Who Absorbs the Debt-Deflation Channel? Empirical Evidence from Historical Balance Sheets during the 1920s Swiss Deflation

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Abstract

We test Fisher (1933)'s debt-deflation theory using novel data on historical balance sheets. Exploiting the sharp price decreases in Switzerland in 1921 and 1922, we do not find a statistically significant difference in cash holdings, inventory, equity or profits between low- and high-leverage non-financial firms based on their initial debt ratio at the onset of deflation. In contrast, we find heterogenous results for financial firms. During the deflationary years of 1921 and 1922, profits as a share of assets of high-leverage banks fell by 0.7 to 1.8 percentage points respectively compared to low-leverage banks, with especially pronounced declines for non-state backed banks. The equity-to-asset ratio of banks deteriorated by 5.5 to 6.2 percentage points. As a potential countermeasure, issued loans as a share of assets increased by 2.2 percentage points in 1922. While firm bankruptcies indicate adverse effects of deflation on economic activity at the aggregate-level, our findings at the firm-level suggest that banks at least partially sheltered the real economy through an absorption of the price shock, though at the cost of increased balance sheet risks. As a policy implication, our results highlight the importance to stabilize banking systems during deflationary periods.

JEL-Classification: E31, M41, N14 | *Keywords:* firms, deflation, leverage

*Note: This manuscript is an early-stage, first draft.

1 Introduction

Fisher (1933) argues that deflation increases the real burden of nominal debt and thus financial stress of leveraged non-financial firms. As deflation progresses, liabilities grow which erodes net worth and may force firms to liquidate assets to service their debts. An economic downward spiral may follow as firms struggle to maintain solvency and avoid bankruptcy which may impact aggregate demand and thus real economic activity. The effect of such a deflationary shock on banks remains ambigous, however, as an increase of the real value of assets may be counteracted by higher non-performing loan ratios. While the debt-deflation theory has been instrumental in financial economic theory (Ruoss, 1992; Shiller, 2013), empirical evidence on its mechanisms remains rather limited.

Recent work by Brunnermeier et al. (2024) examines the transmission of unexpected inflation to real economic activity through financial frictions, which amends theoretical work by (Gomes et al., 2016). In the context of Germany's price increases between 1919 to 1923, the authors find that the impact of inflation was at least partially transmitted to the real economy through a debt-inflation channel.

Regarding the debt-deflation channel, Giroud and Mueller (2017) argues that monetary effects may have been impacted firms through rigidities in their balance sheets during the Great Recession, although empirical findings remain inconclusive. We examine firms' financial performance during the Swiss deflationary period in the early-1920s which was stronger to comparable settings by a magnitude. Between 1920 and 1922 alone, the aggregate price level fell by nearly 40 percent. The deflation coincided with a pronounced spike in unemployment, a rapid decline of the GDP and a marked increase in firm bankruptcies. Its monetary, fiscal and macroeconomic effects were drastic (Baltensperger, 2012; Baltensperger and Schaltegger, 2023; Ruoss, 1992).

Following the high inflation of the First World War, the Swiss National Bank (SNB) decreased the money supply, initiated measures to limit currency volatility and implemented policies to reduce the excessive capital flows. Aiming to reinforce the credibility of the Swiss franc in alignment with the gold standard, these policies were not only restrictive in nature, but constrasted sharply with monetary policies of Germany and Austria, among others at that time (Lopez and Mitchener, 2021; Ruoss, 1992; Schneebeli, 1932). Simultaneously, Swiss Federal Councillor Jean-Marie Musy implemented strict austerity measures to repay debt incurred during the war years, which further fuelled deflationary dynamics especially in 1921 and 1922. As both the SNB and the Swiss government announced their intentions in advance, the deflation was likely expected. We argue that such predictability of deflation provides a distinct setting for examining its impacts on bank-firm relationships, as institutions may have had time to adjust their behaviour.

Financial institutions play a crucial role for the transmission of deflationary dynamics to the real economy, as described by Bernanke (1995). Banks whose assets are primarily composed of nominal claims face mounting defaults and declining asset values, which undermines their capital base. High-leverage banks, in particular, are more vulnerable due to their greater reliance on borrowed funds relative to equity. The reduced capacity to absorb losses leaves these banks exposed to higher risks of profitability declines, and funding crises, which undermines their ability to lend. High-leverage banks may tighten their lending standards more sharply than low-leverage banks. These dynamics exacerbate credit contractions, further restricting firms' access to financing for operations or expansion, and deepen the economic downturn.

For non-financial firms, real debt burdens adversely affect financial conditions. While low-leverage firms may increase their holdings of cash or cash equivalents to capitalize on the increased purchasing power of cash in a deflationary environment, high-leverage firms might be forced to sell tangible assets to meet debt obligations. In turn, high-leverage firms may exhibit greater financial losses and thus increased risks of bankruptcy compared to low-leverage firms, as the increased real debt burden erodes financial stability.

While macroeconomic data suggest that the deflationary period had adverse effects at the aggregate level, we find no statistically significant different impact of deflation on non-financial firms based on their leverage ratio at the onset of deflation. However, we empirically show that banks with higher debt-to-asset ratios at the onset of deflation experienced lower profitability during the deflationary period compared to banks with lower leverage. Issued loans increased in the first year of deflation, however, which potentially reflects increasing financial needs by firms and households. Overall, our results highlight the heterogenous effects of the debt-deflation channel by a firm's sector and indebtness which supports adequate policy responses.

The remainder of the paper is organized as follows. Section 2 presents some historical background and descriptive statistics. Section 3 outlines the dataset and explains how we arrived at the structure used for our analyses, while section 4 discusses our empirical approach. Results are discussed in section 5. The paper concludes with section 6.

2 Historical background and descriptive statistics

The years following the First World War were marked by significant socio-political upheavals and economic turmoil in Switzerland which sat the stage for a period of prolonged deflation. In November 1918, the *Landesstreik*, a nationwide strike involving 250,000 workers, erupted due to grievances over rising inflation, low wages, supply shortages, and the Spanish flu's impact on both health and economic activity. The demands for a 48-hour workweek, pension reforms,

and women's suffrage highlighted deep social unrest. While some of the demands were later met, the Swiss Federal Council at first responded by mobilizing the army to end the strike by force, which left a polarized political landscape as a result.

