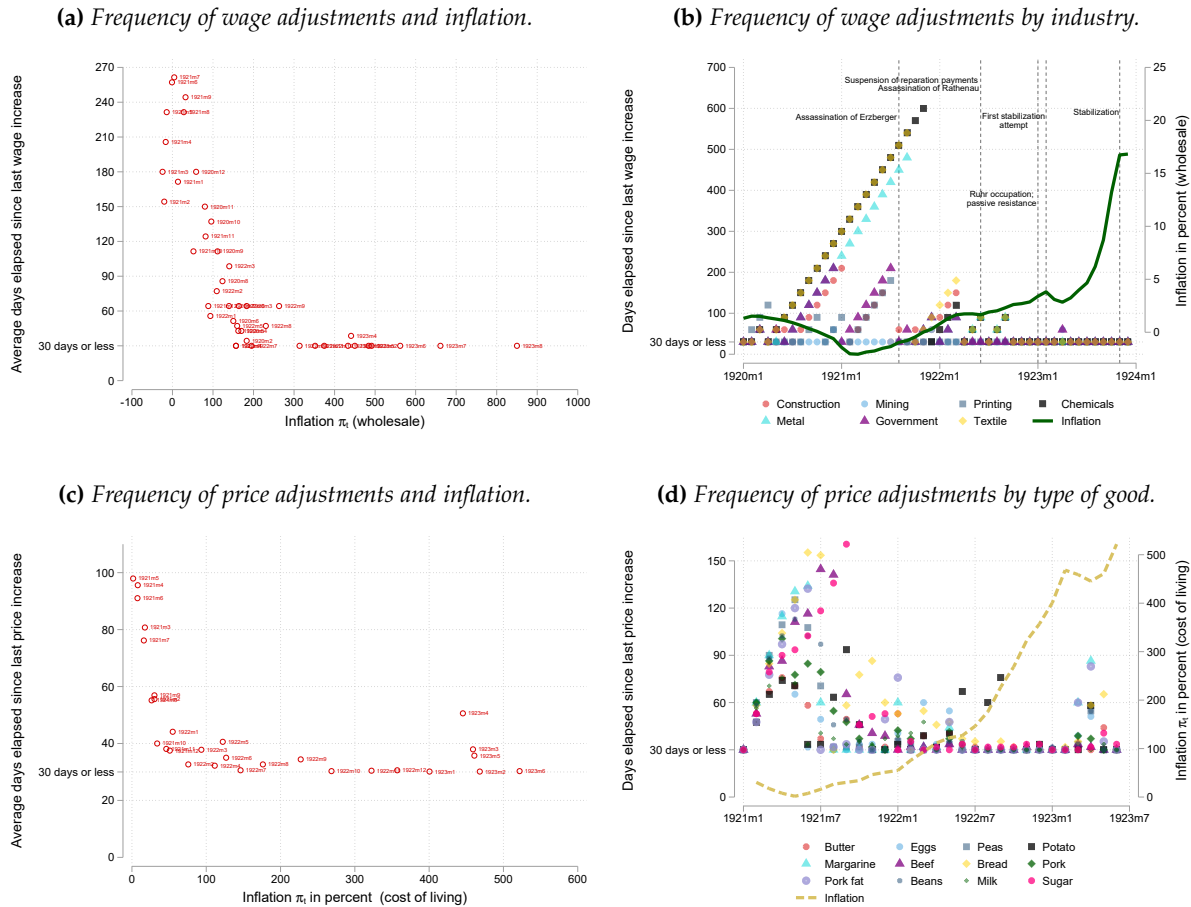
We first analyze wages. The “Stinnes-Legien” agreement from November 1918 enshrined a set of workers’ rights long coveted by the German labor movement, including the recognition of trade unions as the official representatives of the workforce. This allowed for industry-level union bargaining, so we collect industry-level wages for seven industries from 1920 through 1923. Panels (a) and (b) in Figure 7 examine the frequency of wage adjustment during the inflation. Panel (a) plots the number of days since wages were last increased, averaged across the seven industries, against wholesale price inflation. As inflation accelerated, wages were adjusted with increasing frequency. At lower levels of inflation, wages were adjusted on average every 9 months, increasing to every 60 days or less once inflation exceeded 100% and every 30 days or less during hyperinflation. Panel (b) in Figure 7 plots the days elapsed since the last wage change across seven different industries from 1920 to 1923. It shows that, as inflation accelerated in 1922, the gap between wage adjustments declined. By the hyperinflation in July 1922, wages were adjusted at least monthly.²⁸

The increasing flexibility of wages informs the evolution of real wages. Relative to pre-war levels, real wages declined during the inflation. Given that the Stinnes-Legien agreement primarily benefited blue-collar and low-skilled workers, the decline is more pronounced for higher-skilled salaried workers that were less likely to have union representation and thus were in a worse position to renegotiate wages when inflation picked up (see Appendix Figure A.3.12 for state employees from 1914 through 1923). However, most of the decline in real wages had already occurred by the end of 1920. During 1920-23, real wages fluctuate substantially, but there is no clear evidence of a downward trend. This is consistent with wages becoming flexible and racing to keep up with prices once inflation becomes high, as predicted by menu cost models of nominal rigidity.

²⁷This is sometimes referred to as the Pazos-Simonsen mechanism (Pazos, 1972; Simonsen, 1983).

²⁸Narrative evidence suggests that wages were adjusted weekly once the inflation became hyper (Feldman, 1993). We obtain union-bargained wages only at the monthly frequency and thus can only provide an upper bound on the time elapsed since the last wage increase.

Figure 7: Interval between Price Adjustment Falls during the Inflation: Evidence from Wages and Cost-of-Living Index Prices.



Notes: This figure plots the duration of unchanged wages and of prices of products underlying the cost-of-living index. Wages and retail prices are as reported in *Zahlen zur Geldentwertung in Deutschland von 1914 bis 1923* and *Wirtschaft und Statistik* (various issues). Inflation is defined as the difference between the log of the price level in month t and month $t - 12$, times 100.

Inflation also led to a shortening in the duration of retail prices. Figure 7 panels (c) and (d) present similar figures for the frequency in the adjustment of goods prices, based on prices of goods underlying the cost-of-living index. The underlying data we obtain are at the city-product-month level for 18 major cities and 12 retail products such as sugar, pork, and milk.²⁹

Panel (c) relates the average days elapsed since the last price increase against the level of inflation. It shows that once cost-of-living inflation exceeds 50%, product prices in the cost-of-living index are adjusted at least once every 30 to 40 days. Panel (d) plots the days elapsed since

²⁹The price quoted for each city is the average of 4 samples taken over the course of a month for each city. Thus, the fact that the data are not quoted prices but averages of quoted prices implies that they may overstate the frequency at which prices were adjusted upwards.

the prices of individual goods in the cost-of-living index are updated. By early 1922, before the hyperinflation phase, prices of most goods in all cities are adjusted upwards every 30 to 60 days. By the hyperinflation, prices are adjusted even every 7 days or less (see Appendix Figure A.3.10). During the first stabilization attempt in February and March 1923, inflation slowed, and the interval of price adjustment increased. But prices were once again adjusted more than monthly by early summer 1923 as inflation accelerated again.³⁰

Overall, Figure 7 indicates that prices and wages are essentially flexible by 1922, once inflation is high. Intuitively, menu costs are not sufficient to induce price stickiness for large inflationary shocks (see, e.g., Golosov and Lucas, 2007). Our evidence suggests that during the period of high and hyperinflation, inflation had limited potential to affect output positively through New Keynesian channels. Nevertheless, menu costs could have induced large economic costs through price dispersion, as documented by Alvarez et al. (2019) using micro-data on prices in Argentina's 1989-90 hyperinflation.

5 Firm Level Evidence on the Debt-Inflation Channel of the Inflation

The analysis of aggregate data in section 4 suggests that non-financial firms in Germany benefited from the inflation of 1919-1923. The increase in the price level reduced the real value of nominal debt claims and interest payments, which in turn led to a drastic decline in firm bankruptcies. The aggregate data thus suggest that inflation helped reduce firms' financial constraints and thus stimulated economic activity through the debt-inflation channel. A concern with interpreting patterns in aggregate data, however, is that other unobserved shocks that are correlated with inflation may have reduced bankruptcies, leading to a spurious negative relation. Moreover, while the inflation may have redistributed from debt-holders to equity-holders, this redistribution may not necessarily have affected real economic activity.

In this section, we address these concerns by analyzing cross-sectional variation using firm-level data. We ask: do firms with higher leverage experience differential outcomes during the inflation? We exploit that firms with relatively higher leverage naturally have a higher nominal

³⁰Consistent with this evidence, the daily prices of two widely circulated newspapers were also adjusted at shorter and shorter intervals during the inflation and hyperinflation, as shown in Figure A.3.11, which is based on new hand-collected data from individual newspapers.

balance sheet exposure to unexpected increases in the price level such as observed in the earlier years of the German inflation. This analysis allows us to tighten the empirical link between inflation and real economic outcomes through the debt-inflation channel.

5.1 Main Result: Leverage and Firm-level Employment

Employment growth across terciles of firm leverage. We begin by testing whether firms with high leverage increase their overall level of economic activity relative to firms with low leverage. We proxy a firm's real economic activity by its total number of employees. Studying employment as the outcome variable is especially informative, as balance sheets and income statements become less reliable during the hyperinflation. Hence, the reported number of employees dominates alternative indicators of real economic activity constructed from financial statements, such as capital expenditure.

We measure a firm's exposure to inflation by its leverage ratio at the onset of the inflation. Intuitively, firms with relatively more nominal liabilities—to the extent these are not short-term and constantly repriced, floating rate, or indexed to the price level—benefit more from unexpected increases in the price level. In a frictionless economy in which the Modigliani-Miller theorem holds, only equity-holders would benefit from unexpected inflation and the resulting changes in a firm's capital structure have no impact on firm real investment or employment decisions. However, if firms are financing constrained, unanticipated inflation can relax financing constraints for levered firms, leading them to increase investment and employment, as we outlined in section 2.

We define leverage either as the ratio of a firm's total liabilities to total assets or a firm's financial debt to total assets. The latter measure incorporates both short and long-term financial debt such as trade credit, bank debt, and bonds. The former measure also includes other nominal liabilities such as accrued wages, unpaid taxes, and pensions. Debt contracts were typically fixed-rate; floating-rate contracts were not common in Germany during this time. Long-term debt was also common and firms often issued fixed-rate bonds with a maturity of 10 and up to 50 years. Further, when calculating a firm's leverage we average over the respective ratio reported in 1918 and 1919.³¹

³¹We prefer the average for two reasons. First, as seen in Figure 2 inflation starts to pick up towards the later months of 1919, implying that the treatment date is slightly different than the available as-of dates of the firm balance sheet data. Most balance sheet data are available for December 31 of a given year and thus the end of 1918 balance sheets may

We sort firms into three terciles based on their 1918-1919 average liabilities-to-assets ratio.³² Panel (a) of Figure 8 shows that most firms see strong employment growth from 1918 through 1924, irrespective of their initial leverage. The strongest employment growth occurs in 1921 and 1922. This is in line with evidence from section 4 that the inflation was associated with increased economic activity through 1922. Further, the strongest employment gains during the inflation occur for high leverage firms, followed by intermediate leverage firms. Employment at firms in the top tercile of the leverage distribution grows by approximately 30% from 1918 through 1922. In contrast, firms in the lowest tercile only experience a 5% increase in employment. This finding indicates that firms with more nominal liabilities benefited from the inflation, possibly becoming less financially constrained and thereby being able to hire more employees.

Difference-in-differences analysis. We next examine the evolution of employment by firm leverage more formally through the lens of a standard dynamic difference-in-differences model that allows us to control for observable characteristics. We estimate the following specification:

$$\ln(\text{Employment}_{it}) = \alpha_i + \delta_{st} + \sum_{k \neq 1918} \beta_k \text{Leverage}_{i,1918-1919} \mathbf{1}_{k=t} + \sum_{k \neq 1918} X_i \Gamma_k \mathbf{1}_{k=t} + \epsilon_{it} \quad (1)$$

where $\ln(\text{Employment}_{it})$ is firm i 's number of employees (in logs, multiplied by 100) in year t and $\text{Leverage}_{i,1918-1919}$ is firm i 's liabilities-to-assets ratio averaged over 1918 and 1919.³³ Further, α_i is a firm fixed effect, δ_{st} is an industry-time fixed effect, and X_i is a set of firm-level control variables such as size, fixed assets-to-total assets, return on assets, and profit margin.³⁴ All controls are constructed by averaging across 1918 and 1919 and have year-specific coefficients.

The identifying assumption behind our empirical strategy is that of parallel trends: In the absence of differences in leverage, firms with high and low leverage would have evolved in parallel

be outdated by mid-1919. Second, using the average of both years also alleviates the concern that the 1918 end-of-year balance sheets may be affected by the Armistice and the political instability around the revolution in November 1918 and arguably less reliable and more noisy. Table A.3.4 in the Appendix shows that results are robust to using either leverage in as reported in 1918 or in 1919 as opposed to their average.

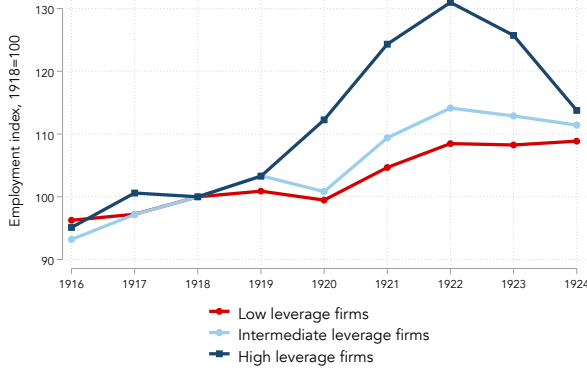
³²As additional robustness, Figure A.3.13 show that the results are similar using financial debt to assets (averaged over 1918-1919) and liabilities to assets averaged over 1917- 1919 (instead of 1918-1919). As an alternative way to visualize the results, Figure A.3.15 plots binned scatterplots of employment growth from 1918 onwards against initial firm leverage.

³³In the Appendix we provide evidence that the findings are similar when using the ratio of financial debt to assets, see Figure A.3.21.

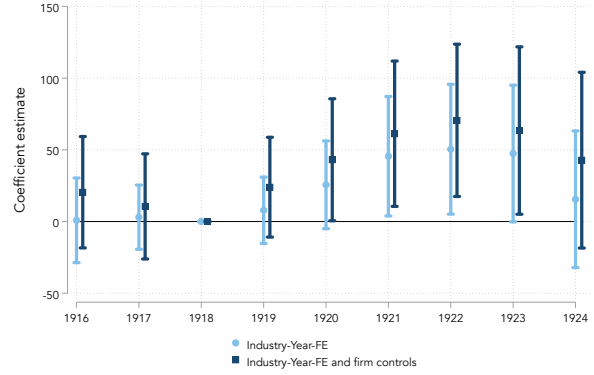
³⁴The industry classification corresponds approximately to two-digit SIC industries.

Figure 8: Employment Dynamics across Low and High Leverage Firms.

(a) Evolution of employment by tercile of liabilities to assets.



(b) Results from estimating equation (1).



Notes: Panel (a) presents the average evolution of employment for firms in the bottom, middle, and top terciles of leverage. Leverage is defined as the average ratio of liabilities to assets over 1918-1919. Employment is indexed to 100 in 1918 for each group.

Panel (b) presents the sequence of estimates $\{\beta_k\}$ from estimating the following model:

$$\ln(\text{Employment}_{it}) = \alpha_i + \gamma_{st} + \sum_{k \neq 1918} \beta_k \text{Leverage}_{i,1918-1919} \mathbf{1}_{k=t} + \sum_{k \neq 1918} X_i \Gamma_k \mathbf{1}_{k=t} + \epsilon_{it},$$

where α_i is a set of firm fixed effect, γ_{st} a set of industry-year fixed effects, where $\text{Leverage}_{i,1918-1919}$ is firm i 's liabilities-to-assets ratio averaged over 1918 and 1919, and X_i is our set of firm-level control variables. Errors bars represent 95% confidence intervals based on standard errors clustered at the firm level.

during the inflation. Identification does not require that leverage be randomly assigned, but it assumes that leverage at the onset of the inflation is uncorrelated with other shocks during the inflation, conditional on controls and industry-year fixed effects. This identifying assumption would be violated if, for example, highly levered firms were also exposed to positive demand shocks or faced better investment opportunities.

What explains the variation in firm leverage at the onset of the inflation. Table A.3.3 reports the correlates of firm leverage in 1919 and shows that the main correlates are firm size and industry. The positive correlation between leverage and size is consistent with a size-dependent borrowing constraint (Gopinath et al., 2017). After controlling for these variables, leverage is uncorrelated with EBIT margin, return on assets, and the share of fixed assets in total assets. Moreover, there is considerable unexplained variation, consistent with the evidence that debt ratios often vary widely even for similar firms (Myers, 1984). Historical accounts suggest that firms did not borrow in 1918-19 in anticipation of the inflation, as the inflation was unexpected (Lindenlaub, 1985;

Balderston, 1991). Below, we also provide evidence that leverage is not correlated with higher cyclicity in subsequent business cycles.

The cross-section provides a stronger test than the aggregate time series, as we can control for aggregate and industry-specific shocks impacting on firms. Industry-year fixed effects, δ_{st} , absorb aggregate shocks such as the Ruhr invasion as well as industry-specific shocks that might be correlated with leverage. For example, inflation led to a flight from the mark toward durable assets, which disproportionately benefited firms in industries producing these assets (Graham, 1931). Related to this, the depreciation benefited exporting firms, so industry-year fixed effects control for industry-level differences in exposure to the exchange rate channel. Further, union-bargained wage setting was quite common but industry-specific. Industry-year fixed effects absorb such effects from industry-specific stickiness of wages or prices.

Results from estimating (1) are displayed in panel (b) of Figure 8. Firms with higher leverage see stronger employment growth in 1919-1922 relative to firms with lower leverage. The estimates are similar when including industry-year fixed effects and firm-level controls interacted with year fixed effects. In line with the evidence of panel (a), panel (b) of Figure 8 reveals that employment at high leverage firms remains elevated through 1923, before a partial reversal in 1924. The timing of the reversal is consistent with narrative accounts of “rationalization” in the aftermath of the inflation, as some firms overexpanded during the inflation boom (Garber, 1982). Altogether, we interpret the patterns from panel (b) of Figure 8 as a robust indication that the inflation starting in 1919 transmitted to the real economy at least partially via a debt-inflation channel.