Amid this political unrest, Switzerland's economy faced substantial challenges, too. Post-war financial instability in Europe led to fluctuations in foreign currencies and a sell-off of Swiss securities in 1919 which reflected a widespread loss of confidence. An overestimated post-war economic boom turned into a bust which caused a sharp decline in stock prices by 1920. The situation worsened in 1921 with a proposed one-off wealth levy, which drove capital out of the country and led to panic in financial markets. To stabilize the situation, major banks formed a consortium at the end of 1921 to support industrial stock prices.

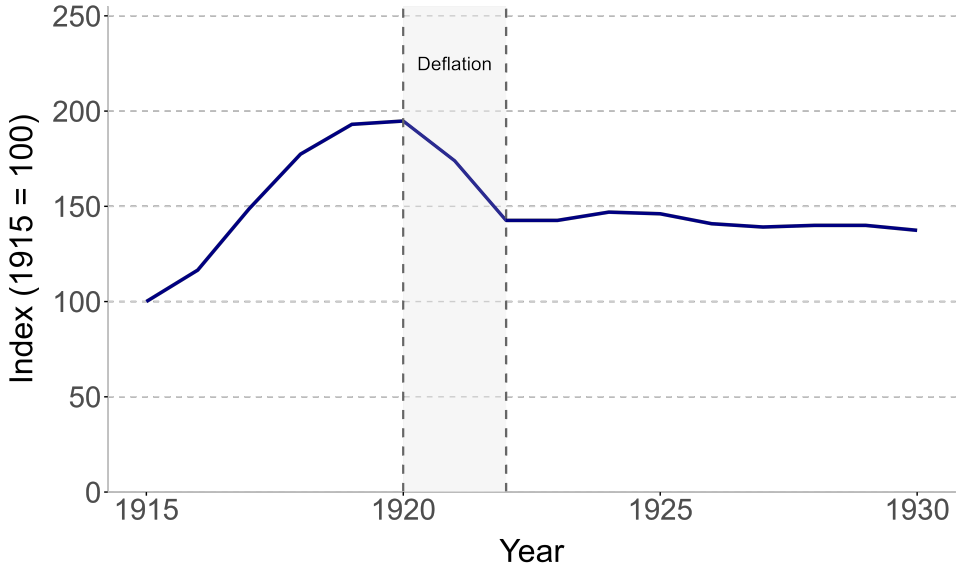
During the early 1920s, the SNB intended to support a return to the gold standard, a goal which was stated publicly at two international conferences in Brussels in 1920 and Genoa in 1922. In 1924, the Swiss franc reached pre-war parity again, setting Switzerland apart as one of the first European countries to do so after the turmoil of the war (Bordo and James, 2007; Crettol and Halbeisen, 1999). At the same time, Federal Councillor Jean-Marie Musy as sitting Minister of Finance from 1920 until 1935 implemented austerity measures to repay debt that was incurred during the First World War. These austerity measures where deemed necessary because Switzerland still incurred non-negligible amounts of debt although it did not participate on either coalition in the war. A substantial increase in expenditure on national defense and, towards the end and after the war, on social programs to ease and stabilize the heated political situation following a surge in both socialist and nationalist sentiments had led to a mounting debt pile (Guex, 2012).

Governance concerns between non-financial and financial firms were present at the early-20th century, too, as the Swiss corporate sector at the time had a cohesive unitary elite (Rossier et al., 2022). Personal relations between members of the corporate leadership in the industrial sector and in the banking sector were wide-spread. In some cases, members of the corporate elite were even directly members of the boards of banks, and vice versa. Overall, entrepreneurs from industry, finance and trade as well as their most important associations such as the Swiss Bankers Association, the Federal Council and the higher government administration, the leaders of the centre-right parties and the Governing Board of the Swiss National Bank had established a deep network of interdependencies (Guex, 2012).

Against this institutional and macroeconomic setting, Figure 1 shows the annual development of the Swiss consumer price index from 1915 to 1930. With the outbreak of the First World War, the gold standard was suspended, and bank notes became legal tender in Switzerland. The confederation resorted to loans from the central bank to cover the costs of national defense and the SNB greatly expanded its loans to the economy. In nominal terms, the confederation's debt

increased ten-fold between 1914 and 1918, or a five-fold increase in real terms (Halbeisen and Straumann, 2012).

Figure 1: Swiss consumer price index, 1915 to 1930 (1915 = 100)



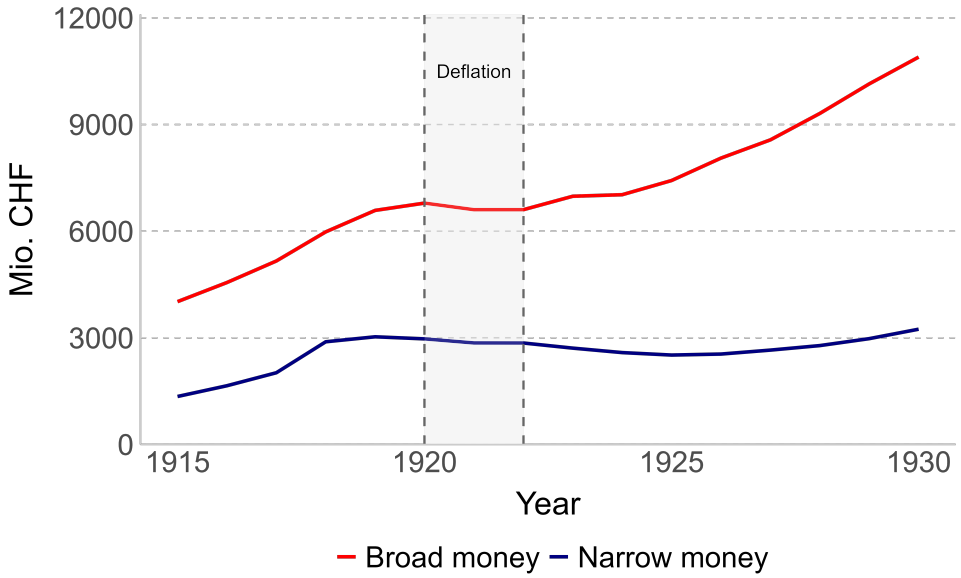
Data source: Jordà et al. (2017)

These dynamics also led to a doubling of the amount of outstanding banknotes, as shown in Figure 2. As a consequence, the price level almost doubled between 1915 and the end of the First World War. Nominal wages did not keep up with prices, which led to social tensions and increased criticism of the SNB's monetary policy stance (Jordan and Rossi, 2010; Straumann, 2015). Critics blamed the SNB for the expansion of the money supply and thus for the inflation of the war years (Bordo and James, 2007).