Table 2 reports results for employment from a difference-in-differences specification of the form:

$$\ln(\text{Employment}_{it}) = \alpha_i + \delta_{st} + \beta(\text{Leverage}_{i,1918-1919}\mathbf{1}_{t \geq 1920}) + X_i\Gamma + \epsilon_{it}, \quad (2)$$

where $\text{Leverage}_{i,1918-1919}$ is either the ratio of total liabilities to assets or financial debt to assets, and $\mathbf{1}_{t \geq 1920}$ is a dummy that takes the value one after 1920. The estimation period is 1916 to 1923. The estimated coefficient on $\text{Leverage}_{i,1918-1919}$ interacted with $\mathbf{1}_{t \geq 1920}$ is positive and statistically significant at the 5% level or lower, irrespective of how we proxy firm leverage. Further, as above, the effects of leverage on employment during the inflation is robust to the inclusion of firm-level

Table 2: Firm Leverage and Employment.

Dependent Variable	ln(Employment)					
	(1)	(2)	(3)	(4)	(5)	(6)
Liabilities/Assets _{<i>i</i>,1918–1919} × 1 _{<i>t</i>≥1920}	44.8*** (15.8)	37.0** (16.7)	43.5** (19.3)			
Debt/Assets _{<i>i</i>,1918–1919} × 1 _{<i>t</i>≥1920}				42.5*** (16.2)	38.8** (16.7)	38.9** (19.6)
Observations	1920	1872	1734	1920	1872	1734
Number of Firms	358	352	323	358	352	323
R ²	0.97	0.97	0.97	0.97	0.97	0.97
Year FE	✓			✓		
Firm FE	✓	✓	✓	✓	✓	✓
Industry-Year-FE		✓	✓		✓	✓
Controls × 1 _{<i>t</i>≥1920}			✓			✓

Notes: This table reports results from a model estimating:

$$y_{it} = \alpha_i + \delta_{st} + \beta \times (\text{Leverage}_{i,1918-1919} \times \mathbf{1}_{t \geq 1920}) + \Gamma \times (X_i \times \mathbf{1}_{t \geq 1920}) + \epsilon_{it}.$$

where y_{it} is firm i 's number of employees (in logs). $\text{Leverage}_{i,1918-1919}$ is either the ratio of firm i 's financial debt or total liabilities to total assets. α_i is a set of firm fixed effects, and δ_{st} is a set of industry-time fixed effects. Further, X_i is a vector of firm-level controls consisting of firm size (log of assets), the share of fixed assets to total assets, return on assets, and profit margin (EBIT-to-revenue). *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

control variables and granular industry-year fixed effects.

The magnitude of the effects are economically meaningful. Increasing a firm's ratio of debt-to-assets by 10 percentage points implies 3.5-4.5% higher average level in employment between 1920 and 1923 compared to the average level from 1916 through 1919. Applying the estimated coefficient (37%) to the average *ex ante* leverage of 47% implies a partial equilibrium aggregate increase in employment of 17% from the debt-inflation channel. This is similar to the average firm increase in employment from 1919 to 1922 of 17.5%. We stress that this calculation abstracts from general equilibrium effects. For example, if more exposed firms expand at the expense of less exposed firms, this would dampen the aggregate effect. Further, losses to creditors could be contractionary by depressing credit supply, as we discuss further below, or they could be expansionary by boosting the labor supply of households who hold debt claims, as in our model in appendix A.2.

Robustness to credit supply shifts and other potential confounders. Our hypothesis is that high leverage firms benefit from the inflation through an increase in their net worth and a relaxation of financing constraints. A related channel that may differentially affect high and low leverage firms is a shift in credit supply caused by inflation. Financing was available in much of the first phase of the inflation when additional inflation was not expected.³⁵ However, credit supply contracted in 1922 with increased expectations of depreciation.³⁶ Moreover, credit and mortgage banks experienced large losses during the inflation from making loans and from having to hold significant amounts of paper money for customer withdrawals.³⁷

The bias introduced by the credit supply channel in the estimation of (1) could be either positive or negative, as it is not clear whether high or low leverage firms are most exposed to a credit supply contraction. Controlling for size, industry, and profit margin partially addresses this concern, as these are common proxies of exposure to credit supply (e.g., Gertler and Gilchrist, 1994). Furthermore, our evidence below that the effect of leverage is strongest for firms with longer maturity debt also points to the importance of the firm balance sheet channel.

As additional robustness, in Table A.3.5 we add controls that more directly proxy for differential exposure to shifts in bank credit supply (see also Figure A.3.14). First, we collect information on firm-bank relationships in 1920.³⁸ With this, we control for bank-time fixed effects, distinguishing between seven major banks, other banks, and firms without banking relationships. This essentially compares two firms with different leverage but connected to the same bank, thereby holding fixed bank-specific changes in credit supply.³⁹ Second, we control for the distance to Berlin, as firms located closer to Berlin may have had better access to Reichsbank credit during the inflation. The

³⁵Banks were “swimming in money” during the first phase of the inflation (Feldman, 1993), and banks were slow to raise interest rates due to various factors. Bresciani-Turroni (1937) argues they did not require high interest rates because they did not anticipate inflation and because the “phenomenon of monetary depreciation had not yet been properly understood by the majority of bank directors.” Schacht (1927) notes that interest rates on bank loans were usually set based on the Reichsbank’s discount rate, which remained low for much of the inflation. See Appendix A.1 for a detailed discussion of the impact of the inflation on banks and credit conditions.

³⁶For example, in July 1922, *The Economist* reported that “the instability of the standard of value is gradually killing long-period credit in Germany.”

³⁷Balderston (1991) estimates that by 1924 banks had lost about two thirds of their capital. Mitigating this loss, banks were aided by the Reichsbank through a low discount rate, which transferred losses from banks to all holders of currency. Graham (1931) notes: “It has indeed been suggested that the big industrial borrowers virtually stole the banks, but, insofar as this occurred, the commercial bank directorates largely recouped their losses at the expense of the Reichsbank.”

³⁸We follow Doerr et al. (2018) and measure firm-bank relationships based on information on the banks that paid out a firm’s dividends (“Zahlstellen”).

³⁹We note that this only controls for credit-supply shocks that are bank specific. It would not capture credit-supply changes that affect firms differently based on their unobservables (i.e., conditional on the firm-level controls).

estimated effect of leverage on employment is quantitatively similar with these controls.

Another concern is that firms with high leverage at the onset of the inflation could be more exposed to business cycle risk. To address this concern, Figure A.3.16 shows that firms with high leverage as of 1918-19 do not see a larger increase in employment in the late 1920s boom or a larger employment decline during the Great Depression (our data do not allow us to examine earlier cycles). Leverage at the onset of the inflation therefore does not appear to capture general exposure to business cycle risk. In addition, one would expect that industry-year fixed effects would capture a significant portion of cross-firm differences in cyclicality.

5.2 Evidence Supporting the Debt-Inflation Channel

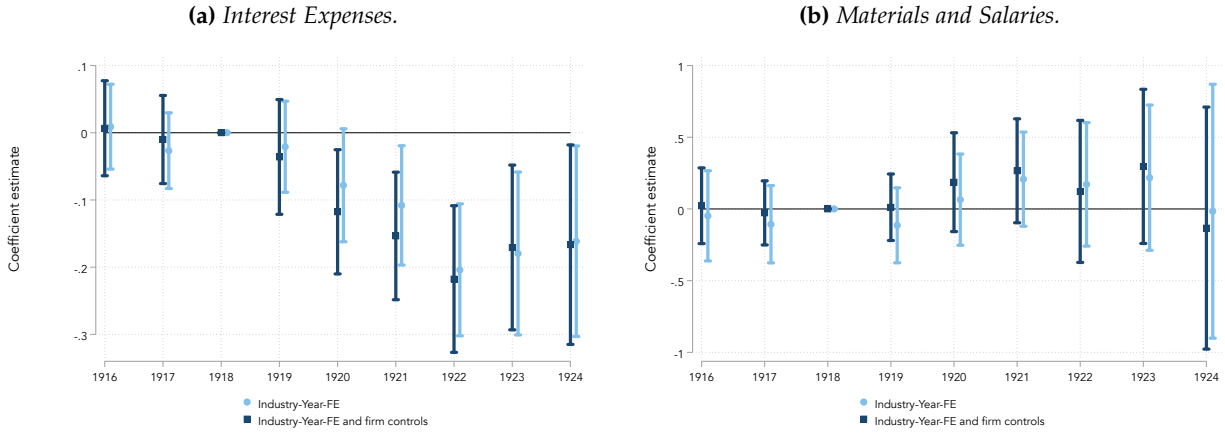
We next provide evidence that allows for a better understanding of the mechanisms through which the inflation affected firms through the debt-inflation channel. First, we ask, do more levered firms pay less in interest expenses and have more resources available to spend on salaries and materials? Second, are the effects stronger for firms with a higher proportion of long-term debt? Third, do firms with higher leverage see a larger increase the book equity values and a higher valuation in the stock market?

Interest, salary and material expenses. First, we study the dynamics of interest expenses and salary plus material expenses at the firm level. Recall from Figure 6b that the average share of interest expenses to total expenses falls during the inflation. We now ask whether this fall is more pronounced for high leverage firms, thereby freeing up liquidity for firms to pay salaries and purchase materials for production.

Similar to our analysis of firm-level employment, we estimate equation (1) using either the share of interest expenses to total expenses or the sum of salaries and material expenses as a share of total expenses as the dependent variable. Figure 9 shows the results. Firms with a higher share of nominal liabilities relative to total assets at the onset of the inflation dedicate fewer resources to servicing their debt claims, as the real burden of debt service declined. The effect is persistent and builds throughout the inflation. A similar pattern arises when using the financial debt-to-assets ratio (see Appendix Figure A.3.21).

The decline in interest expenses allows a financially constrained firm to spend more of its

Figure 9: Firm Leverage, Interest Expenses, and Material Expenses and Salaries.



Notes: This figure plots the sequence of estimates $\{\beta_k\}$ from estimating the following model:

$$y_{it} = \alpha_i + \gamma_{st} + \sum_{k \neq 1918} \beta_k Liabilities/Assets_{i,1918-1919} \mathbf{1}_{k=t} + \sum_{k \neq 1918} X_i \Gamma_k \mathbf{1}_{k=t} + \epsilon_{it},$$

where y_{it} is either the ratio of interest expenses to total expenses (panel (a)) or the ratio of materials and salary expenses to total expenses (panel (b)). α_i is a set of firm fixed effects, γ_{st} a set of industry-year fixed effects, $Liabilities/Assets_{i,1918-1919}$ is firm i 's liabilities-to-assets ratio averaged over 1918-1919 and X_i is our set of firm-level control variables. Error bars represent 95% confidence intervals based on standard errors clustered at the firm level.

revenue on expenses to boost production. Indeed, we find that more levered firms start spending relatively more of their total expenses on materials and salaries, in line with higher economic activity at more levered firms during the inflation. This effects is less precisely estimated, as the sample size declines because fewer firms report salary and material expenses separately in their income statement.

We also estimate a model similar to equation (2) using interest expenses and salaries and material expenses as the outcome variables. Table 3 reports the results. Our findings confirm the patterns in Figure 9 and indicate that more levered firms paid less interest as a share of their total expenses after the inflation started in 1919. For instance, we find that a 10 percentage point increase in initial leverage is associated with 1.5 to 2 percentage points lower interest payments as a share of total expenses from 1920 onward. At the same time, a firm with a 10 percentage point higher leverage ratio spends around 2 percentage points more of its total expenses on salaries and materials. Altogether, these findings are in line with highly levered firms benefiting from the inflation by decreasing the amount of resources that need to be spent on interest payments. This is consistent with the inflation relaxing a firm's working capital constraint, allowing it to

hire more employees and spend more funds on salaries and materials. This provides more direct evidence supporting the view that the debt-inflation channel can affect firm outcomes above and beyond the New Keynesian nominal rigidity channels.

Table 3: Firm Leverage, Interest Expenses, and Material Expenses and Salaries.

Dependent Variable	Interest Expenses/Tot. Expenses				Salaries and Materials/Tot. Expenses			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Liabilities/Assets _{<i>i</i>,1918–1919} × 1 _{<i>t</i>≥1920}	-0.13*** (0.038)	-0.15*** (0.039)			0.21 (0.13)	0.19 (0.15)		
Debt/Assets _{<i>i</i>,1918–1919} × 1 _{<i>t</i>≥1920}			-0.17*** (0.037)	-0.20*** (0.037)			0.18 (0.13)	0.20 (0.15)
Observations	3714	3456	3720	3462	1008	910	1011	910
Number of Firms	551	502	553	504	144	128	145	128
R ²	0.69	0.72	0.69	0.73	0.71	0.72	0.70	0.72
Firm FE	✓	✓	✓	✓	✓	✓	✓	✓
Industry-Year-FE	✓	✓	✓	✓	✓	✓	✓	✓
Controls × 1 _{<i>t</i>≥1920}		✓		✓		✓		✓

Notes: This table reports results from estimating:

$$y_{it} = \alpha_i + \delta_{st} + \beta \times (\text{Leverage}_{i,1918-1919} \times \mathbf{1}_{t \geq 1920}) + \Gamma \times (X_i \times \mathbf{1}_{t \geq 1920}) + \epsilon_{it}.$$

where y_{it} is either firm i 's share of interest expenses of total expenses, or the share of salaries and materials of total expenses. $\text{Leverage}_{i,1918-1919}$ is either ratio of firm i 's ratio of financial debt or total liabilities to total assets averaged over 1918-1919, α_i is a set of firm fixed effects, δ_{st} is a set of industry-time fixed effects, and $\mathbf{1}_{t \geq 1920}$ is a indicator variable for observations from 1920 onward. Further, X_i is a vector of firm-level controls consisting of firm size (log of assets), the share of fixed assets to total assets, return on assets, and profit margin. The estimation period is from 1916 through 1923. Standard errors are clustered at the firm level.

*, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Impact on firms with longer maturity debt. The debt-inflation channel should be especially strong for firms with a higher proportion of long-term debt (see, for example, Gomes et al., 2016). As a finer test of this channel, we therefore examine whether, within firms that are more levered, firms with more long-term debt benefit relatively more.

Non-financial German firms relied extensively on fixed-rate long-term bond finance. We collect information on the loan terms of all bonds issued by firms in our sample as of 1918 and 1919. These loan terms are detailed in Table 4. All bonds in the sample pay a fixed coupon, and the coupon rates are almost all between 400 and 500 basis points of par. After origination, the loan terms typically specified an interest-only period lasting around 5 years on average during which no amortization took place. Once repayment started, bonds would be typically amortized evenly until a specified final repayment date. Notably, bonds were of very long maturity. For instance, for

bonds outstanding in 1918 and 1919, the median origination year was 1906 and the final maturity year was 1940. Figure A.3.22 in the Appendix also shows that most bonds were originated before WW1, and a final maturity date after 1950 was not uncommon.

Table 4: *Interest Rates, Volume, and Maturity Structure of Bonds Outstanding in 1918 and 1919.*

	Mean	p5	p25	Median	p75	p95
Panel A: Interest rates and volume						
Interest rate (ppt)	4.4	4	4.25	4.5	4.5	5
Volume (in thousand RM)	3961	500	1000	2000	5000	13000
Panel B: Origination and maturity						
Origination year	1906	1895	1901	1906	1910.8333	1919
Repayment start year	1910	1897	1905	1910	1916	1922
Repayment end year	1941	1925.5	1933	1940	1946.75	1960.5

Notes: This table provides information on the all outstanding bonds issued by firms in our sample. Data are obtained from *Saling's Börsenjahrbuch* published in 1919 and 1920 (covering 1918 and 1919). The table is based on a sample of $N = 417$, and 51% of firms in the sample report information on at least one bond.

To test whether the impact of the debt-inflation channel is stronger for firms with relatively more long-term bond financing, we interact a firm's debt-to-assets ratio with a set of four dummies that indicate the quartile of the firms' ratio of long-term-debt to total debt. Here, we use the ratio of debt-to-assets rather than the ratio of liabilities-to-assets, as interest expenses are more naturally connected to financial debt rather than other non-debt nominal liabilities. Specifically, we estimate a triple-difference specification of the following form

$$y_{it} = \alpha_i + \delta_{st} + \sum_{s \neq 1} \beta_{1,s} \mathbf{1}[LTD/Debt_{i,1918-1919} \in Q_s] \times Debt/Assets_{i,1918-1919} \times \mathbf{1}_{t \geq 1920} \\ + \beta_2 \times Debt/Assets_{i,1918-1919} \times \mathbf{1}_{t \geq 1920} + \Gamma \times (X_i \times \mathbf{1}_{t \geq 1920}) + \epsilon_{it},$$

where $\mathbf{1}[LTD/Debt_{i,1918-1919} \in Q_s]$ is an indicator for each quartile s of the distribution of long-term debt to total debt.

The results are presented in Table 5. Only firms with a high share of long-term debt to total debt experience a substantial reduction in the share of interest payments of total expenses. The effect is close to zero for firms in the lowest quartile of the long-term debt and builds monotonically for firms in higher quartiles of the long-term debt distribution. For example, a 10 percentage point increase in the debt-to-assets ratio implies that firms in the second, third, and fourth quartiles of the long-term debt share experience a reduction of interest payments of about 1%, 2%, and 3.2%, respectively.

Table 5: Firm Leverage, Long-term Debt, Interest Expenses, and Employment.

Dependent Variable	Int. Expenses/Tot. Expenses			ln(Employment)		
	(1)	(2)	(3)	(4)	(5)	(6)
Debt/Assets _{<i>i</i>,1918–1919} × 1 _{<i>t</i>≥1920}	0.016 (0.051)	0.016 (0.051)	0.013 (0.056)	20.7 (25.5)	20.7 (25.5)	10.1 (30.8)
Q ₂ × Debt/Assets _{<i>i</i>,1918–1919} × 1 _{<i>t</i>≥1920}	-0.092 (0.080)	-0.100 (0.079)	-0.085 (0.079)	24.7 (50.4)	23.4 (50.8)	12.1 (48.2)
Q ₃ × Debt/Assets _{<i>i</i>,1918–1919} × 1 _{<i>t</i>≥1920}	-0.18** (0.084)	-0.18** (0.084)	-0.15* (0.085)	14.4 (34.8)	14.4 (34.8)	21.0 (36.5)
Q ₄ × Debt/Assets _{<i>i</i>,1918–1919} × 1 _{<i>t</i>≥1920}	-0.32*** (0.091)	-0.33*** (0.090)	-0.31*** (0.090)	79.0* (40.4)	79.0* (40.4)	91.3* (49.3)
Observations	3482	3480	3482	2132	2131	2131
Number of Firms	547	547	547	369	369	369
R ²	0.67	0.67	0.72	0.96	0.96	0.97
Year FE	✓			✓		
Firm FE	✓	✓	✓	✓	✓	✓
Industry-Year-FE	✓	✓	✓	✓	✓	✓
Controls × 1 _{<i>t</i>≥1920}			✓			✓

Notes: This table reports results from estimating:

$$y_{it} = \alpha_i + \delta_{st} + \sum_{s \neq 1} \beta_{1,s} \mathbf{1} [LTD/Debt_{i,1918-1919} \in Q_s] \times Debt/Assets_{i,1918-1919} \times \mathbf{1}_{t \geq 1920} \\ + \beta_2 \times Debt/Assets_{i,1918-1919} \times \mathbf{1}_{t \geq 1920} + \Gamma \times (X_i \times \mathbf{1}_{t \geq 1920}) + \epsilon_{it},$$

where y_{it} is either firm i 's share of interest expenses of total expenses, or a firm's numbers of employees. We interact the ratio of debt total debt with the ratio of long-term debt to total debt (using dummies indicating each quartile). Further, α_i is a set of firm fixed effects, and δ_{st} is a set of industry-time fixed effects. Further, X_i is a vector of firm-level controls consisting of firm size (log of assets), the share of fixed assets to total assets, return on assets, and profit margin. Data from 1916 through 1923.

*, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

We also ask whether the employment effects are stronger for firms with relatively more long-term debt. Although the results are less precise, we indeed find that not only do more highly levered firms hire more employees after 1920, but the effect is strongest for firms with more long-term debt. The effect of leverage is especially strong for firms in the top quartile of the long-term debt distribution. These findings provide additional evidence that the inflation

relaxes firms' financial constraints, thus allowing firms to hire more employees and expand their production.

Market equity returns. Do more levered firms see an increase in their stock market valuations? The decline in interest expenses suggests that the inflation should benefit equity holders of highly levered firms. Studying market equity values also has the benefit that they are not subject to accounting errors but instead reflect the equity values of firms as perceived by investors in real-time.⁴⁰

Table 6 reports the returns across firms with high and low leverage. We follow the standard asset pricing approach and sort firms into five portfolios by quintiles of lagged leverage each year of the postwar inflation, from 1919 to 1923. We then compute the equal-weighted average log total return for each portfolio, as well as the difference between the high-minus-low portfolio. Returns are deflated by wholesale prices. Panel A reports results using the liabilities to assets ratio as a proxy for leverage, and Panel B reports results using the ratio of financial debt to assets.

Table 6 reveals two notable patterns. First, returns are on average negative during the inflation. This is consistent with Figure A.3.20 in the Appendix, which shows that the real value of stocks of non-financial firms fell considerably during the inflation. Prior research argues that the poor performance of the stock market is explained by lower expected future cash flows, including from high expected taxes on firms, high uncertainty, and money illusion on the part of investors. Bresciani-Turroni (1937) argues that investors mistook large nominal capital gains for large real capital gains. Consistent with this, Braggion et al. (2022) provide empirical evidence that stock market investors exhibited money illusion during Germany's hyperinflation.

Second, returns are (almost) monotonically increasing across the leverage portfolios. The difference between the high minus low portfolio is large (10-13% annual return) and statistically significant (p -values of 0.6% and 3.6% for panels A and B, respectively). Figure 10 plots the cumulative return on the high-minus-low leverage portfolio over time. The portfolio has significantly positive returns in 1919, 1922, and 1923. Returns are especially high during 1922-23, when annual inflation surpassed 1000%. The relatively poor performance in 1921 is puzzling given the high

⁴⁰Of course, equity investors subject to "money illusion" may also misperceive the impact of inflation on firm value, as argued by Modigliani and Cohn (1979).

Table 6: Stock Returns across Portfolios Sorted by Leverage.

Panel A: Sorting by Liabilities-to-Assets.

Quintile of Liabilities/Assets _{<i>i,t-1</i>}	Liabilities/Assets _{<i>i,t-1</i>}		Return _{<i>t</i>}	
	Mean	S.E.	Mean	S.E.
1	0.29	(0.01)	-36.63	(3.93)
2	0.48	(0.00)	-34.42	(3.87)
3	0.58	(0.01)	-30.89	(3.82)
4	0.67	(0.01)	-30.40	(3.62)
5	0.79	(0.01)	-24.03	(3.88)
High-Low	0.51	(0.01)	12.61	(4.63)

Panel B: Sorting by Debt-to-Assets.

Quintile of Debt/Assets _{<i>i,t-1</i>}	Debt/Assets _{<i>i,t-1</i>}		Return _{<i>t</i>}	
	Mean	S.E.	Mean	S.E.
1	0.34	(0.01)	-36.06	(3.95)
2	0.49	(0.01)	-35.93	(3.80)
3	0.57	(0.01)	-31.99	(3.67)
4	0.65	(0.01)	-25.60	(3.85)
5	0.77	(0.01)	-26.45	(3.83)
High-Low	0.44	(0.01)	9.62	(4.61)

Notes: This table presents log total returns (multiplied by 100) on five portfolios of nonfinancial firms sorted by lagged leverage. Panel A uses firm debt-to-assets in year $t - 1$ as the measure of leverage, while Panel B uses liabilities-to-assets. Returns are defined as log returns (times 100) and are deflated by the wholesale price index. The sample period is 1919-1923.

rate of inflation in that year (141%). One possible explanation is that investors were slow to realize the benefits of high inflation for highly levered firms, as hypothesized by Modigliani and Cohn (1979).

Table 7 explores the robustness of the relation between leverage and subsequent returns using linear regressions of the form:

$$Return_{it} = \gamma_t + \beta Leverage_{it-1} + \epsilon_{it}.$$

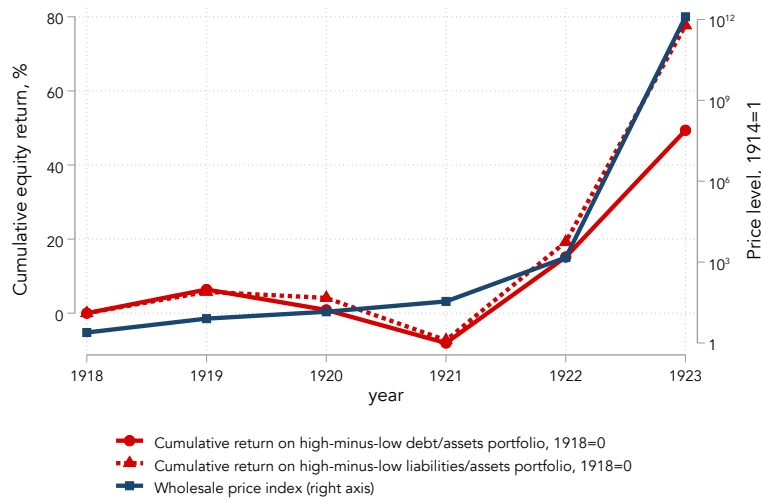
We include time fixed effects in all specifications to compare firms within-year.⁴¹ Columns 1 and

⁴¹Results are considerably stronger without a time fixed effect. On the other hand, the estimates are smaller and usually statistically insignificant when fixing leverage in 1918 or 1919. For the result that high leverage firms have higher stock returns, resorting firms each year using lagged leverage is important, especially as most of the excess return for high-leverage firms occurs in 1922 and 1923. Note that we avoid using leverage based on balance sheets from 1923, which are subject to measurement error, as we discussed in Section 3. Results are also similar if we use

4 show that there is a robust, positive, and highly statistically significant relation between both leverage measures and subsequent equity returns during the inflation.

A concern is that leverage may be capturing other characteristics that may correlate with better performance during the German inflation. Columns 2 and 5 in Table 7 include industry-year fixed effects, and columns 3 and 6 further include lagged firm-level controls. The estimate on $Leverage_{it-1}$ is essentially unchanged with these controls.

Figure 10: High Leverage Firms' Stock Returns Outperformed Low Leverage Firms during the Inflation.



Notes: This figure plots the cumulative return on a portfolio that goes long firms in the top quintile of leverage and short firms in the bottom quintile of leverage (1918=0). Returns for year t are based on portfolios that are resorted at the end of year $t - 1$ based on leverage reported in year $t - 1$.

Non-financial firms with higher leverage fare relatively better during the inflation. By definition, the gain must come at someone else's expense. Thus, we ask: who loses at the same time? Nonfinancial firms' equity should have greater positive net nominal exposure compared to banks. Nonfinancial firm equity is a levered claim on real assets, while bank equity is a levered claim on nominal assets. Moreover, banks are exposed to duration mismatch. Figure A.3.20 in the Appendix compares the returns on nonfinancial firms and banks during the inflation. While inflation was associated with negative real returns on both indexes, we find that non-financial firms performed better than banks. Altogether, our findings suggest that the inflation redistributed from those that held debt of non-financial firms (such as banks) to equity holders, with equity investors in leverage from balance sheets only through 1921.

Table 7: *Leverage and Stock Returns: Linear Regressions, 1919-1923.*

	(1)	(2)	(3)	(4)	(5)	(6)
Liabilities/Assets _{<i>i,t-1</i>}	19.0*** (5.47)	16.7*** (5.89)	19.7*** (6.50)			
Debt/Assets _{<i>i,t-1</i>}				16.1*** (5.10)	14.5*** (5.25)	16.5*** (5.48)
Observations	2739	2735	2735	2740	2736	2736
R ²	0.71	0.76	0.76	0.71	0.76	0.76
Year Fixed Effects	✓			✓		
Industry-Year FE		✓	✓		✓	✓
Firm Controls			✓			✓

Notes: Firm controls are size (log of assets), the share of fixed assets to total assets, return on assets, and profit margin (EBIT-to-revenue) in $t - 1$. Robust standard errors in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

leveraged firms benefiting relatively more.

Book equity. Finally, we examine the impact of inflation on book equity for firms with high and low leverage. As discussed in section 3, balance sheet outcomes during the hyperinflation (especially in 1923) are subject to systematic measurement error. For this analysis, we therefore focus on the evolution of balance sheet outcomes at the start of the postwar inflation in 1919 to the aftermath of the inflation in 1924, when firms were required to construct new Goldmark balance sheets by estimating the market values of their assets and liabilities in Goldmarks. Table 8 presents estimates of the following long-difference firm-level regression for various balance sheet outcomes:

$$\Delta_{19-24}Y_i = \alpha + \beta \text{Leverage}_{i,1918-1919} + X_i\Gamma + \epsilon_i. \quad (3)$$

Panel A of Table 8 documents that firms with higher leverage at the start of the inflation see a larger subsequent increase in equity to assets, or, equivalently, a larger decline in leverage. Moving from a zero to 100% leverage ratio is associated with a decline in leverage of about 60 percentage points. Columns 2 and 4 show that the relation is robust to controlling for firm controls and detailed industry fixed effects for 30 industries. Industry fixed effects absorb differential growth rates across industries, which might be correlated with initial leverage. Panel B of Table 8 shows

that firms with higher leverage see faster growth in the real value of book equity from 1919 to 1924. In the revalued book values constructed after the inflation, equity holders of more levered firms thus experienced an increase in equity values. Book equity measures thus also suggest that the inflation led to redistribution from debt to equity holders of levered firms.

Table 8: *Firm Leverage in 1919 and Change in Firm Leverage and Book Equity from 1919 to 1924.*

<i>Panel A: Dependent var.= $\Delta_{19-24} \frac{Equity}{Assets}$</i>				
	(1)	(2)	(3)	(4)
Liabilities/Assets _{<i>i</i>,1918–1919}	0.60*** (0.046)	0.78*** (0.064)		
Debt/Assets _{<i>i</i>,1918–1919}			0.55*** (0.044)	0.69*** (0.064)
Observations	655	601	655	601
R ²	0.263	0.346	0.234	0.296
<i>Panel B: Dependent var.= $\Delta_{19-24} \ln(Equity)$</i>				
	(1)	(2)	(3)	(4)
Liabilities/Assets _{<i>i</i>,1918–1919}	99.6*** (26.8)	187.4*** (34.1)		
Debt/Assets _{<i>i</i>,1918–1919}			78.7*** (28.4)	162.3*** (35.7)
Observations	650	599	650	599
R ²	0.015	0.094	0.010	0.087
Industry FE		✓		✓
Firm Controls		✓		✓

Notes: This table presents estimates of equation (3). The dependent variable in panel A is the change in book equity-to-assets from 1919 to 1924. The dependent variable in panel B is the change in log deflated book equity, using the wholesale price index as the deflator. Firm controls are size (log of assets), the share of fixed assets to total assets, return on assets, and profit margin (EBIT-to-revenue), all as of 1918-1919. Robust standard errors in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

6 Conclusion

This paper examines how inflation transmits to the real economy through a *debt-inflation* channel via firm balance sheets. We study Weimar Germany's big inflation from 1919 to 1923 using newly

digitized macro and firm-level data. Inflation led to a substantial decline in nonfinancial firms' leverage and interest expenses, resulting in a downward sloping and convex relation between inflation and firm bankruptcies. Exploiting variation across firms in initial leverage, we find that high leverage firms saw larger increases in employment, book equity, and market equity valuations during the inflation. These firms also saw larger declines in the share of interest expenses along with an increase in salary and material spending. These results are consistent with the view that the inflation affected real activity through a debt-inflation channel. At the same time, we find that prices and wages were adjusted at shorter and shorter frequencies with rising inflation, consistent with menu cost models. Overall, our results suggest that the real economic effects of the inflation were more likely to operate through a financial channel than the traditional New Keynesian nominal rigidity channel.

Our analysis invites questions of external validity. Previous researchers have studied hyperinflations as extreme events that can provide insights into the workings of inflation more broadly (e.g., Sargent, 1982).⁴² The debt-inflation channel may be present during times of more moderate inflation if debt contracts are nominal, long-term, and denominated in domestic currency. However, with other debt contract structures, such as floating or foreign currency debt, inflation would be neutral or even negative for more levered firms. Moreover, the debt-inflation channel, while still present, may be dominated by other forces during times of lower inflation. For example, if monetary policy responds aggressively to rising inflation by raising interest rates and tightening financial conditions, this can offset the expansionary effects from the reduction in real debt burdens. Further, we focus on firm debt due to data availability, but the debt-inflation channel through household debt can also be quantitatively important (Doepke and Schneider, 2006). Finally, an important caveat is that we have not quantified the effect of inflation through bank balance sheets and credit supply, which presumably offsets the expansionary effect of the debt-inflation channel. We are exploring the impact of the inflation on bank credit supply in ongoing work.

⁴²The insights that can be gleaned from studying the German hyperinflation, as well as the concerns about external validity, were perhaps best summarized by Lionel Robbins's foreword to Bresciani-Turroni (1937)'s study of the German inflation: "When disturbance takes place, it is sometimes possible to snatch good from evil and obtain insight into the working of processes which are normally concealed. No doubt there are dangers here. We must not ignore the possibility that the processes thus revealed are themselves abnormal. . . We must not infer... that propositions which apply to large inflations necessarily apply, without modification, to small inflations. But the dangers are clear: it is not difficult to keep them in mind and guard against them. And the opportunities for fruitful research are enormous."

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APPENDIX [FOR ONLINE PUBLICATION ONLY]

- Appendix A.1: Historical Background
- Appendix A 2: Model of the Financial Channel of Inflation
- Appendix A.3: Supplementary Figures and Tables

A.1 Historical Background

In this section, we provide additional historical context for the German Hyperinflation.

A.1.1 Chronology of Key Events

WWI and first phase of the postwar inflation. The origins of the German inflation lie in WWI (Feldman, 1993). Before the start of WWI, the mark was on the gold standard, and the exchange rate relative to the U.S. dollar stood at 4.2 marks per dollar. The Banking and Currency Laws of August 4, 1914 led to the abandonment of the gold standard, and the Reichsbank started to discount *Reichsschatzwechsel*, de facto moving to a fiat currency. Exchange controls and price controls were maintained during WWI, which suppressed inflation but led to distortions and black marketeering (Feldman, 1993).

Relative to the Allied Powers, Germany relied heavily on domestic loan issuance rather than on new taxes and foreign bond issuance to finance the war (Graham, 1931; Feldman, 1993). However, Germany's public finances were not in a significantly worse condition than France's in the immediate aftermath of the war. Prices also rose in the U.K., U.S., and France during the war.¹ The most important difference would be the reparations imposed at the Treaty of Versailles (Graham, 1931).

The WWI Armistice was signed on November 11, 1918, leading to the end of WWI fighting. November 1918 marked the start of the German Revolution. In January 1919, a Constitutional congress was convened, and the new Weimar Constitution was adopted on August 11, 1919. Meanwhile, the Treaty of Versailles was signed on June 28, 1919, which included the War Guilt Clause. As a result, Germany owed staggering but initially uncertain reparations, negatively impacting Germany's public finances. Under the treaty, Germany lost 13% of its land area and 10% of its population. The signing of the Treaty of Versailles also ended the Allied war blockade of Germany, which hamstrung Germany's economy and public finances (Graham, 1931).

Following high inflation in the second half of 1919, inflation slowed in 1920. This was due to the Erzberger fiscal reforms of 1919 and 1920, which led to large tax increases, and the suppression of the Kapp Putsch in March 1920, which led to a strengthening of the mark. However, inflation accelerated again in the spring of 1921 after the Reparations Committee determined exact the reparations in May 1921, which amounted to about 6% of GDP per year (Dornbusch, 1985). Moreover, the London Ultimatum required an up front payment of 1.5 billion gold marks, about half of tax revenues, in 1921 (Dornbusch, 1985). Inflation continued to increase following the assassination of Matthias Erzberger on August 26, 1921.

On April 16, 1922 Germany and the Soviet Union signed the Treaty of Rapallo, which opened diplomatic relations between the two countries and involved a mutual cancellation of financial claims. The Treaty violated the Treaty of Versailles.

Second phase of the inflation. The summer of 1922 was the turning point in the inflation when high inflation turned into hyperinflation. In early June, the French government decided that the Bankers Committee could not provide reparations relief to Germany by reconsidering the May 1921 reparations schedule. Moreover, the Bankers Committee determined that Germany did not have the credit to warrant an international loan to stabilize the mark (Kindleberger, 1985). Germany suspended all payments of reparations in June 1922, and Germany formally demanded postponement of reparations for 2.5 years on July 12, 1922. Cagan (1956) dates the start of the

¹By the end of WWI, the mark had depreciated to 8 marks per U.S. dollar.

hyperinflation in July 1922, and Cagan (1991) refers to summer 1922 as the start of a “new regime” of collapse in the confidence in the mark.

Conflict over reparations was compounded by the assassination of the highly capable foreign minister Walther Rathenau by right-wing paramilitaries on June 24, 1922. *The Economist* noted that the Rathenau assassination and political turmoil were followed by “panic on the Berlin exchange bourse” (July 1, 1922). The mark depreciated by 7% on the day of the assassination. This led to a flight from the mark to foreign exchange, as markets began to expect additional depreciation, resulting in a large capital outflow.² The boost to international competitiveness from the depreciation also subsided by the second half of 1922, leading to a rising trade deficit, while firms pulled back on investment due to a shortage of working capital and increased uncertainty (Feldman, 1993).

Economic performance and inflation took another turn for the worse with the occupation of the Ruhr by France and Belgium in January 1923, following arrears on German deliveries of reparations in kind. The occupation was met by passive resistance, which the Reichsbank financed by discounting of Treasuries. This led to a surge in the issuance of paper currency. During 1923, the Reichsbank also discounted commercial bills.

There was a pause in the inflation from mid February to mid April 1923, when the Reichsbank attempted a first stabilization of the mark by intervening in the foreign exchange market. This briefly led to falling prices and an appreciation of the mark. The intervention was abandoned due to a large loss of central bank foreign currency reserves, as exchange rate was unsustainable given the large deficit (Dornbusch and Fischer, 1986). From May to October 1923, the price level spiraled out of control with increasingly higher rates of monthly inflation.

By the hyperinflation, the economy was in crisis. Food shortages became common, as farmers refused to accept marks for their products (Feldman, 1993). Worker-employer relations deteriorated, as workers demanded wage increased to keep pace with inflation. In July 1923, government employee wages became explicitly indexed to inflation. Economic distress led to rising left- and right-wing extremism.

Stabilization. Consensus for the need for stabilization grew in the hyperinflation phase, as there was a realization that the costs of inflation began to exceed the benefits of the stimulus (Feldman, 1993). The foundations for the stabilization were laid starting in August 1923. The Cuno government was replaced by a “Great Coalition” government with Gustav Stresemann as chancellor and the SPD in the finance ministry. The new government introduced new tax measures with accelerated indexation and issued a 500 million Goldmark loan, which paved the way for a new monetary unit linked to the Goldmark. Passive resistance in the Ruhr was ended on September 26, 1923. At this stage, the economy was in crisis; worker-employer relations had broken down and farmers had stopped accepting marks for products, leading workers to raid farmers’ fields for food (Feldman, 1993). In October 1923, the SPD left the finance ministry after cabinet reshuffle, and Hans Luther became the new finance minister. Inflation peaked at a monthly rate of 30,000% (more than 20% per day) in October, and exchange rate based pricing became widespread. The extremely rapid increase in prices led to a fall in real money balances (Cagan, 1956).

A monetary reform was introduced on October 15, 1923. The decree created a new currency unit called the Rentenmark, which was declared equivalent to 1 trillion (10^{12}) paper marks. The Rentenmark would be issued by a new bank, the Rentenbank, which would replace the

²The size of the capital outflow and the amount of German wealth held abroad is highly uncertain and debated in relation to Germany’s ability to meet reparations (Feldman, 1993).

Reichsbank's note issue function. The Rentenbank was backed by "fictitious" claims on industry and land and faced limits on the amount of loans it could make to the government and private sector, as well as limits on the maximum amount of Rentenmarks that could be issued. The legislation also prohibited the Reichsbank from discounting government bills. The Rentenbank came into operation and started issuing Rentenmarks on November 15, 1923. The exchange rate was fixed from November 20, 1923. There was a final depreciation of the currency from 1.26 trillion paper marks/USD to 4.2 trillion paper marks/USD between November 14 and November 20, leading to a large reduction in the real money supply. The Rentenmark was then stabilized at 4.2 Rentenmarks/USD, and the Rentenmark was then equivalent to one Goldmark.

There were several important factors behind the success of the stabilization.³ Sargent (1982) argues that fiscal stabilization in the form of both increased taxes and cuts in government spending were crucial for success of stabilization. Spending was cut through personnel reduction of 25% over four months and retiring civil servants over age 65. Stresemann and Luther balanced the budget. In contrast, stabilization coincided with strong money growth. In addition to fiscal reform, Dornbusch (1985) emphasizes the importance of exchange rate stabilization, very high interest rates (at times around 90% per year) in November and December 1923, discounting restraints on the Reichsbank and Rentenbank, political stabilization with the end of passive resistance, and the large decrease in real money balances from final 330% devaluation between November 14 and 20, 1923. The success of the stabilization was highly uncertain in the first few months.⁴

In August 1924, the Dawes Plan substantially aided Germany's fiscal situation by providing reparations relief. Reparations payments were temporarily suspended, and the Dawes plan assigned Germany a much more manageable schedule of payments. The plan involved a reorganization of the Reichsbank and the introduction of the Reichsmark to replace the Rentenmark. The Reichsmark (sign RM) was equal to one Rentenmark. Under the plan, France and Belgium agreed to withdraw from the Ruhr.

A.1.2 Historical Accounts of the Economic Impact of the Inflation

Aggregate effects of inflation and stabilization. The German economy experienced high growth and low unemployment from the end of the war to the second half 1922, avoiding "Depression" of 1920-21 in the US, UK, and France (see Figure 4).⁵ From the final months of 1922, inflation was associated with contraction, and 1923 saw a large decline in production due to a combination of the Ruhr occupation, hyperinflation, and stabilization. Graham (1931) argues that much of the adverse real effects of the inflation were due to coincident factors such as the loss of productive capacity during the war and the invasion of the Ruhr, although both Graham (1931) and Garber (1982) suggest that inflation may have resulted in a distortionary reallocation of resources toward large capital goods producers. Feldman (1993) argues that the hyperinflation itself contributed to economic crisis toward the second half of 1922, due to capital flight and a credit shortage, increased uncertainty leading firms to hold back production, large distortions in relative prices, breakdown in labor relations, a breakdown of trade, and rising social unrest.

The impact of the stabilization has been the subject of debate. Sargent (1982) argues that the stabilization was not associated with substantial negative effects and was actually expansionary

³In contrast to the stabilization of Austria and Hungary, the German stabilization did not involve foreign assistance.

⁴The stabilization also coincided with the death of the Reichsbank President Havenstein, who was replaced by Hjalmar Schacht.

⁵Graham (1931) writes: "That business in Germany was booming during most of the inflation period is a universally admitted fact" (p. 278).

based on annual industrial production data, though it is difficult to know how much of the increase in industrial production from 1923 to 1924 was due to the end of the Ruhr crisis. Garber (1982) argues that aftermath of stabilization was associated with large transitional costs through a reallocation of resources away from industrial firms that benefited from the inflation.

Distributional effects of the inflation and the impact on firms. The inflation had distributional effects through balance sheets, as we show in the paper. Debt-financed industrialists and landowners, especially those with mortgages, benefited from the inflation, while households on fixed income lost out.⁶ This allowed industrial firms to self-finance a higher share of their activity, making them less reliant on banks (p. 276 Feldman, 1993). Graham (1931) argues these redistributive effects were expansionary, but also notes that it caused over-investment and misallocation of resources to less productive users. Inflation also wiped out much of public debt, though lags between assessment and collection increased the deficit through the Tanzi effect (Dornbusch and Fischer, 1986).

There were also distributional effects through wages and prices. Real wages declined, especially for the middle class and up through 1920 (see Figure A.3.12). By the hyperinflation stage, wages raced to keep pace with rising prices. The depreciation of the mark also disproportionately benefitted exporters, who were able to regain foreign markets (Graham, 1931).

Firms responded to the inflation by increasing consolidation, such as the Stinnes' Siemens Concern. Mergers were financed by cheap debt. Vertical integration allowed firms to reduce uncertainty about the cost of materials. Horizontal integration was ostensibly pursued to diversify risk of volatile goods prices (Graham, 1931). This wave of consolidation was an acceleration on previous structural trends in the German economy (p. 272 Feldman, 1993). Some of the concerns built up during the inflation collapsed during the stabilization.

Banking and credit conditions during the inflation Banks saw large declines in the real value of their capital during the inflation. Based on data on 19 credit banks Goldschmidt (1928), finds that deflated bank capital declined by 54% from 1918 to 1923, with most of the decline occurring in 1919. Bank credit was available for firms in the first phase of the inflation (1919-21), but the second phase of the inflation witnessed a "credit crisis." This section provides further details on banking and credit conditions during the inflation.

There was a banking boom from 1919-21, as banks saw large inflows of mark-denominated foreign deposits from speculators betting on an appreciation of the mark. Banks also benefited from a widening deposit spread and from commissions on the high activity of stock and money market transactions. Banks were reported to be "swimming in money" during the first phase of the postwar inflation (Feldman, 1993).

As a result, credit conditions were not particularly tight in the first phase of the postwar inflation, and banks continued lending to industrial firms in this period. Bresciani-Turroni (1937) refers to a report of the General Association of German Banks and Bankers for 1923, which reported that: "Thanks to the aid of the banks, German industry and commerce were given the means not only to preserve their resources but to increase them in considerable measure. Industry rapidly recognized that it was economically more advantageous to incur the highest possible

⁶Graham (1931) notes that 40 billion marks of mortgage debt (one-sixth of German wealth) in 1913 was wiped out by the inflation. While urban landlords benefited from the erosion of their mortgage debt, strict regulation of rents made housing almost free for tenants during the hyperinflation. Feldman (1993) notes that this redistribution was well understood by contemporaries.

debts at the bank rather than to keep large deposits.”⁷ Bresciani-Turroni (1937) argues that banks lost by providing cheap credit to firms, perhaps because they did not understand the implications of inflation.

Between 1921 and 1922, there was a large decline in real deposits, as depositors sought assets that would provide a better hedge against depreciation and to avoid taxes (Feldman, 1993). During this phase, the term structure of deposits also shortened, leading to a shortening of loan terms. Banks also gradually raised interest rates, though never sufficiently to yield positive *ex post* returns (Graham, 1931).

Credit conditions became tight during the hyperinflation phase, starting in summer 1922. In this phase, it became very difficult for firms to obtain credit and external financing almost disappeared (Graham, 1931; Dornbusch and Fischer, 1986; Feldman, 1993). For example, in July 1922, *The Economist* noted a shortage of credit due to contraction of supply and elevated demand, as depreciation became widely anticipated. Narrative accounts refer to a credit “famine” or “crisis” (Balderston, 1991; Feldman, 1993). This is evidenced in rising interest rates on various types of credit, including money market interest rates (Holtfrerich, 1986; Feldman, 1993).

In the hyperinflation phase, many businesses were severely liquidity constrained with rising nominal input prices and wages. Banks could not keep up the supply of credit to finance firms’ working capital.⁸ This led to the reintroduction of bills of exchange, which could be discounted at the Reichsbank. From the middle of 1922, the Reichsbank partially substituted for credit bank’s credit by discounting bills of large firms, which made these firms less reliable on the banks (Feldman, 1993). The loan bureaus of the Reichsbank also became more active in granting credit. Large firms benefited from discounting at low real rates at the Reichsbank. Banks could also discount bills at the Reichsbank, and Graham (1931) argues banks recouped some of their losses by discounting bills at low rates at the Reichsbank.

The inflation was also characterized by an acceleration in banking sector consolidation through banking alliances.⁹ Over the period 1914-1925, the Berlin “great banks” absorbed many provincial and private banks (Balderston, 1991). For example, Deutsche Bank increased its number of branches from 15 in 1913 to 142 in 1924 (Feldman, 1993). Balderston (1991) argues that it is not clear exactly why mergers accelerated, while Feldman (1993) argues it was because provincial banks traded at a discount relative to the big banks and because big banks partly saw acquiring the assets of smaller banks (at least the real assets such as buildings) as an inflation hedge.

⁷However, Lindenlaub (1985) argues that, before late 1921, businesses generally did not respond to inflation by maximizing borrowing in anticipation of low real interest rates. This is consistent with narrative evidence and the behavior of forward exchange rate, which both indicate that agents did not anticipate continued high inflation before the summer of 1922. Therefore, while some industrial firms benefited from high leverage at the expense of banks, it is not clear that this was a systematic policy of the nonfinancial corporate sector.

⁸Banks could not index advances to the price level (Balderston, 1991). More broadly, indexation of financial contracts was not widespread due to restrictions on foreign currency pricing, though commodity-indexed bonds started to be issued in late 1922 (Feldman, 1993).

⁹A notable example was the merger between Darmstadt Bank für Handel und Industrie and Nationalbank für Deutschland into Danat Bank (Damstädter- und Nationalbank) in July 1922.

A.2 Model of the Debt-Inflation Channel of Inflation

This section lays out a simple model to illustrate the following mechanisms:

1. Inflation and Bankruptcies: When firms have nominal debt and can default, unexpected inflation increases firms' net worth, leading to a decline in default rates.
2. The Debt-Inflation Channel and Firm Activity: If firms are financing-constrained, unexpected inflation relaxes financing constraints and leads to an increase in labor demand, employment, and output. The debt-inflation channel is stronger for a higher initial level of leverage.
3. The Nominal Rigidity Channel: If unions face a menu cost in adjusting wages, small increases in inflation have a large effect on output through the nominal rigidity channel by reducing real wages. The nominal rigidity channel thus complements the debt-inflation channel. However, for high inflation, wages become flexible, and inflation only has real effects through the debt-inflation channel.

We consider a static model with two subperiods: "morning" and "evening." The economy is populated by a unit mass of entrepreneurs, who operate the productive technology, and workers, who monopolistically provide labor to firms.

Firms. Firms are run by risk neutral entrepreneurs and with utility function $U(C) = C$. Firms have initial capital stock K_0 and owe nominal debt to workers D_0 . Capital is subject to a real shock $Z_i \sim G$. In the morning, the entrepreneur decides whether to default or produce. The real value of an entrepreneur is the maximum of zero and

$$J = K_0 - Z_i - \frac{D_0}{P} + V,$$

where V is the value of the firm to the entrepreneur from continuing production (defined below) and P is the price level, which is assumed to be exogenous.¹⁰ Firms with negative value default. The cutoff value for Z^* for default is defined by:

$$Z^* = K_0 - \frac{D_0}{P} + V(Z^*). \quad (\text{A.1})$$

When a firm defaults, the entrepreneur gets zero consumption and exits the economy. The capital of the entrepreneur is then destroyed (i.e., it has a liquidation value of zero). The measure of active entrepreneurs is $G(Z^*)$. The value of nominal debt in the economy is $G(Z^*)D_0$.

Each firm i operates a Cobb-Douglas technology using capital and labor $\{L_{ij}\}_{j \in [0,1]}$ from each worker,

$$Y_i = F(K_i, \{L_{ij}\}) = AK_i^\alpha L_i^{1-\alpha},$$

where

$$L_i = \left(\int_0^1 (L_{ij})^{\frac{\epsilon-1}{\epsilon}} dj \right)^{\frac{\epsilon}{\epsilon-1}},$$

is a CES aggregate of labor provided by each worker j to entrepreneur i .

¹⁰The price level can be endogenized by assuming that there is stock of money that is required for transactions and that is randomly adjusted by the monetary authority. In that case, the price level is determined by $M = P(K_0 - K + Y)$, where K_0 is initial capital, K is capital used in production, Y is aggregate production.

Each firm with $Z \leq Z^*$ uses initial capital net of debt along with intra-period debt D_i to invest in capital and pay labor in the morning. The flow of funds condition for entrepreneur i is

$$D_i - D_0 - PZ_i = WL_i + P(K_i - K_0) \quad (\text{A.2})$$

To introduce financing constraints, we assume that firms are subject to a working capital constraint on D_i , similar to Jermann and Quadrini (2012). The constraint is given by:

$$D_i \leq \zeta PAK_i^\alpha L_i^{1-\alpha}. \quad (\text{A.3})$$

Combining (A.2) and (A.3) yields the following constraint:

$$D_0 + PZ_i + WL_i + P(K_i - K_0) \leq \zeta PAK_i^\alpha L_i^{1-\alpha} \quad (\text{A.4})$$

The firm's problem is

$$P \cdot V = \max_{K_i, L_i} PAK_i^\alpha L_i^{1-\alpha} - WL_i - PK_i \quad \text{s.t. (A.4).}$$

The first-order conditions are:

$$\begin{aligned} [K_i] : \quad & F_K - 1 - \lambda(1 - \zeta F_K) = 0 \\ [L_i] : \quad & PF_L - W - \lambda(W - \zeta PF_L) = 0, \end{aligned}$$

where λ is the Lagrange multiplier on the constraint (A.4).

There are two cases, depending on whether the financing constraint binds. In the following, for simplicity to illustrate the main points, we consider parametrizations of G and ζ such that all firms are constrained. Regardless of whether the constraint binds, the capital-labor ratio is

$$\frac{K_i}{L_i} = \frac{\alpha}{1-\alpha} \frac{W}{P}. \quad (\text{A.5})$$

When the constraint binds, we can solve for firm i 's labor demand by combining (A.4) and (A.5):

$$L_i^d = \frac{K_0 - \frac{D_0}{P} - Z_i}{\frac{1}{1-\alpha} \frac{W}{P} - \zeta A \left(\frac{\alpha}{1-\alpha} \frac{W}{P} \right)^\alpha}. \quad (\text{A.6})$$

Firm labor demand is an increasing function of its initial resources, $K_0 - \frac{D_0}{P} - Z_i$. Again assuming all firms are constrained, aggregate labor demand is given by

$$L^d = G(Z^*) \frac{K_0 - \frac{D_0}{P} - \frac{\int_Z^{Z^*} Z dG(Z)}{G(Z^*)}}{\frac{1}{1-\alpha} \frac{W}{P} - \zeta A \left(\frac{\alpha}{1-\alpha} \frac{W}{P} \right)^\alpha} \quad (\text{A.7})$$

For a constrained firm, the real value of production is,

$$V = \frac{D_0}{P} + Z_i - K_0 + (1 - \zeta)AK_i^\alpha L_i^{1-\alpha}$$

so the value of the firm from not defaulting is

$$J = (1 - \xi)AK_i^\alpha L_i^{1-\alpha} = (1 - \xi)A \left(\frac{\alpha}{1-\alpha} \right)^\alpha \left(\frac{W}{P} \right)^\alpha L_i^d.$$

Thus, a firm defaults if it would choose a negative amount of labor, L_i^d . From (A.6), we see that the cutoff value of default is the value such that $L_i^d = 0$, or

$$Z^* = K_0 - \frac{D_0}{P},$$

In other words, the firm defaults if the real value of its initial debt exceeds the value of capital. it has negative initial net worth. The share of defaulting firms is $1 - G(Z^*)$, which provides our first result.