Restrictive fiscal and monetary policies implemented to stabilize the economy and return the Swiss franc to pre-war parity were announced by the SNB, for example at an international conference in Brussels in 1920 (Ruoss, 1992; Schneebeli, 1932). A sharp decline of the consumer price index followed, falling from 195 index points in 1920 to 143 in 1922. As the gold standard was often seen as an indispensable prerequisite for growth and prosperity, political parties and associations were confident that monetary policy should aim to restore convertibility and revalue the Swiss franc to the pre-war parity level. The main differences were thus not on the question if but rather how quickly the Swiss franc should reach pre-war parity again. Political support even remained intact during the deflationary period, when the real exchange rate of the Swiss franc increased sharply. Post-war deflation often seen as a natural consequence of war-related inflation (Bordo and James, 2007; Halbeisen and Straumann, 2012).

At the same time, the post-war monetary tightening in Switzerland aligned with the debt-deflation mechanism outlined by Lin et al. (2015). Their model shows that once central

Figure 2: Swiss narrow and broad money, 1915 to 1930



Data source: Jordà et al. (2017)

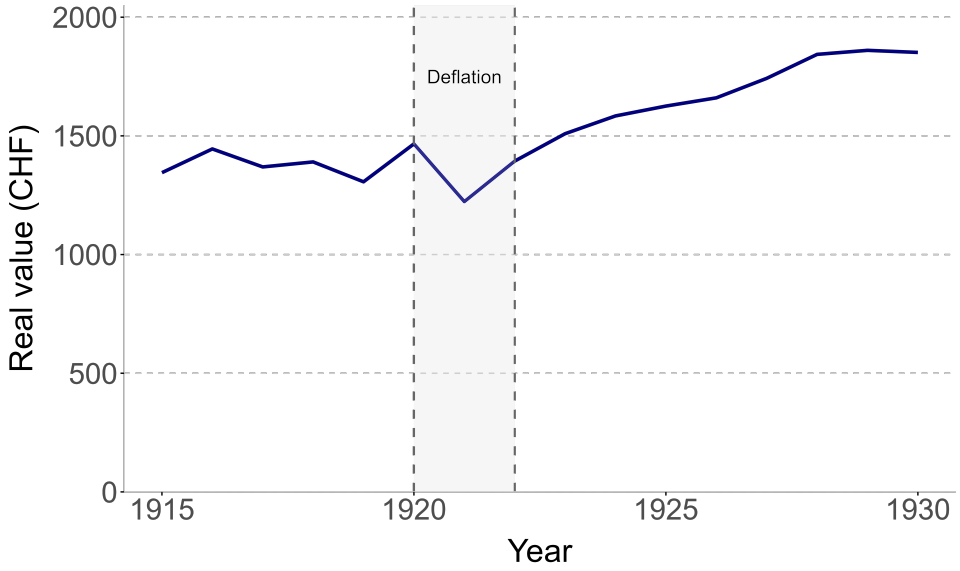
banks reduce the money supply, the real burden of nominal debt can rise abruptly, which leads to defaults and inefficiencies in production. This is also in line with more general evidence which highlight that firms clearly react to monetary policy changes (Durante et al., 2022; Gertler and Gilchrist, 1994; Ottonello and Winberry, 2020). Although Switzerland's deflationary policies sought to restore pre-war monetary stability, the contraction in liquidity likely added to firms' vulnerabilities by increasing the real value of their debts. After the fast decline in the price level, it stabilized with only moderate fluctuations in the following years.

Such monetary shocks may lead to output fluctuations as shown by (Cordoba and Ripoll, 2004). Likewise, economic models with binding collateral constraints predict how sudden declines in asset prices or deflationary shocks can amplify real debt burdens and trigger large output drops (Mendoza, 2010). Similarly, Eichengreen and Grossman (1997) show that periods of deflation can coincide with heightened banking instability, as falling prices increase the real burden of debt and erode borrower collateral.

In Switzerland's post–First World War setting, the combination of heavy debts and strained financial institutions likely reinforced the contraction in economic activity. Accordingly, the Swiss deflation caused a sharp decline in production and considerable unemployment (Ruoss, 1992). Figure 3 illustrates Swiss real GDP per capita from 1915 to 1930. From 1920 to 1921, the first deflation year, GDP per capita fell by over 15 percent. GDP per capita already partially recovered by 1922 with an increase of around 14 percent.

This unfavorable economic development was reflected in a rise in the unemployment rate in 1921, followed by a smaller increase in 1922 (see Figure 4). The rise in unemployment was

Figure 3: Swiss real consumer price index-deflated GDP per capita, 1915 to 1930, base year 1915

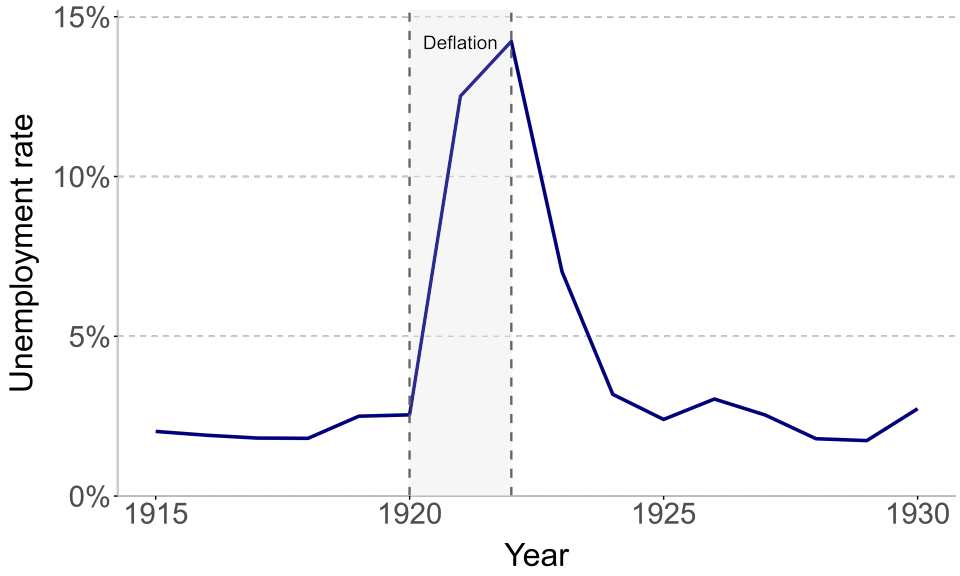


Data source: Jordà et al. (2017)

driven by export-dependent industries, particularly watches, metals and machinery, and textiles (Baltensperger, 2012; Ruoss, 1992). Nearly all foreign trade was based on compensation deals and export credits during the First World War. Although the Entente severely restricted imports into the country, Switzerland was still able to import the most important raw materials and food. Nevertheless, international transportation routes became increasingly insecure in the later stages of the war (Halbeisen and Straumann, 2012). After the war, foreign trade initially nearly bounced back to pre-war levels, but international trade almost immediately ran into new difficulties due to deflation, as illustrated by Figure 5.

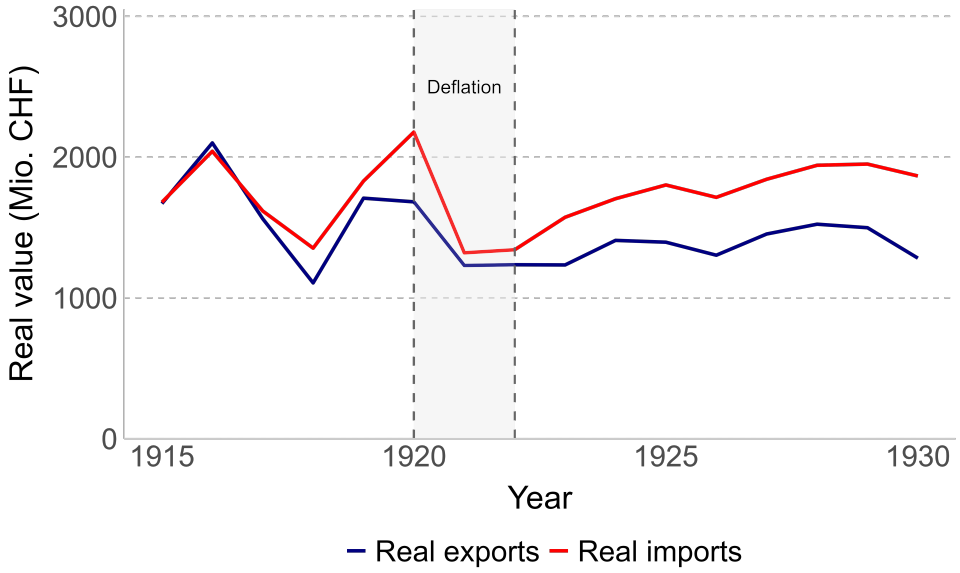
As deflation and deflation expectations lead to an increase in the real value of debt, it should translate to financial distress and higher firm bankruptcies for leveraged firms (Bhamra et al., 2011; DeLong and Sims, 1999; Fisher, 1933). Figure 6 shows the Swiss consumer rpice index and the bankruptcies of companies registered in the commercial register as a share of all registered firms. During the First World War, bankruptcies were particularly high. After the war, they initially declined again. As prices fell sharply from 1921 to 1922, bankruptcies increased again, however, from around 1.5 percent to approximately 2.5 percent of all companies registered in the commercial register. The decline in bankruptcies immediately in 1923 and its stabilization at around 2 percent afterwards suggests that as deflationary pressures subsided, bankruptcies were less frequent.

Figure 4: Swiss unemployment rate 1915-1930



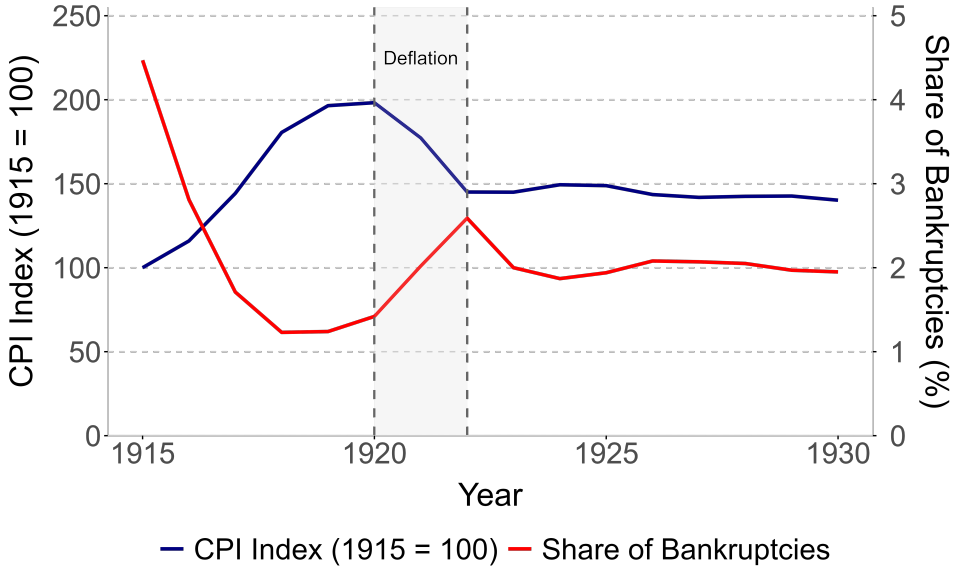
Data source: Jordà et al. (2017)