Result 1: Debt-Inflation and Firm Bankruptcies. The share of defaulting firms declines for higher levels of inflation, P :

$$\frac{\partial(\text{Default share})}{\partial P} = -\frac{D_0}{P^2} G' \left(K_0 - \frac{D_0}{P} \right) < 0.$$

Workers. The household chooses its overall level of consumption and labor to maximize

$$U(C, L) = \ln(C) - \chi \frac{L^{1+\varphi}}{1+\varphi}$$

subject to the budget constraint:

$$C = \frac{W}{P}L + \frac{G(Z^*)D_0}{P}$$

The budget constraint uses the assumption that workers hold a diversified portfolio of debt claims with aggregate nominal value $G(Z^*)D_0$. Each worker sets a wage W_j at which they are willing to work. Given that the production technology aggregates different varieties of labor according to a CES function, the total units of labor demanded from a worker j who sets wage W_j will be

$$L(W_j) = \left(\frac{W_j}{W} \right)^{-\epsilon} L^d,$$

where L^d is the aggregate quantity of labor demanded by entrepreneurs. In equilibrium, all varieties of labor set the same wage $W_j = W$. Household aggregate labor supply is given by

$$\frac{W}{P} = \frac{\epsilon}{\epsilon - 1} \chi L^\varphi C,$$

which can be rewritten as

$$\frac{W}{P} = \frac{\frac{\epsilon}{\epsilon-1} \chi L^\varphi}{1 - \frac{\epsilon}{\epsilon-1} \chi L^{1+\varphi}} \left(\frac{G(Z^*)D_0}{P} \right). \quad (\text{A.8})$$

An increase in inflation P lowers real debt held by households, raising labor supply through a wealth effect. Intuitively, households reduce consumption of leisure and increase labor as the inflation erodes their wealth.¹¹

Flexible wage equilibrium. With flexible wages, the equilibrium in the labor market is given by the solution to (A.7) and (A.8). Capital of non-defaulting firms can be consumed immediately or used for production, at which point it depreciates entirely. Hence, the aggregate resource constraint is

$$\int_{\underline{Z}}^{Z^*} AK_i^\alpha L_i^{1-\alpha} dG(Z) = \int_{\underline{Z}}^{Z^*} [C_{ie} + K_i - K_0] dG(Z) + C_w,$$

where C_e and C_w denote the consumption of the entrepreneur and household.

The labor market equilibrium is illustrated in Figure A.1. In response to an increase in the price level P , labor demand shifts outward, as firms financing constraints are relaxed. Moreover, labor supply shifts outward due to the negative wealth effect. The increase in labor supply dampens the increase in the real wage, consistent with the fact that real wages did not rise and actually declined during the German inflation.

Result 2: The Debt-Inflation Channel and Firm Activity. If firms have nominal debt and are financing-constrained, inflation boosts labor demand (A.7), increasing employment and output. The higher the level of initial debt D_0 , the stronger the increase in labor demand and, thereby, the debt-inflation channel. The increase in the real wage is offset by the wealth effect on labor supply from the erosion of workers' real debt holdings.

Introducing nominal wage rigidity. We introduce nominally rigidity by assuming that initially, the wage for all workers is set at W_0 , which we assume is the equilibrium flexible wage with $P = 1$. Workers can alter their wages W_j , but incur a cost by doing so. Specifically, there is a menu cost of altering the wage: a worker that changes W_j from its baseline W_0 pays a cost $\psi \geq 0$ regardless of the final value of W_j . The presence of a menu cost will generate different behavior of the economy in times of normal inflation and times of hyperinflation, since workers will choose to change their wages only when inflation is at a high enough level.

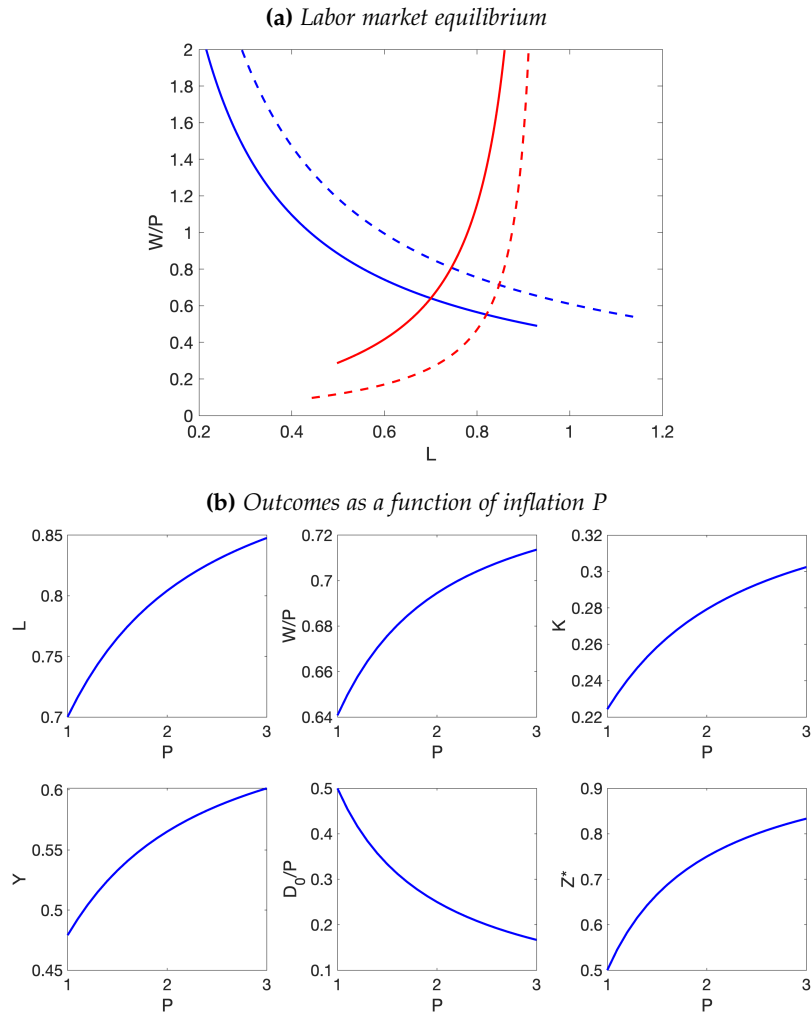
Denote W^* , L^* denote equilibrium in the labor market if the wage is adjusted. $L^d(W)$ is labor demand for a given wage W . The wage is adjusted if utility from the flexible price equilibrium, net of the cost of adjustment, exceeds the utility from the allocation with $W = W_0$:

$$\ln \left(\frac{W^*}{P} L^* + G(Z^*) \frac{D_0}{P} \right) - \chi \frac{(L^*)^{1+\varphi}}{1+\varphi} - \psi \geq \ln \left(\frac{W_0}{P} L^d(W_0) + G(Z^*) \frac{D_0}{P} \right) - \chi \frac{L^d(W_0)^{1+\varphi}}{1+\varphi}$$

Result 3: Nominal Rigidity Channel of Inflation: Labor market equilibrium in response to shock to P depends on the size of the inflation shock. For a small inflation, the nominal wage is not updated, W/P falls, and employment increases significantly through both the nominal rigidity and debt-inflation channels. For a large increase in the price level, the wage is updated, and inflation only affects real outcomes through the debt-inflation channel. This result is illustrated with an example in Figure A.2 for various levels of the price level P .

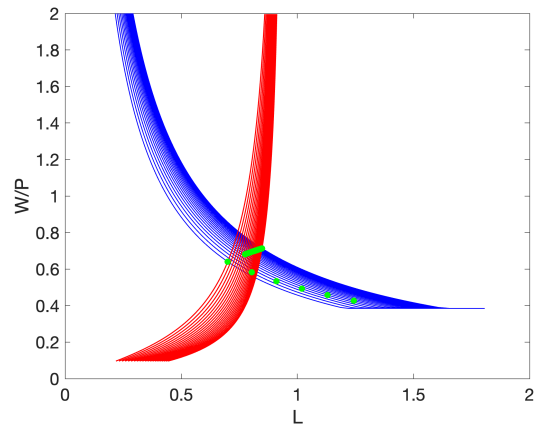
¹¹If we instead assume that utility is quasi-linear, $U(C, L) = C - \chi \frac{L^{1+\varphi}}{1+\varphi}$, then labor supply would be $\frac{W}{P} = \frac{\epsilon}{\epsilon-1} \chi L^\varphi$, removing the wealth effect.

Figure A.1: Labor Market Equilibrium with Flexible Wages Following an Inflation Shock



Notes: Panel (a) illustrates the labor market equilibrium for a low (solid curves) and high (dashed curves) of P . Panel (b) plots equilibrium outcomes from the model with flexible wages as a function of P .

Figure A.2: *Labor Market Equilibria with Nominal Wage Rigidity for Different Levels of P*

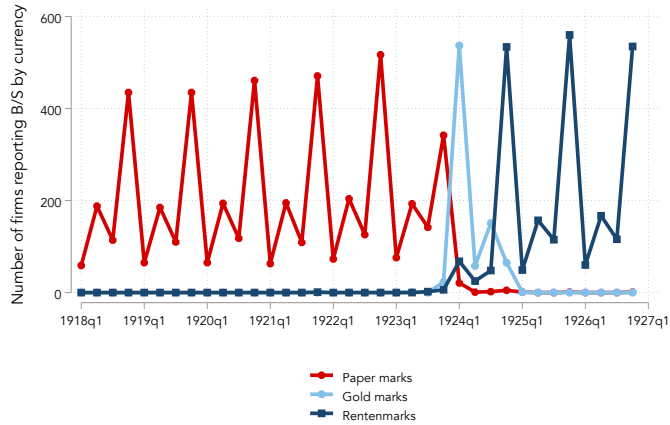


Notes: This figure illustrates labor market equilibrium for increasing values of P in the model with nominal wage rigidity. The downward sloping blue curves are labor demand curves for different levels of P , while the upward sloping red curves are labor supply curves. Green dots indicate the equilibrium, which depends on whether the nominal wage is adjusted.

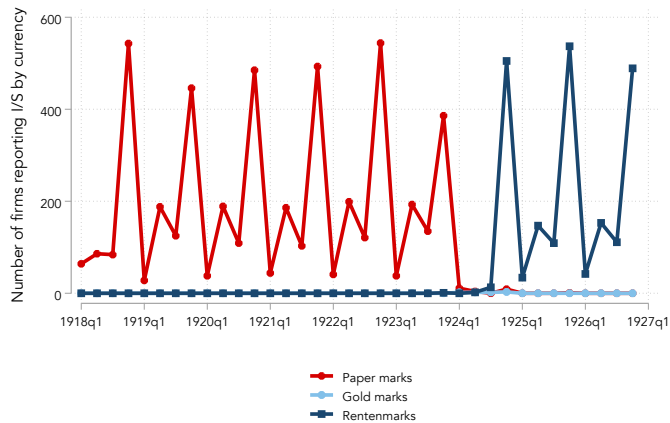
A.3 Supplementary Figures and Tables

Figure A.3.1: *Number of Firms in Reporting in Saling After Sample Restriction.*

(a) *Number of firms reporting B/S by currency of reporting.*

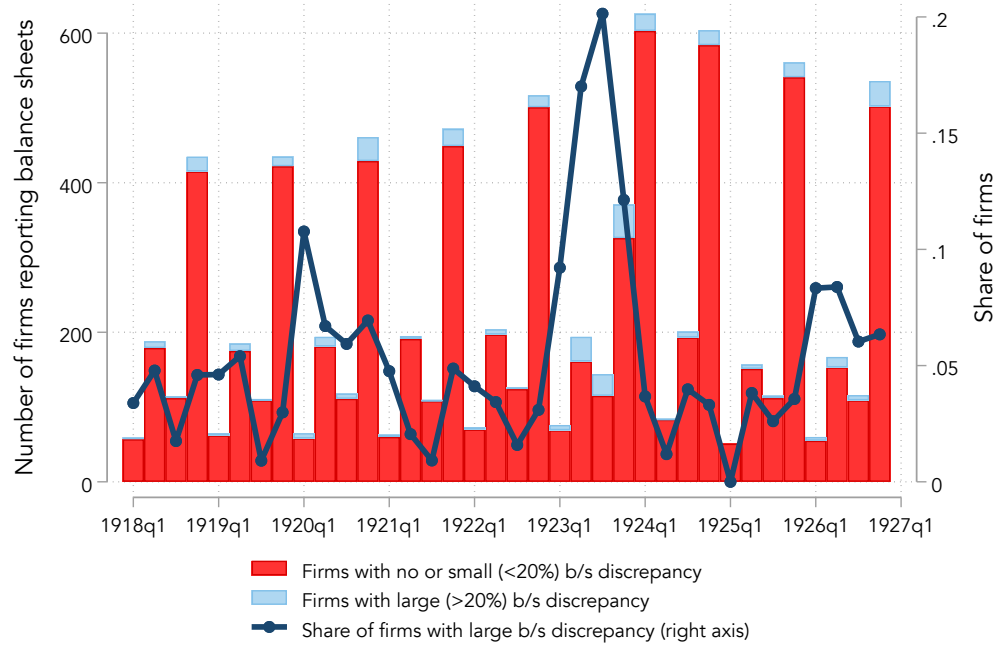


(b) *Number of firms reporting I/S by currency of reporting.*



Notes: This figure plots the number of firms reporting balance sheets and income statements by quarter and currency of reporting in the *Saling's* data. The majority of firms report balance sheets at the end of the year (fourth quarter). The spike in balance sheets in 1924Q1 is the new Goldmark balance sheets. Rentenmark balance sheets refers to Rentenmarks or Reichsmarks, which have the same value.

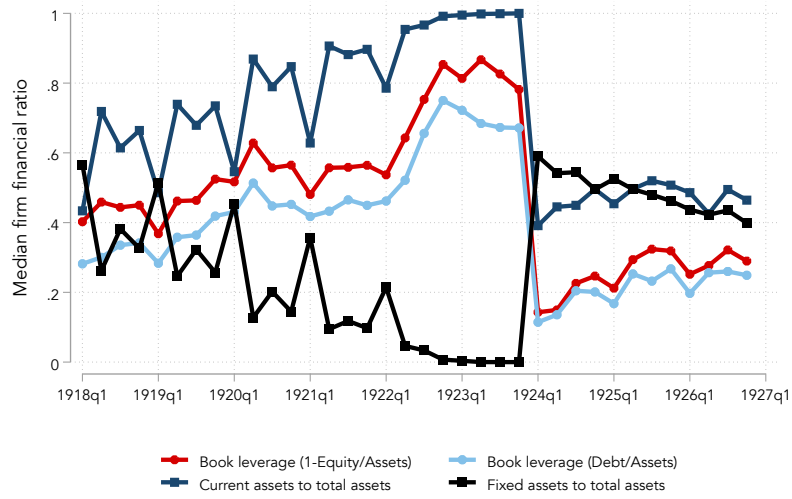
Figure A.3.2: *Saling Firm-Level Balance Sheet Data: Data Quality.*



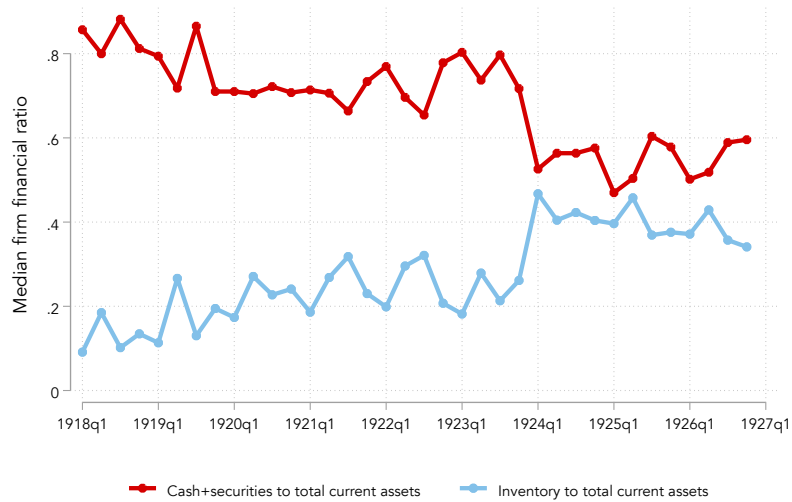
Notes: This figure plots the number and share of firms with no or small balance sheet discrepancies and large balance sheet discrepancies. Balance sheet discrepancies are defined as instances of a larger than 20% pairwise difference between either the sum of assets, the sum of liabilities and equity, or reported total assets.

Figure A.3.3: Balance Sheet Dynamics in Saling: Ratios.

(a) Evolution of median financial ratios.



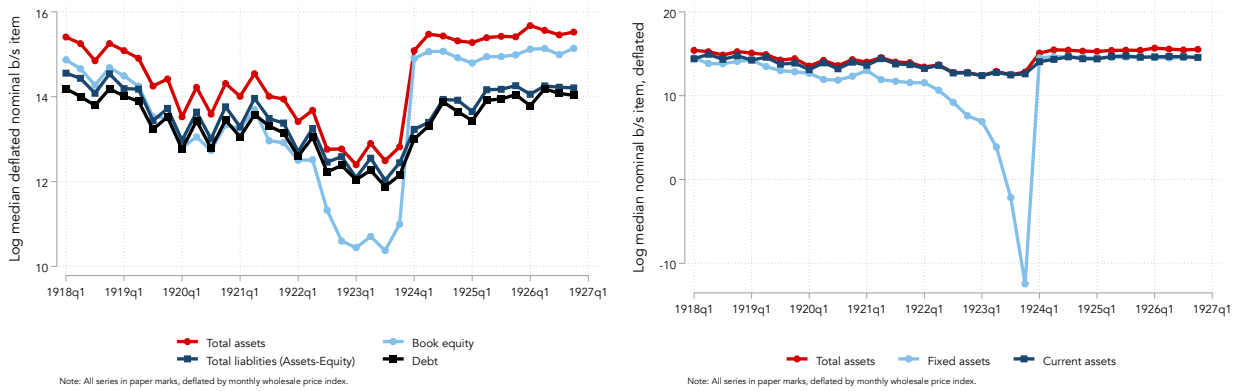
(b) Evolution of working capital ratios.



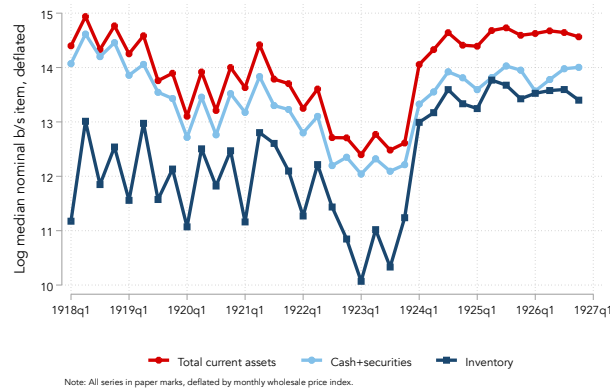
Notes: This figure plots the evolution of the median of key balance sheet ratios in the *Saling's* data over time. The large changes in 1924Q1 occur due to the introduction of revalued Goldmark balance sheets.

Figure A.3.4: Balance Sheet Dynamics in Saling: Deflated Levels.

(a) Evolution of median of liability components in paper marks, deflated. **(b)** Evolution of median of asset components in paper marks, deflated.