Figure 5: Swiss real consumer price index-deflated international trade, 1915 to 1930, base year 1915



Data source: Jordà et al. (2017)

Figure 6: Swiss consumer price index, 1915 to 1930, base year 1915, and share of firm bankruptcies



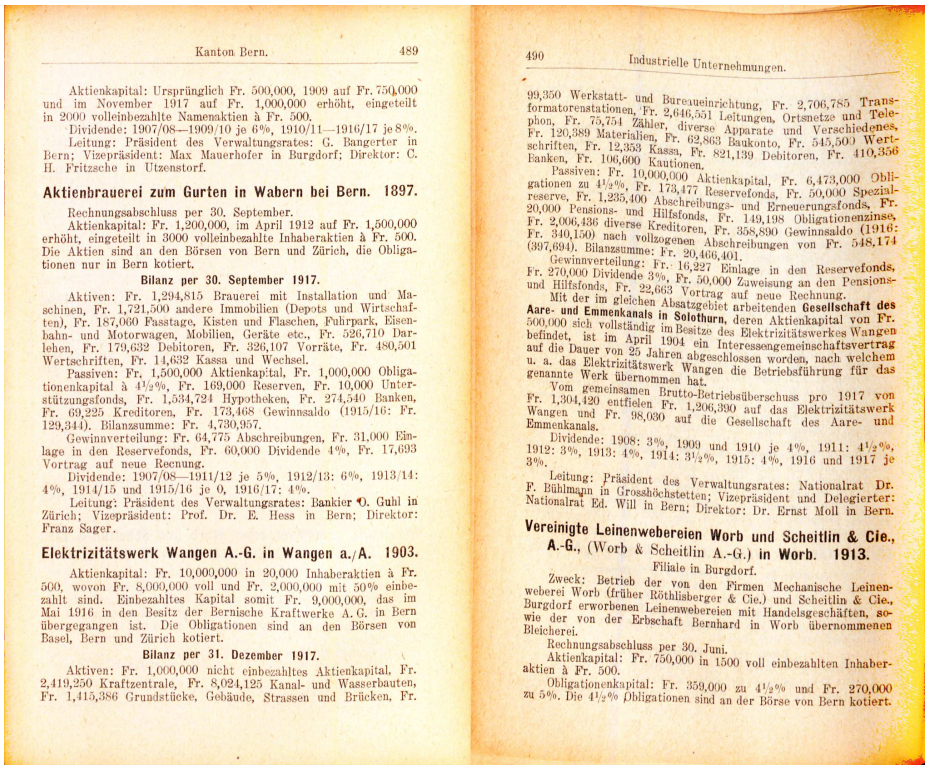
Data source: HSSO (2012a,b); Jordà et al. (2017)

3 Data

We compile novel data on balance sheet items for non-financial firms and banks as reported in editions of the *Schweizerisches Finanz-Jahrbuch*, an annual publication that provides detailed financial data (Steiger, 1918, 1919, 1920, 1921, 1922, 1923, 1924). Our sample period spans from 1917 to 1923, which corresponds to the *Schweizerisches Finanz-Jahrbuch* editions published between 1918 to 1924 and thus covers the period from the end of First World War to the end of the deflationary episode in Switzerland.

The balance sheets have been digitized from copies of the original books. We have checked entries for accuracy, and flagged instances where accounting identities failed to hold due to inaccuracies in the original reports. After an according data cleaning, 610 observations in our non-financial firm dataset and around 540 observations in our bank datasets remain. As shown in Figure 7, the balance sheet items are not consistently reported. We adopt a general financial statement structure following the International Financial Reporting Standards (IFRS). Table 1 presents the top-level structure used for non-financial firms, while a partially modified structure was applied to bank balance sheets to account for industry-specific entries. In most cases, these definitions have several sub-categories. Where applicable, we categorized balance sheet items using sub-categories within this framework.

Figure 7: Example pages of the *Schweizerisches Finanz-Jahrbuch*, 1918



Kanton Bern. 489

Aktienkapital: Ursprünglich Fr. 500,000, 1909 auf Fr. 750,000 und im November 1917 auf Fr. 1,000,000 erhöht, eingeteilt in 2000 volleinbezahlte Namenaktien à Fr. 500.
Dividende: 1907/08—1909/10 je 6%, 1910/11—1916/17 je 8%.
Leitung: Präsident des Verwaltungsrates: G. Bangerter in Bern; Vizepräsident: Max Mauerhofer in Burgdorf; Direktor: C. H. Fritzsche in Utzenstorf.

Aktienbrauerei zum Gurten in Wabern bei Bern. 1897.

Rechnungsabschluss per 30. September.
Aktienkapital: Fr. 1,200,000, im April 1912 auf Fr. 1,500,000 erhöht, eingeteilt in 3000 volleinbezahlte Inhaberaktien à Fr. 500. Die Aktien sind an den Börsen von Bern und Zürich, die Obligationen nur in Bern kotiert.

Bilanz per 30. September 1917.

Aktiven: Fr. 1,294,815 Brauerei mit Installation und Maschinen, Fr. 1,721,500 andere Immobilien (Depots und Wirtschaften), Fr. 187,060 Fasstage, Kisten und Flaschen, Fuhrpark, Eisenbahn- und Motorwagen, Mobilien, Geräte etc., Fr. 526,710 Darlehen, Fr. 179,632 Debitoren, Fr. 326,107 Vorräte, Fr. 480,501 Wertschriften, Fr. 14,632 Kassa und Wechsel.
Passiven: Fr. 1,500,000 Aktienkapital, Fr. 1,000,000 Obligationenkapital à 4½%, Fr. 169,000 Reserven, Fr. 10,000 Unterstützungsfonds, Fr. 1,534,724 Hypotheken, Fr. 274,540 Banken, Fr. 69,225 Kreditoren, Fr. 173,468 Gewinnsaldo (1915/16: Fr. 129,344). Bilanzsumme: Fr. 4,730,957.
Gewinnverteilung: Fr. 64,775 Abschreibungen, Fr. 31,000 Einlage in den Reservefonds, Fr. 60,000 Dividende 4%, Fr. 17,693 Vortrag auf neue Recnung.
Dividende: 1907/08—1911/12 je 5%, 1912/13: 6%, 1913/14: 4%, 1914/15 und 1915/16 je 0, 1916/17: 4%.
Leitung: Präsident des Verwaltungsrates: Bankier O. Guhl in Zürich; Vizepräsident: Prof. Dr. E. Hess in Bern; Direktor: Franz Sager.

Elektrizitätswerk Wangen A.-G. in Wangen a./A. 1903.

Aktienkapital: Fr. 10,000,000 in 20,000 Inhaberaktien à Fr. 500, wovon Fr. 8,000,000 voll und Fr. 2,000,000 mit 50% einbezahlt sind. Einbezahltes Kapital somit Fr. 9,000,000, das im Mai 1916 in den Besitz der Bernische Kraftwerke A.-G. in Bern übergegangen ist. Die Obligationen sind an den Börsen von Basel, Bern und Zürich kotiert.

Bilanz per 31. Dezember 1917.

Aktiven: Fr. 1,000,000 nicht einbezahltes Aktienkapital, Fr. 2,419,250 Kraftzentrale, Fr. 8,024,125 Kanal- und Wasserbauten, Fr. 1,415,386 Grundstücke, Gebäude, Strassen und Brücken, Fr.

490 Industrielle Unternehmungen.

99,350 Werkstatt- und Bureaueinrichtung, Fr. 2,706,785 Transformatorenstationen, Fr. 2,646,551 Leitungen, Ortsnetze und Telephon, Fr. 75,754 Zähler, diverse Apparate und Verschiedenes, Fr. 120,389 Materialien, Fr. 62,863 Baukonto, Fr. 545,500 Wertschriften, Fr. 12,353 Kassa, Fr. 821,139 Debitoren, Fr. 410,356 Banken, Fr. 106,600 Kautionen.
Passiven: Fr. 10,000,000 Aktienkapital, Fr. 6,473,000 Obligationen zu 4½%, Fr. 173,477 Reservefonds, Fr. 50,000 Spezialreserve, Fr. 1,235,400 Abschreibungs- und Erneuerungsfonds, Fr. 20,000 Pensions- und Hilfsfonds, Fr. 149,198 Obligationenzinse, Fr. 2,006,436 diverse Kreditoren, Fr. 358,890 Gewinnsaldo (1916: Fr. 340,150) nach vollzogenen Abschreibungen von Fr. 548,174 (397,694). Bilanzsumme: Fr. 20,466,401.
Gewinnverteilung: Fr. 16,227 Einlage in den Reservefonds, Fr. 270,000 Dividende 3%, Fr. 50,000 Zuweisung an den Pensions- und Hilfsfonds, Fr. 22,663 Vortrag auf neue Rechnung.
Mit der im gleichen Absatzgebiet arbeitenden **Gesellschaft des Aare- und Emmenkanals in Solothurn**, deren Aktienkapital von Fr. 500,000 sich vollständig im Besitze des Elektrizitätswerkes Wangen befindet, ist im April 1904 ein Interessengemeinschaftsvertrag auf die Dauer von 25 Jahren abgeschlossen worden, nach welchem u. a. das Elektrizitätswerk Wangen die Betriebsführung für das genannte Werk übernommen hat.
Vom gemeinsamen Brutto-Betriebsüberschuss pro 1917 von Fr. 1,304,420 entfielen Fr. 1,206,390 auf das Elektrizitätswerk Wangen und Fr. 98,030 auf die Gesellschaft des Aare- und Emmenkanals.
Dividende: 1908: 3%, 1909 und 1910 je 4%, 1911: 4½%, 1912: 3%, 1913: 4%, 1914: 3½%, 1915: 4%, 1916 und 1917 je 3%.
Leitung: Präsident des Verwaltungsrates: Nationalrat Dr. F. Bühlmann in Grosshöchstetten; Vizepräsident und Delegierter: Nationalrat Ed. Will in Bern; Direktor: Dr. Ernst Moll in Bern.

Vereinigte Leinenwebereien Worb und Scheitlin & Cie., A.-G., (Worb & Scheitlin A.-G.) in Worb. 1913.

Filiale in Burgdorf.

Zweck: Betrieb der von den Firmen Mechanische Leinenweberei Worb (früher Röthlisberger & Cie.) und Scheitlin & Cie., Burgdorf erworbenen Leinenwebereien mit Handelsgeschäften, sowie der von der Erbschaft Bernhard in Worb übernommenen Bleicherei.
Rechnungsabschluss per 30. Juni.
Aktienkapital: Fr. 750,000 in 1500 voll einbezahlten Inhaberaktien à Fr. 500.
Obligationenkapital: Fr. 359,000 zu 4½% und Fr. 270,000 zu 5%. Die 4½% Obligationen sind an der Börse von Bern kotiert.

Data source: Steiger (1918)

Table 1: Balance sheet structure based on International Financial Reporting Standards

Assets	**Equity**
Property, Plant, and Equipment	Total Equity attributable
Investment Property	to Owners of Parent
Goodwill	Retained Earnings
Intangible Assets	Other Reserves
Other Financial Assets	Other Equity Items
Inventories	Non-controlling Interests
Accruals and Additional Assets	**Liabilities**
Receivable and Contracts	Trade and Other Payables
Tax Assets	Provisions
Agricultural (Biological) Assets	Other Financial Liabilities
Cash and Cash Equivalents	Accruals, Deferrals and Additional Liabilities

Similiar to Brunnermeier et al. (2024), it is likely not the case that deflation was fully dealt with in firms' accounting practices, as specialised inflation accounting techniques did rarely exist at the time. Such distorted balance sheet reporting was an issue in particular during the hyperinflations in other European countries (Sweeney, 1934). In our setting with pronounced deflation, this implies that real accounting items such as fixed assets could become overvalued relative to nominal items such as cash holdings. Where applicable, we follow the approach of Brunnermeier et al. (2024) to address these issues. On the one hand, we rely on balance sheet data before the onset of deflation to categorize our firms and banks according to their leverage ratios and provide estimates up to the year after the deflation. Our analysis thus sorts firms based on their balance sheet exposure to deflation before the start of the deflation. On the other hand, we use ratios instead of absolute or logarithmic values, which at least partly mitigate the empirical issue.