(c) Evolution of median of current asset components in paper marks, deflated.



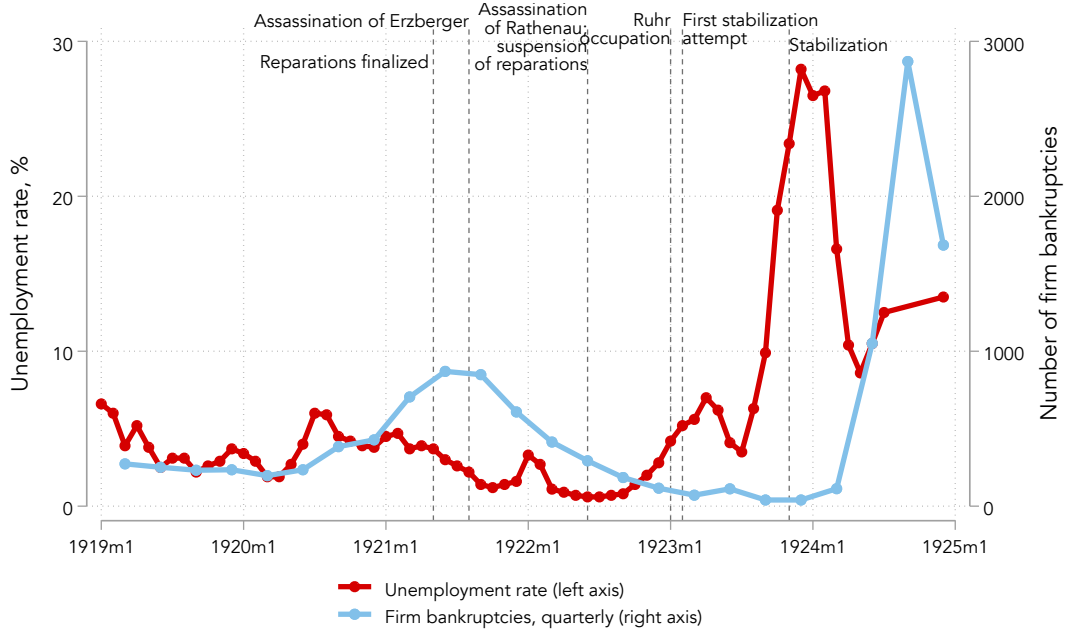
Notes: This figure plots the evolution of the medians of key balance sheet items in paper marks, deflated by the wholesale price index. The large changes in 1924Q1 occur due to the introduction of revalued Goldmark balance sheets.

Figure A.3.5: Employment Growth in Saling's Compared with the Aggregate Unemployment Rate.



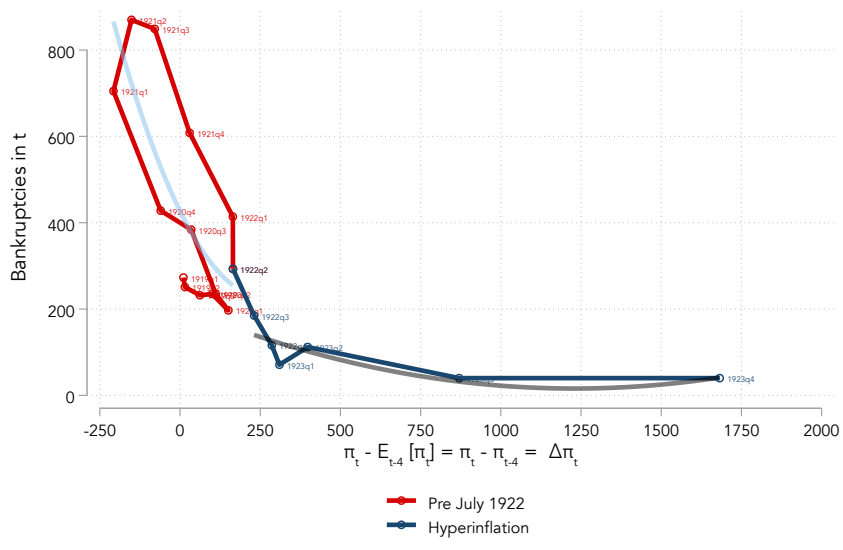
Notes: This figure validates self-reporting employment in the *Saling's* data by comparing it with the change in the aggregate unemployment rate. Aggregate employment growth in *Saling's* is computed as the unweighted average of the change in firm log employment (multiplied by 100). The annual unemployment rate is the annual average of the monthly rate and is from the *Reichsarbeitsblatt*.

Figure A.3.6: Unemployment and Firm Bankruptcies.



Notes: Quarterly bankruptcies are from the *Vierteljahrshefte zur Statistik des Deutschen Reichs Herausgegeben vom Statistischen Reichsamt* and *Wirtschaft and Statistik*. Unemployment for industries is from *Reichsarbeitsblatt*.

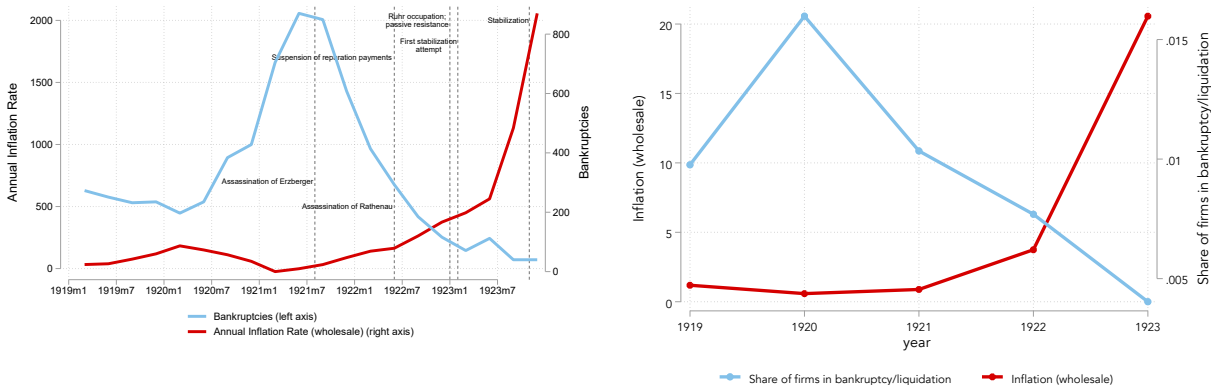
Figure A.3.7: Inflation and Firm Bankruptcies: Robustness using the Acceleration in Inflation.



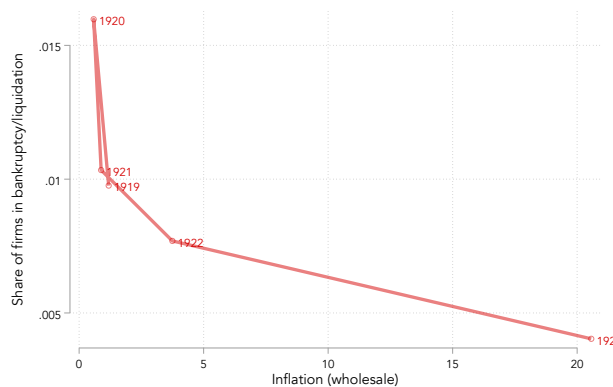
Notes: This figure plots the number of firm bankruptcies in quarter t against inflation over the past four quarters net of expected inflation over the same period. Expected inflation is assumed to be inflation over the past year from quarter $t - 8$ to $t - 4$. Inflation is calculated as the log change (times 100). Quarterly counts of firm bankruptcies are obtained from the *Vierteljahrshefte zur Statistik des Deutschen Reichs Herausgegeben vom Statistischen Reichsamt*. Inflation of wholesale prices as reported in *Zahlen zur Geldentwertung*.

Figure A.3.8: Inflation and Firm Bankruptcies.

(a) Inflation and no. of bankruptcies and liquidation by quarter. (b) Inflation and rate of bankruptcies and liquidation by year.



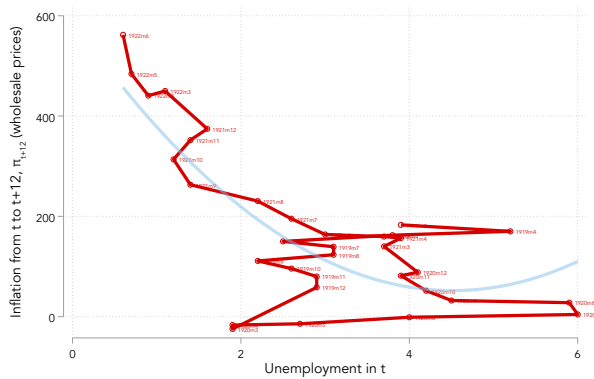
(c) Inflation and rate of bankruptcies and liquidations by year.



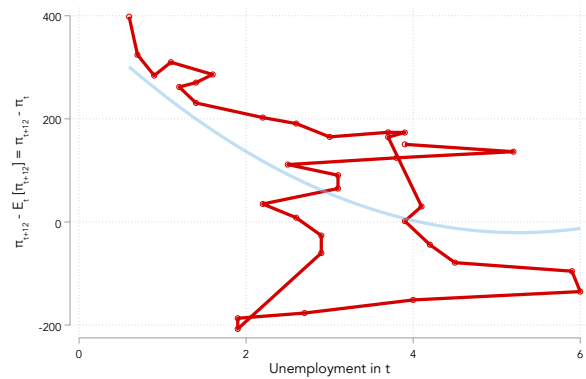
Notes: Quarterly counts of firm bankruptcies are obtained from the *Vierteljahrshefte zur Statistik des Deutschen Reichs* Herausgegeben vom Statistischen Reichsamt. Inflation of wholesale prices as reported in *Zahlen zur Geldentwertung*.

Figure A.3.9: The “Classic” Phillips Curve: Subsample from 1919:1 to 1922:6.

(a) Level-level Phillips Curve, 1919:1-1922:6.

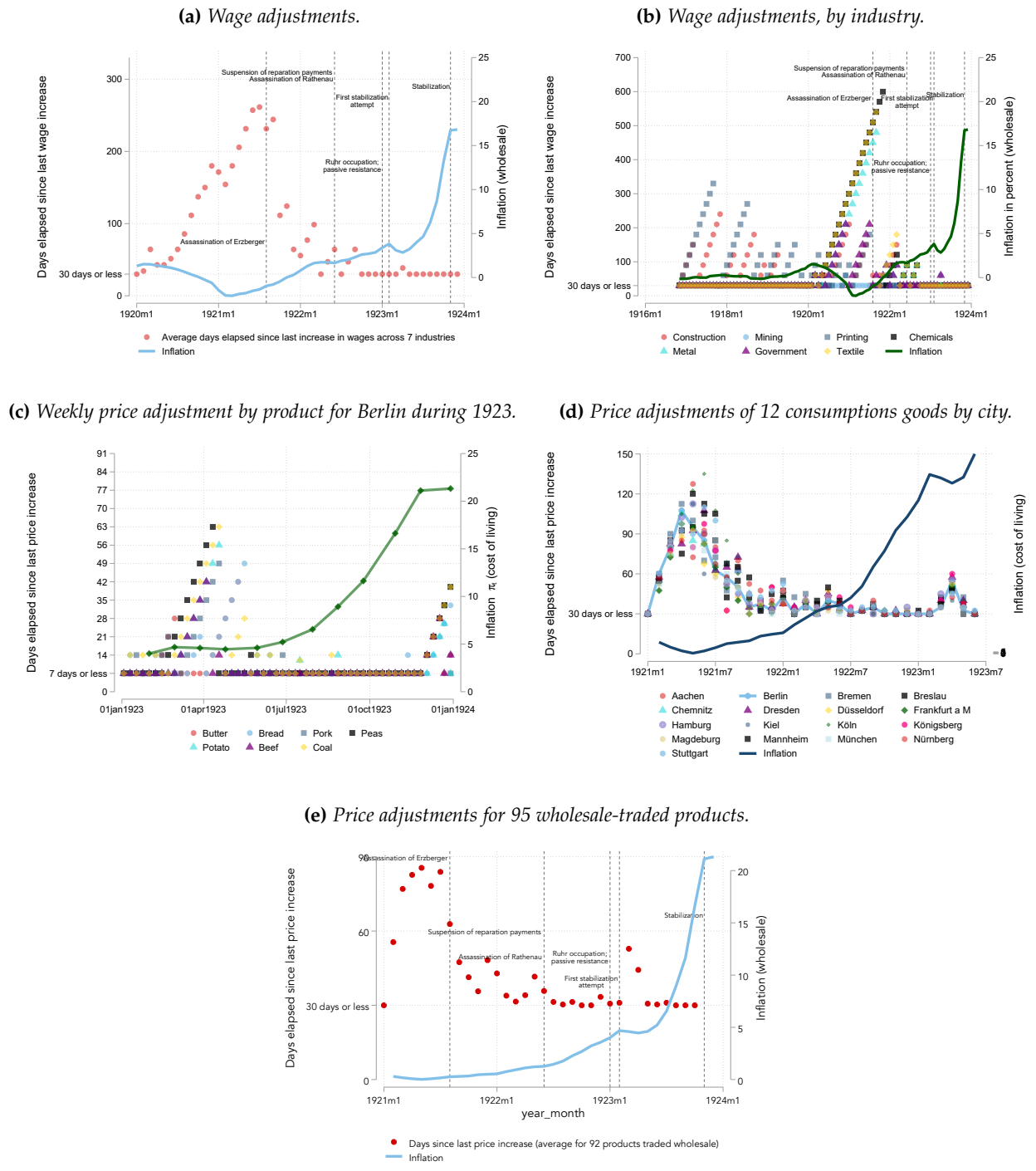


(b) Accelerationist Phillips Curve, 1919:1-1922:6.



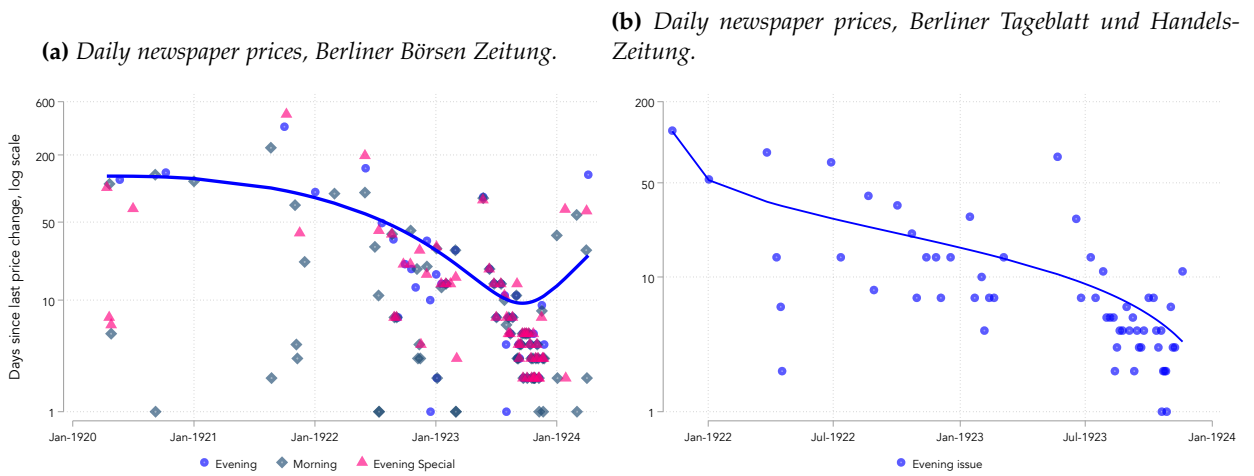
Notes: This figure presents level-level and accelerationist Phillips curves using data from 1919:1 to 1922:6, the first phase of the post-war inflation, before the hyperinflation phase. Inflation of wholesale prices as reported in *Zahlen zur Geldentwertung*. Monthly unemployment in the German industries as reported in the *Reichsarbeitsblatt*.

Figure A.3.10: Interval between Price Adjustment Falls during the Inflation: Evidence from Wages and Cost-of-Living Index Prices.



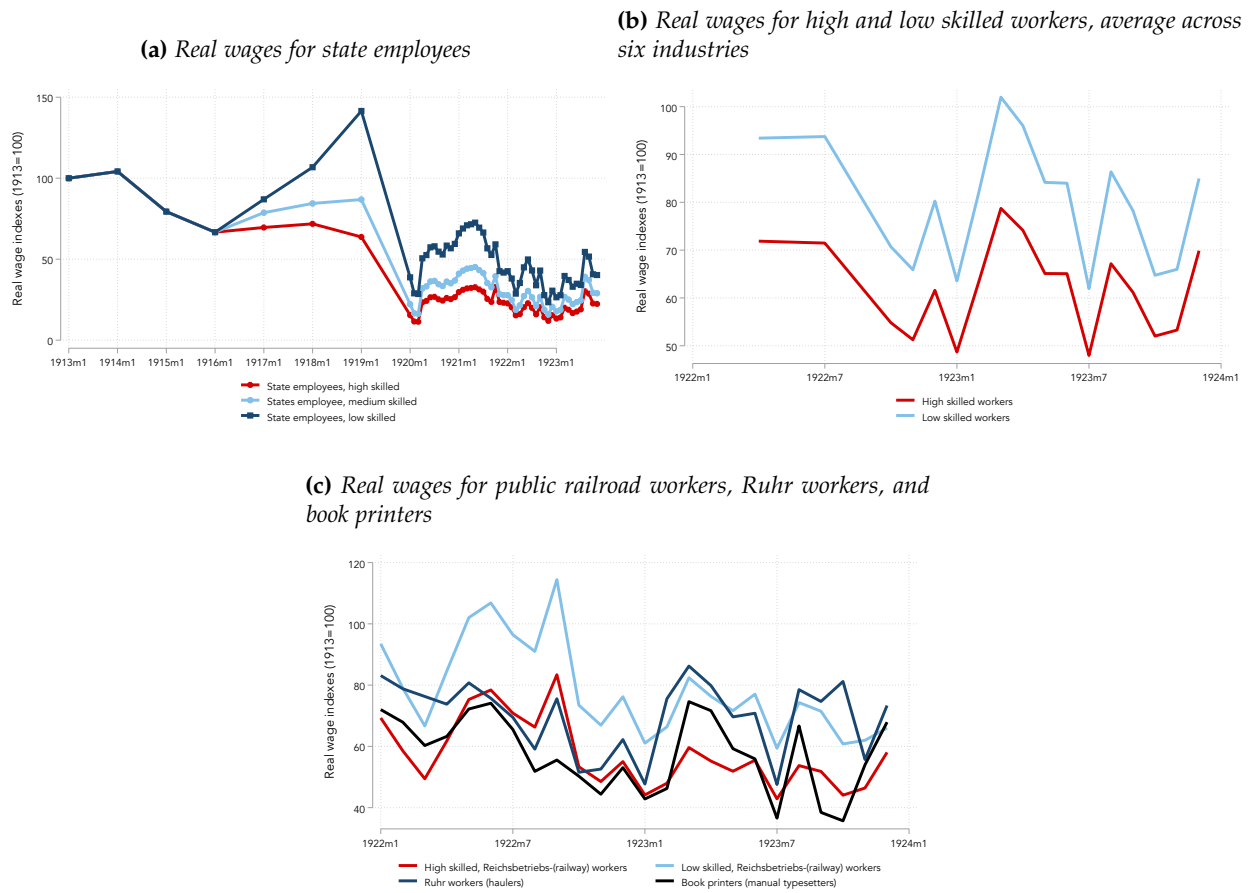
Notes: This figure plots the duration of unchanged wages and prices products underlying the cost-of-living index over time.