We use data by Jordà et al. (2017) for macroeconomic indicators, including the consumer price index, imports and exports, GDP, monetary aggregates, public expenditures and revenues as well as the unemployment rate. Data on firm bankruptices was obtained from HSSO (2012a,b). Additionally, we collect data from HSSO (2012a,b).

4 Empirical approach

We examine the impact of deflation on several balance sheet items of leveraged non-financial firms and banks. Building on Brunnermeier et al. (2024), we use firm-level variation in debt leverage ratios and apply the following dynamic difference-in-differences model:

$$Outcome_{it,f} = \alpha_i + \sum_{y \neq 1920} \beta_y \text{Leverage}_{i,k} 1_{y=t} + \varepsilon_{it} \quad (1)$$

where $Outcome_{it}$ are f = 1, ..., 8 outcome variables of firm i in year t = 1917, ..., 1923. For non-financial firms, these include cash and cash equivalents, inventory as tangible assets, profits and equity as a share of total assets. For banks, we use the financial assets excluding loans issued as well as loans issued, profits and equity as a share of total assets as outcome variables.

$Leverage_{i,k}$ are k = 1,2 measures to assess a firm's potential exposure to deflation through their leverage. The first indicator is a continuous variable representing the leverage ratio of a firm in the year 1920, the year before the deflation. We define the leverage ratio as total liabilities relative to total assets, encompassing all financial and non-financial items including but not limited to debt, bonds, provisions, and accruals. The second indicator is a dummy variable which takes the value 1 if the leverage ratio of a firm in the year 1920 is above the average leverage ratio of all firms, and 0 otherwise. Using the leverage ratio as an indicator for exposure to deflation is based on the hypothesis that firms with higher leverage face an increase in the real value of nominal debt contracts, thereby increasing the financial burden they face as compared to firms with lower leverage. Moreover, the distinguishment is relevant as leverage ratios can vary substantially, even within the same industry (Myers, 1984).

α_i are firm-fixed effects. Standard errors are clustered at the firm-level.

5 Results

Overall, we find no statistically significant differences in financial performance between low- and high-leverage firms in response to deflationary pressures. In contrast, financial institutions exhibit heterogenous effects of deflation depending on their initial leverage ratios

5.1 Effects of deflation on non-financial firms

Table 2 presents the results from the baseline difference-in-differences model on cash and cash equivalents, inventories held by firms, and the profitability of non-financial firms. None of the estimators indicate a statistically significantly different impact of deflation on balance sheet items between low- and high-leverage firms during the deflationary period after 1919. Overall, our empirical findings suggest that the leverage ratio of non-financial firms at the onset of the deflation did not affect financial performance as a share of total assets.

Table 2: Non-financial firms, difference-in-differences by year and indicator

	cash and cash equivalents		*inventory*		*profits*		*equity*	
	dummy	ratio	dummy	ratio	dummy	ratio	dummy	ratio
leverage × year = 1917	−0.025	−0.069	0.042	0.071	0.011	0.020	0.064**	0.194**
	(0.023)	(0.053)	(0.023)	(0.056)	(0.013)	(0.039)	(0.025)	(0.083)
leverage × year = 1918	−0.031	−0.050	0.038	0.048	0.012	0.014	0.055***	0.167***
	(0.022)	(0.052)	(0.024)	(0.061)	(0.013)	(0.042)	(0.020)	(0.054)
leverage × year = 1919	−0.010	−0.035	0.020	0.045	0.004	−0.011	0.013	0.063
	(0.013)	(0.031)	(0.020)	(0.052)	(0.009)	(0.024)	(0.016)	(0.045)
leverage × year = 1921	−0.014	−0.003	−0.009	−0.013	0.018	0.024	−0.006	−0.041
	(0.013)	(0.031)	(0.022)	(0.036)	(0.012)	(0.038)	(0.015)	(0.031)
leverage × year = 1922	−0.029	−0.004	0.018	0.050	0.018	0.037	0.009	0.012
	(0.019)	(0.047)	(0.019)	(0.046)	(0.015)	(0.037)	(0.018)	(0.038)
leverage × year = 1923	−0.010	0.009	0.035	0.073	−0.001	0.004	0.037	0.078
	(0.016)	(0.043)	(0.022)	(0.050)	(0.017)	(0.039)	(0.022)	(0.053)
Observations	550	550	480	480	568	568	586	586
Adjusted R^2	0.737	0.741	0.878	0.877	0.503	0.501	0.854	0.857

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Standard errors clustered at the firm-level are in parentheses.

All estimates are relative to the reference year 1920.

5.2 Effects of deflation on banks

Profits of high-leverage banks declined during the deflationary period of 1921 and 1922 compared to their low-leverage counterparts by 0.7 to 1.8 percentage points relative to assets, respectively (see Table 3). Once we distinguish by the type of institution, we observe that the dynamic is driven by non-state-backed banks whose decline is more pronounced and statistically significant at the one percent level. On average, high-leverage non-state-owned banks had a 1.3 to 3 percentage points lower profit relative to assets compared to low-leverage counterparts.