Figure A.3.11: Interval between Price Adjustment Falls during the Inflation: Evidence from Newspaper Prices.



Notes: This figure plots the duration of unchanged prices for various issues of two German newspapers, the *Berliner Börsen Zeitung* and the *Berliner Tageblatt und Handels-Zeitung*. Daily newspaper prices are hand-collected from scans of the newspapers.

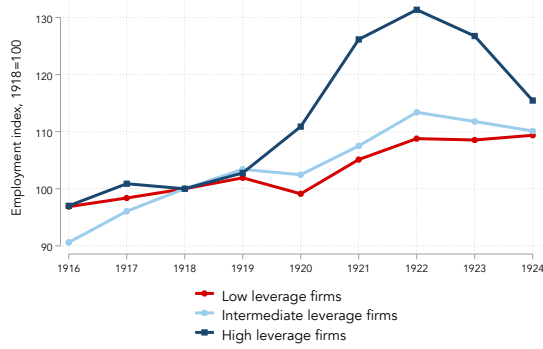
Figure A.3.12: Real Wages Declined Relative 1913 during Germany's Inflation, Especially for High Skilled Workers.



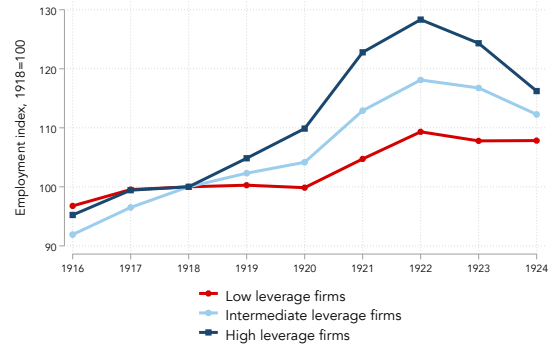
Notes: This figure plots the evolution of real wages for various groups of workers and industries. Real wage data are from *Wirtschaft und Statistik*. Real wages are deflated by wholesale prices.

Figure A.3.13: *Employment Dynamics across Low and High Leverage Firms: Alternative Measures of Leverage.*

(a) *Sorting firms by average liabilities to assets over 1917-1919*

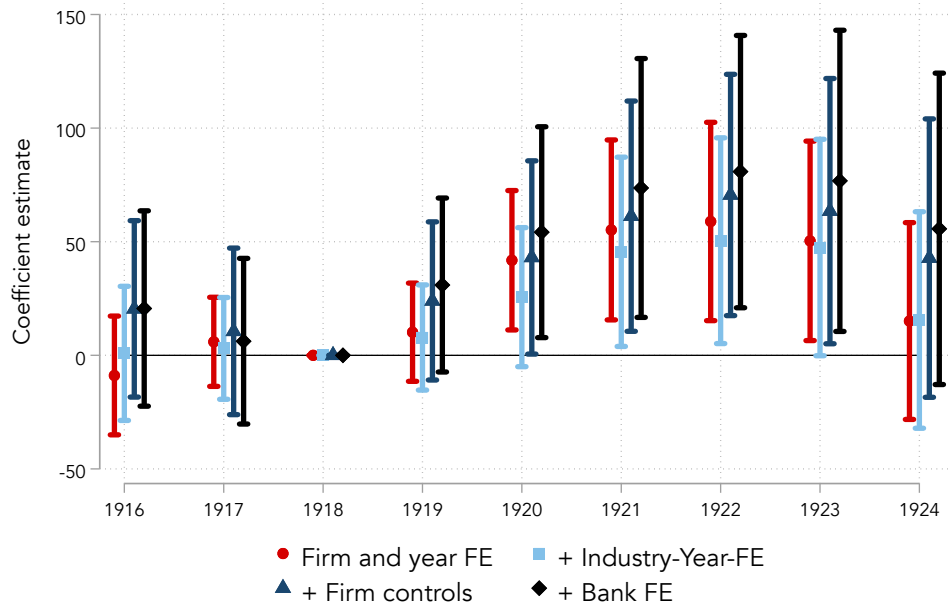


(b) *Sorting firms by average financial debt to assets over 1918-1919*



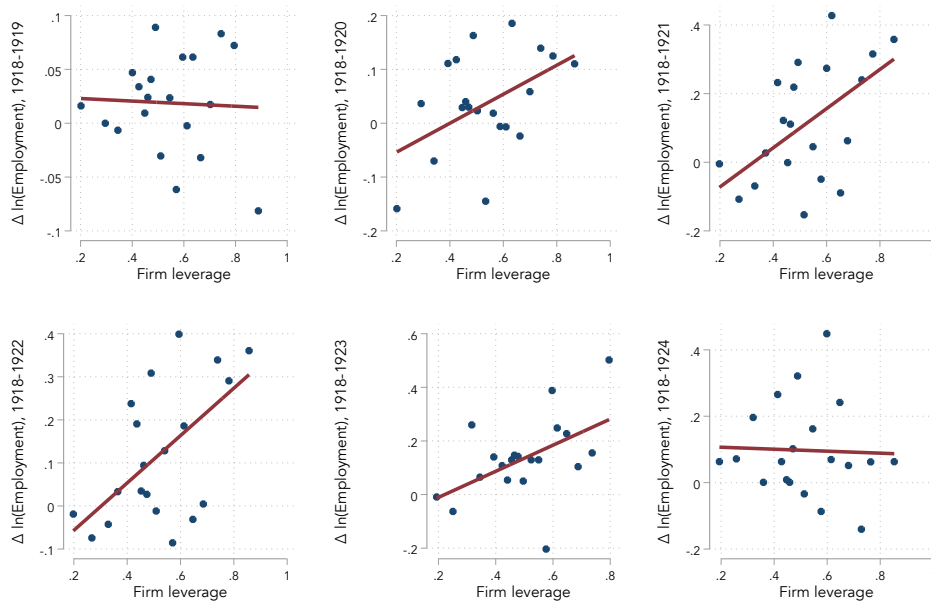
Notes: This figure presents the average evolution of employment for firms in the bottom, middle, and top terciles of leverage. Leverage is defined as the average of liabilities-to-assets over 1917 to 1919 (panel a) or financial debt to assets (panel b). Employment is indexed to 100 in 1918 for each group.

Figure A.3.14: Firm Leverage and Firm Employment: Robustness to Inclusion of Various Sets of Controls.



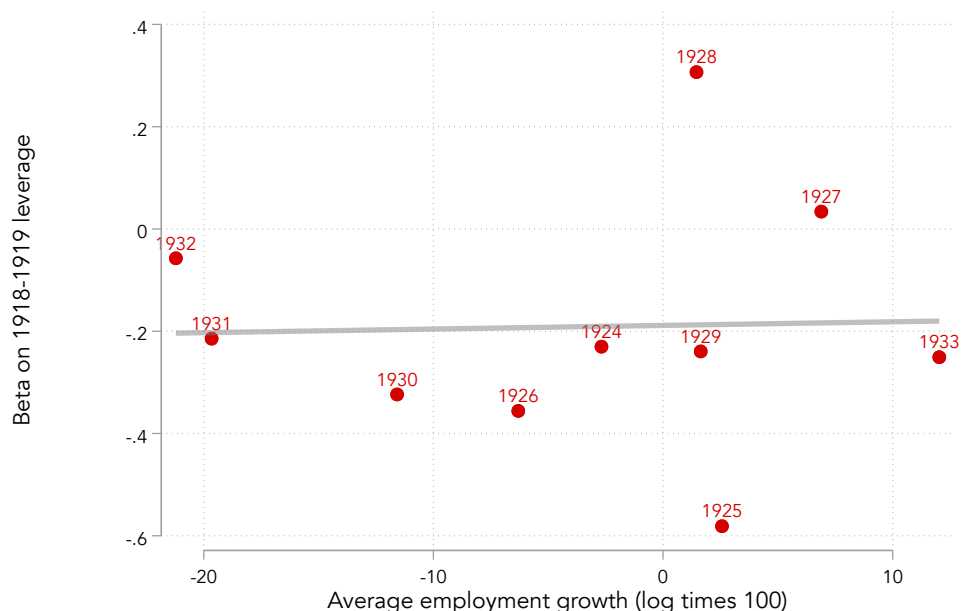
Notes: This figure is similar to Figure 8, but it reports estimates for various other control sets. The red coefficients are from estimates of (1) with only firm and year fixed effects. The light blue coefficients are from a specification that adds industry-year fixed effects. The dark blue coefficients further include firm controls interacted with year fixed effects. Firm controls are log assets, fixed assets to total assets, return on assets, and EBIT margin, all as of 1918-1919. Finally, the black coefficients are from a specification that adds fixed effects for a connection to one of seven major banks, as well a fixed effect for firms with a connection to a bank that is not one of the major banks and a fixed effect indicator for firms without any banking connections. This specification also includes the distance to Berlin, another proxy of exposure to shifts in credit supply. These fixed effects and controls are also interacted with year fixed effects. Error bars represent 95% confidence intervals from standard errors clustered at the firm level.

Figure A.3.15: Firm Leverage and Firm Employment Growth During the Inflation.



Notes: This figure plots binned bivariate means of firm-level employment growth (defined as the change in log employment, multiplied by 100) in each year from 1919 to 1924, relative to 1918. Firm leverage is defined as $\frac{\text{Liabilities}}{\text{Assets}}$, averaged over 1918 and 1919.

Figure A.3.16: Firm Leverage and Firm Employment Growth: Placebo on Post-Hyperinflation period from 1924-1933.



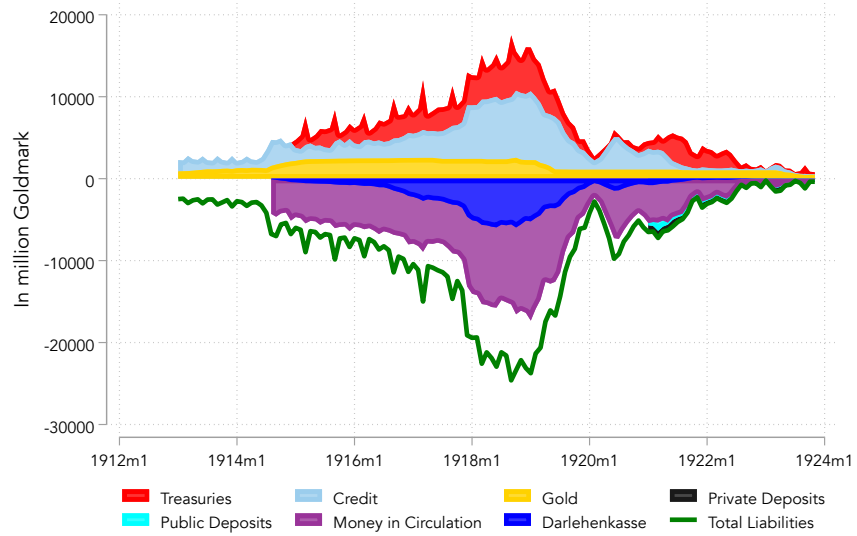
Notes: This figure shows that firms with higher leverage as of 1918-1919 do not have higher business cycle exposure in the post-inflation period (1924-1933). The figure correlates average annual firm employment growth with the beta from a regression of firm employment growth on firm leverage:

$$\Delta \ln(\text{Employment}_{it}) = \alpha^t + \beta^t \text{Leverage}_{i,1918-1919} + \gamma_s^t + X_i \Gamma^t + \epsilon_{it}, \quad t = 1924, \dots, 1933,$$

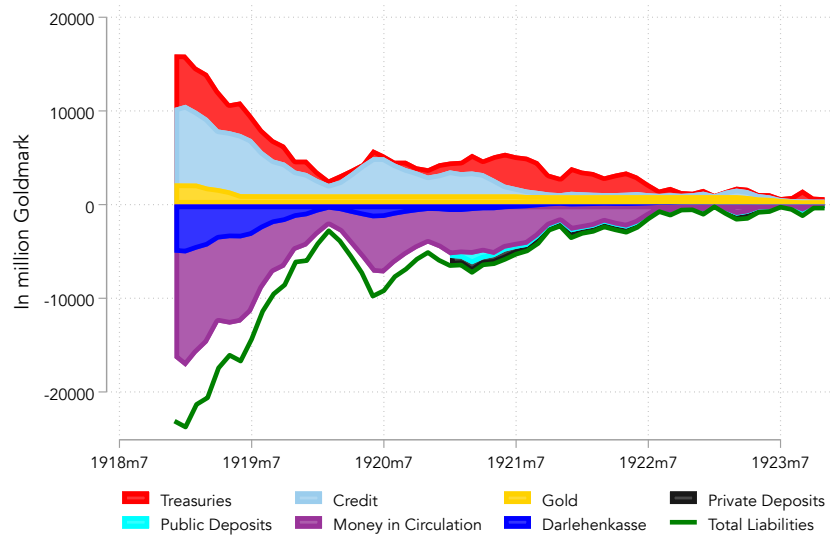
where leverage is defined as $\frac{\text{Liabilities}}{\text{Assets}}$ averaged over 1918 and 1919, γ_s^t is an industry fixed effect, and X_i are firm controls. The regression is estimated each year from 1924 to 1933. This exercise tests whether high leverage firms have higher employment growth during years of high aggregate employment growth. The flat relationship implies that high leverage firms do not have a higher “beta” on the employment expansions and contractions after the hyperinflation. For example, high leverage firms do not have stronger employment growth during the 1927-1928 expansion, and high leverage firms also do not see larger employment declines in the Great Depression (1930-32).

Figure A.3.17: Reichsbank Balance Sheet in Goldmarks.

(a) 1914-1923



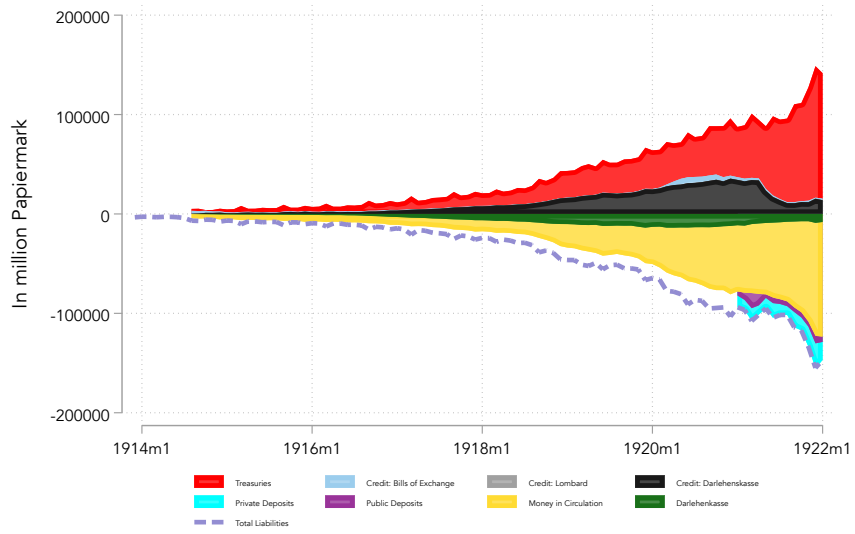
(b) 1919-1923



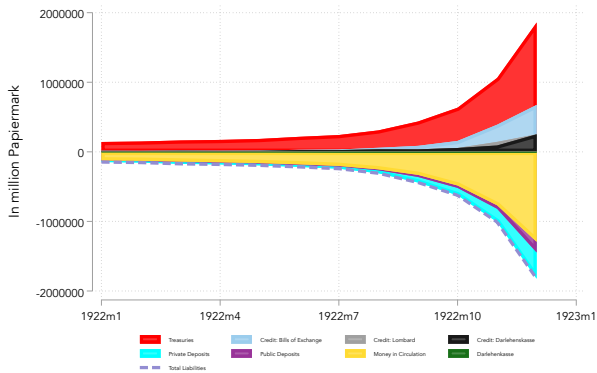
Notes: Data according to *Zahlen zur Geldentwertung*.

Figure A.3.18: Reichsbank Balance Sheet in Papiermarks.

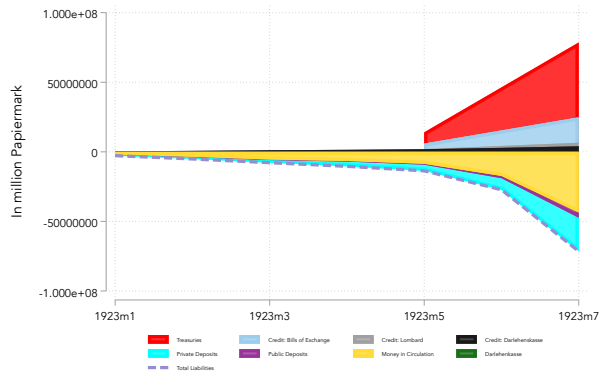
(a) 1914-1921



(b) 1922

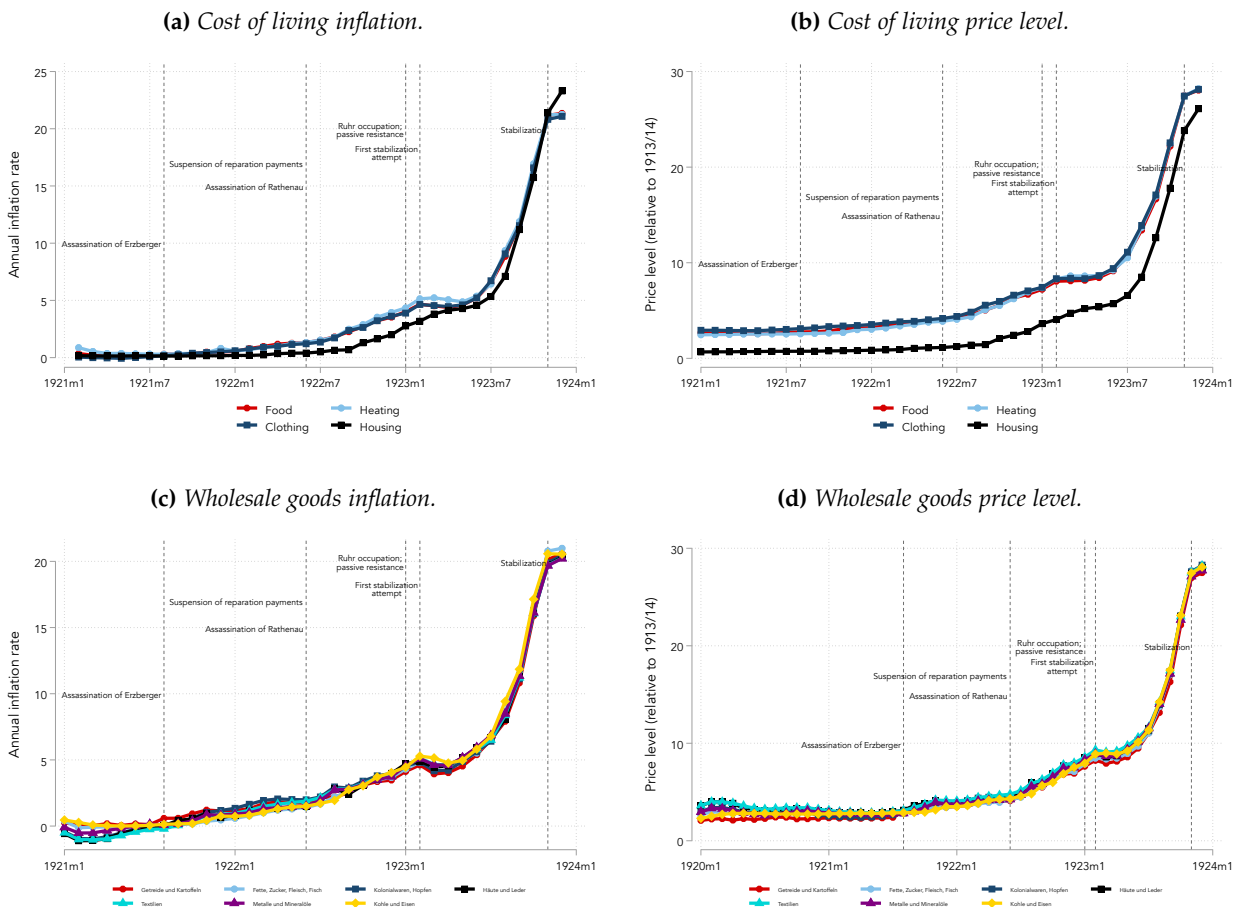


(c) 1923



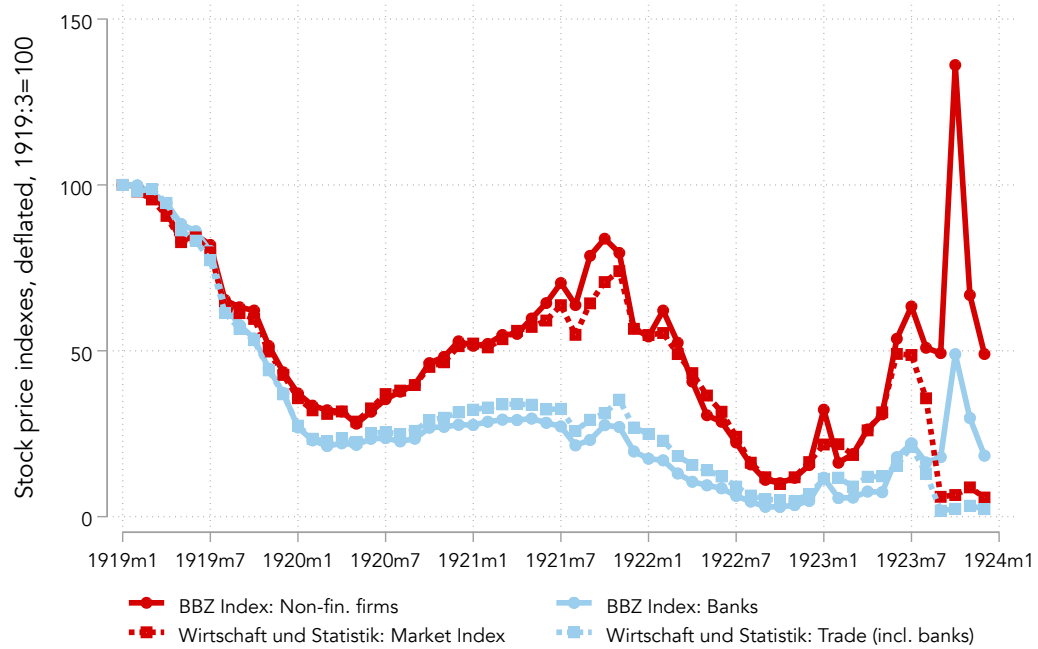
Notes: Source: Data are as reported in *Zahlen zur Geldentwertung*.

Figure A.3.19: Cost of Living and Wholesale Prices by Type.



Notes: Data according to *Zahlen zur Geldentwertung*.

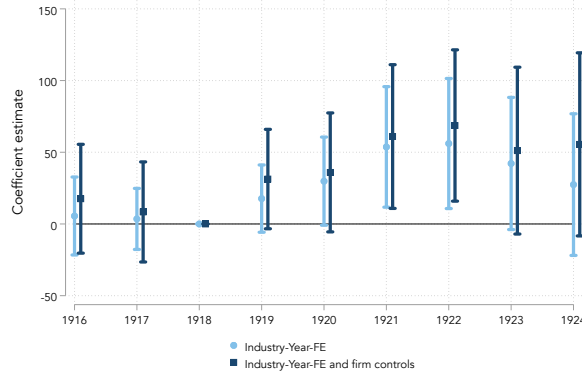
Figure A.3.20: Nonfinancial Equity and Bank Equity Returns Based on Indexes from *Berliner Börsen Zeitung* and *Wirtschaft und Statistik*.



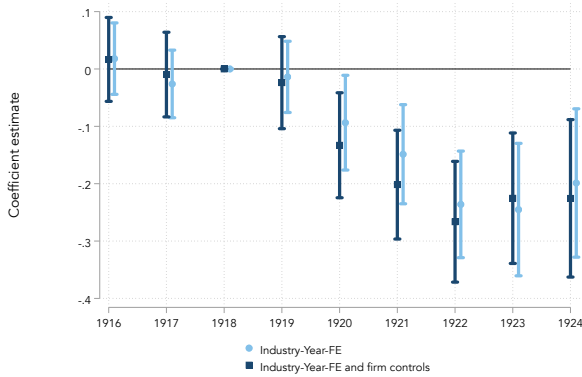
Notes: This figure plots equity indexes for nonfinancial firms and banks. We use two sources. The first is an equal-weighted from our hand-collected stock price data from *Berliner Börsen Zeitung* (BBZ). The second is published stock price indexes from *Wirtschaft und Statistik*. *Wirtschaft und Statistik*'s index for "Trade," includes banks, so we use this series as a comparison for our index of bank stocks from BBZ.

Figure A.3.21: Firm Leverage, Interest Expenses, and Material Expenses and Salaries.

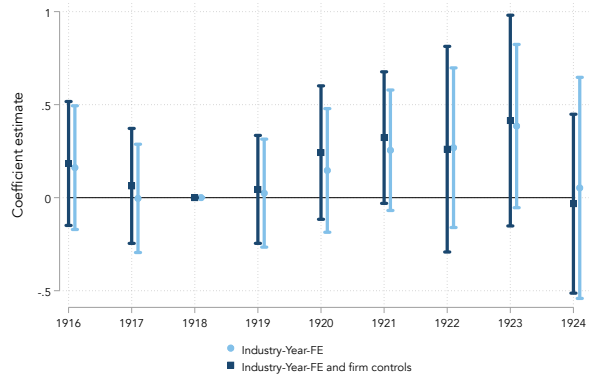
(a) Employment.



(b) Interest Expenses.



(c) Materials and Salaries.

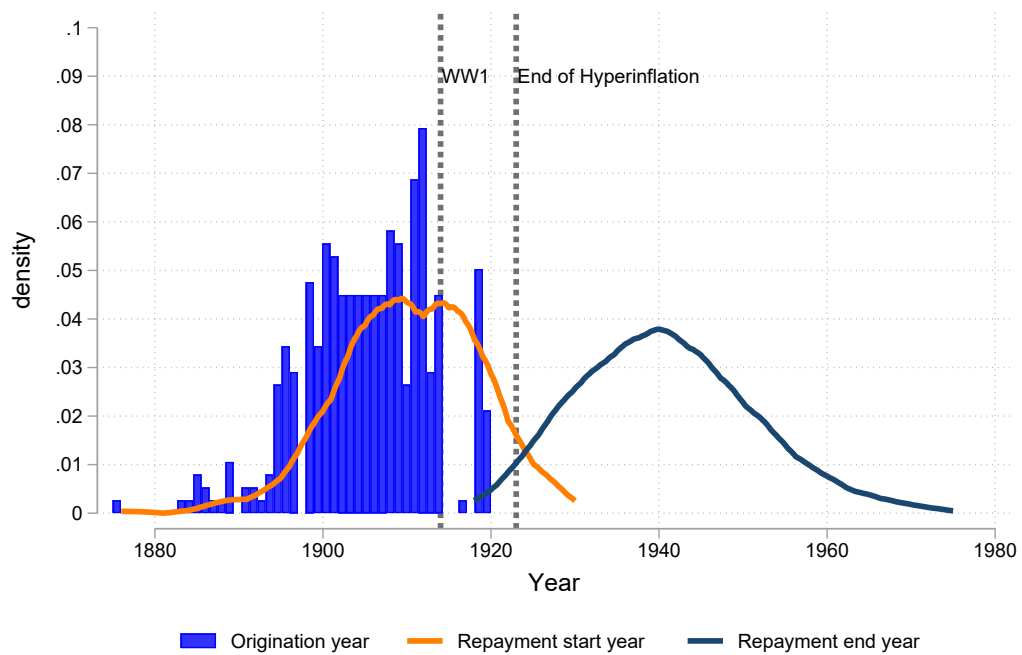


Notes: The figure plots the sequence of estimates $\{\beta_k\}$ from estimating the following model:

$$y_{it} = \alpha_i + \gamma_{st} + \sum_{k \neq 1918} \beta_k Debt/Assets_{i,1918-1919} \mathbf{1}_{k=t} + \sum_{k \neq 1918} X_i \Gamma_k \mathbf{1}_{k=t} + \epsilon_{it},$$

where y_{it} is either the ratio of interest expenses to total expenses (panel (a)) or the ratio of materials and salary expenses to total expenses (panel (b)). Further, α_i is a set of firm fixed effect, γ_{st} a set of industry-year fixed effects, $Debt/Assets_{i,1919}$ is firm i 's financial debt-to-assets ratio in 1919 and X_i is our set of firm-level control variables. 95% confidence bands applied.

Figure A.3.22: *The Prevalence of Long-Term Bonds: Origination Year, Repayment Start Year, and Final Maturity for Outstanding Bonds of Nonfinancial Firms in 1918 and 1919.*



Notes: This figure shows the origination year, repayment start year, and final maturity for outstanding bonds reported by non-financial firms in 1918 and 1919. Data obtained from *Saling's Börsenjahrbuch* published in 1919 and 1920. $N = 417$. 51% of firms in the sample report information on at least one bond.

Table A.3.1: Time Series Estimates of the Bankruptcy-Inflation Relation.

	(1)	(2)	(3)	(4)	(5)	(6)
Inflation	-0.28** (0.10)	-1.06*** (0.29)	-2.39** (0.82)	-4.26 (2.48)	-0.093* (0.044)	-0.43** (0.15)
Inflation ²		0.00041** (0.00015)		0.011 (0.014)		0.00015* (0.000066)
Observations	20	20	14	14	7	7
R ²	0.30	0.52	0.42	0.45	0.47	0.77
Sample	1919-1923	1919-1923	1919-July 1922	1919-July 1922	July 1922-1923	July 1922-1923
Frequency	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly	Quarterly

Notes: This table shows results from estimating the following equation:

$$\text{Bankruptcies}_t = \alpha + \beta \times \pi_t + \epsilon + t,$$

where t is quarterly, and π_t is the inflation in wholesale prices from $t - 4$ to t . Quarterly counts of firm bankruptcies are obtained from the *Vierteljahrshefte zur Statistik des Deutschen Reichs Herausgegeben vom Statistischen Reichsamte*. Inflation of wholesale prices as reported in *Zahlen zur Geldentwertung*. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A.3.2: Time Series Estimates of the "Classic" Phillips Curve.

	(1)	(2)	(3)	(4)	(5)	(6)
Unemployment	-8.16 (17.8)	75.4 (63.6)	-74.0*** (14.1)	-238.5*** (46.5)	-51.4*** (16.6)	89.0 (57.2)
Unemployment ²		-3.27 (2.39)		26.4*** (7.21)		-5.30** (2.09)
Observations	50	50	34	34	17	17
R ²	0.0044	0.042	0.46	0.62	0.39	0.58
Sample	1919-1923	1919-1923	1919-July 1922	1919-July 1922	July 1922-1923	July 1922-1923
Frequency	Monthly	Monthly	Monthly	Monthly	Monthly	Monthly

Notes: This table shows results from estimating the following equation:

$$\pi_{t+12} = \alpha + \beta \times \text{Unemployment}_t + \epsilon + t,$$

where t is monthly, and π_{t+12} is the inflation in wholesale prices from t to $t + 12$. Inflation of wholesale prices as reported in *Zahlen zur Geldentwertung*. Monthly unemployment rate in the German industries as reported in the *Reichsarbeitsblatt*. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A.3.3: Correlates of Firm Leverage.

	Leverage _{<i>i</i>,1918–1919}					
	(1)	(2)	(3)	(4)	(5)	(6)
ln(Total Assets) _{<i>i</i>,1918–1919}	0.061*** (0.0049)					0.065*** (0.0059)
Fixed Assets/Total Assets _{<i>i</i>,1918–1919}		-0.15*** (0.030)				-0.068* (0.036)
EBIT margin _{<i>i</i>,1918–1919}			0.090*** (0.031)			-0.011 (0.031)
ROA _{<i>i</i>,1918–1919}				-0.033 (0.12)		-0.069 (0.11)
Observations	795	795	755	740	794	725
R ²	0.18	0.041	0.013	0.00011	0.12	0.31
Industry Fixed Effects					✓	✓

Notes: This table shows results from estimating the following equation:

$$\text{Leverage}_{i,1918-1919} = \alpha + \beta \times X_{i,1918-1919} + \epsilon_i,$$

where $\text{Leverage}_{i,1918-1919}$ is defined as average liabilities to assets over 1918-1919 and $X_{i,1918-1919}$ is a firm level variable. Robust standard errors in parentheses. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A.3.4: Firm Leverage and Employment—Robustness to Different Measures of Leverage.

Dependent Variable	ln(Employment)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Liabilities/Assets _{<i>i</i>,1918} × 1 _{<i>t</i>≥1920}	36.8** (14.3)	24.9* (15.1)						
Debt/Assets _{<i>i</i>,1918} × 1 _{<i>t</i>≥1920}			35.2** (15.7)	29.5* (16.4)				
Liabilities/Assets _{<i>i</i>,1919} × 1 _{<i>t</i>≥1920}					41.8*** (14.8)	37.4** (15.2)		
Debt/Assets _{<i>i</i>,1919} × 1 _{<i>t</i>≥1920}							42.9*** (14.7)	41.6*** (14.8)
Observations	1785	1742	1785	1742	1865	1817	1865	1817
Number of Firms	331	326	331	326	345	339	345	339
<i>R</i> ²	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Year FE	✓		✓		✓		✓	
Firm FE	✓	✓	✓	✓	✓	✓	✓	✓
Industry-Year-FE		✓		✓		✓		✓

Notes: This table reports results from a model estimating:

$$y_{it} = \alpha_i + \delta_{st} + \beta \times (\text{Leverage}_{i,1919} \times \mathbf{1}_{t \geq 1920}) + \Gamma \times (X_i \times \mathbf{1}_{t \geq 1920}) + \epsilon_{it}.$$

where y_{it} is firm i 's number of employees (in logs, multiplied by 100). $\text{Leverage}_{i,t}$ is either the ratio of firm i 's financial debt or total liabilities to total assets in year t . α_i is a set of firm fixed effects, δ_{st} is a set of industry-time fixed effects, and X_i is a vector of firm-level controls consisting of firm size (log of assets), the share of fixed assets in total assets, return on assets, and profit margin. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.

Table A.3.5: Firm Leverage and Employment—Robustness to Credit Supply Controls.

Dependent Variable	ln(Employment)							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Liabilities/Assets $_{i,1918-1919} \times \mathbf{1}_{t \geq 1920}$	44.8*** (15.8)	51.8** (20.9)	40.2** (20.2)	46.6** (19.8)				
Debt/Assets $_{i,1918-1919} \times \mathbf{1}_{t \geq 1920}$					42.5*** (16.2)	47.5** (21.0)	35.7* (19.9)	42.2** (19.5)
Distance to Berlin $\times \mathbf{1}_{t \geq 1920}$			-0.0057 (0.013)				-0.0057 (0.013)	
Observations	1920	1734	1719	1719	1920	1734	1719	1719
Number of Firms	358	323	321	321	358	323	321	321
R ²	0.97	0.97	0.97	0.97	0.97	0.97	0.97	0.97
Year FE	✓				✓			
Firm FE	✓	✓	✓	✓	✓	✓	✓	✓
Industry-Year-FE		✓	✓	✓		✓	✓	✓
Baseline Controls $\times \mathbf{1}_{t \geq 1920}$		✓	✓	✓		✓	✓	✓
Large Banks-Time FE		✓				✓		
Quintiles of Dist. to Berlin-Time FE				✓				✓

Notes: This table is similar to Table 2 but adds additional controls for proxies of credit supply. Columns 1 and 5 correspond to columns 1 and 4 in Table 2. Columns 2 and 6 (“Large Banks-Time FE”) adds separate indicator variables for whether a firm has a connection to one of seven major banks (Commerz- und Privat-Bank, Darmstädter Bank, Deutsche Bank, Deutsche Nationalbank, Disconto-Gesellschaft, Dresdner Bank, and Berlin Handels-Gesellschaft). We also include an indicator variable for firms with a connection to a bank that is not one of the major banks and an indicator for firms without any banking connections (nine bank-time FE in total). Columns 3 and 7 control for the distance to Berlin (in kilometers). Columns 4 and 8 control for five dummy variables for quintiles of distance to Berlin. The baseline controls are firm size (log of assets), the share of fixed assets in total assets, return on assets, and profit margin. All controls are interacted with the post-1920 fixed effect. *, **, and *** indicate significance at the 10%, 5%, and 1% level, respectively.