Table 3: Banks, difference-in-differences for profits by year and indicator

	all banks		*cantonal banks*		*all banks w/o cantonal banks*	
	dummy	ratio	dummy	ratio	dummy	ratio
leverage × year = 1917	0.003	0.000	0.000	0.009	0.002	−0.003
	(0.003)	(0.006)	(0.001)	(0.013)	(0.005)	(0.007)
leverage × year = 1918	0.002	−0.018	0.000	0.007	−0.001	−0.024
	(0.004)	(0.013)	(0.001)	(0.008)	(0.006)	(0.015)
leverage × year = 1919	−0.004	−0.041	−0.001	0.001	−0.008	−0.046
	(0.006)	(0.030)	(0.001)	(0.008)	(0.009)	(0.032)
leverage × year = 1921	−0.007**	−0.016	0.000	−0.002	−0.013***	−0.015
	(0.003)	(0.010)	(0.001)	(0.011)	(0.005)	(0.010)
leverage × year = 1922	−0.018**	−0.051*	0.000	0.002	−0.030***	−0.045
	(0.008)	(0.030)	(0.001)	(0.013)	(0.011)	(0.032)
leverage × year = 1923	−0.018	−0.050	0.000	0.015	−0.028	−0.046
	(0.013)	(0.036)	(0.001)	(0.014)	(0.017)	(0.036)
Observations	291	291	77	77	214	214
Adjusted R^2	0.587	0.593	0.836	0.837	0.584	0.574

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Standard errors clustered at the firm level are in parentheses.

All estimates are relative to the reference year 1920.

The equity held by banks remained virtually unchanged for high-leverage banks from 1917 to 1923, while low-leverage banks tended to increase their equity in the years 1920 to 1922 (see Figure A.15). In general, the equity ratio of high-leverage banks remained consistently substantially below the equity ratio of low-leverage banks. Our empirical findings suggest that in the years 1921 and 1922 high-leverage banks experienced a more pronounced deterioration of their equity-to-asset ratio compared to low-leverage banks (see Table 4). This result is not statistically significant once we distinguish between cantonal banks and all other financial institutions.

Further empirical findings show that high-leverage banks have statistically significantly issued more loans in the year 1921 relative to total assets compared to low-leverage banks (see Table 5). This finding may suggest that banks have reacted to their declining profits through an increase in assets, though at the cost of a higher risk on their balance sheet. We do not find a statistically different behaviour between state-backed cantonal banks and non-cantonal banks during the deflationary period. Only at the end of the deflation in the year 1923, cantonal

Table 4: Banks, difference-in-differences for issued equity by year and indicator

	all banks		*cantonal banks*		*all banks w/o cantonal banks*	
	dummy	ratio	dummy	ratio	dummy	ratio
leverage × year = 1917	0.026*	0.063	−0.005	−0.055	0.017	0.047
	(0.015)	(0.049)	(0.012)	(0.067)	(0.019)	(0.047)
leverage × year = 1918	0.025*	0.066*	−0.003	−0.039	0.010	0.047
	(0.013)	(0.040)	(0.006)	(0.032)	(0.014)	(0.037)
leverage × year = 1919	0.013	0.040	−0.003	−0.019	0.002	0.024
	(0.012)	(0.032)	(0.006)	(0.025)	(0.011)	(0.031)
leverage × year = 1921	−0.055*	−0.091	0.006	0.073	−0.008	−0.041
	(0.029)	(0.075)	(0.006)	(0.044)	(0.040)	(0.065)
leverage × year = 1922	−0.062**	−0.126	−0.006	−0.166	−0.037	−0.105
	(0.030)	(0.090)	(0.015)	(0.260)	(0.043)	(0.098)
leverage × year = 1923	−0.029	−0.092	−0.006	−0.224	−0.034	−0.098
	(0.023)	(0.082)	(0.018)	(0.297)	(0.032)	(0.091)
Observations	483	483	162	162	321	321
Adjusted R^2	0.921	0.919	0.852	0.864	0.912	0.913

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Standard errors clustered at the firm level are in parentheses.

All estimates are relative to the reference year 1920.

banks reversed the trend: high-leverage state-owned banks experienced a stronger decline in the proportion of loans issued relative to total assets. We note that loans issued often have multi-year maturities and cannot be adjusted without temporal frictions on an annual basis. A delayed reaction to deflation could therefore be plausible, particularly if deflationary effects persist over multiple years.

Table 5: Banks, difference-in-differences for issued loans by year and indicator

	all banks		*cantonal banks*		*all banks w/o cantonal banks*	
	dummy	ratio	dummy	ratio	dummy	ratio
leverage × year = 1917	0.028	0.145	0.035	0.346	0.056	0.196
	(0.038)	(0.099)	(0.029)	(0.234)	(0.040)	(0.118)
leverage × year = 1918	−0.006	−0.042	0.025	0.082	0.043	0.040
	(0.036)	(0.102)	(0.024)	(0.221)	(0.042)	(0.129)
leverage × year = 1919	−0.001	0.013	0.008	0.116	0.042	0.066
	(0.040)	(0.092)	(0.018)	(0.205)	(0.042)	(0.093)
leverage × year = 1921	0.022**	0.102*	0.003	0.199	−0.007	0.037
	(0.011)	(0.056)	(0.018)	(0.152)	(0.014)	(0.064)
leverage × year = 1922	0.017	0.108	−0.025	0.150	0.010	0.072
	(0.017)	(0.074)	(0.029)	(0.244)	(0.021)	(0.076)
leverage × year = 1923	−0.007	0.001	−0.053**	−0.214	−0.026	0.018
	(0.021)	(0.095)	(0.020)	(0.148)	(0.034)	(0.117)
Observations	379	379	162	162	217	217
Adjusted R^2	0.960	0.960	0.956	0.953	0.960	0.959

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Standard errors clustered at the firm level are in parentheses.

All estimates are relative to the reference year 1920.

Finally, Table 6 presents the empirical results regarding banks' other financial asset values excluding issued loans. We do not find a statistically significant effect of deflation on financial assets excluding loans. A heterogeneity analysis reveals that this holds true for cantonal as well as commercial banks. We note that such financial asset values fluctuated substantially between 1917 and 1923 for both high- and low-leverage banks (Figure A.12). Especially during the deflationary period, financial asset values increased sharply in 1921 before declining again in 1922, with a divergent trend emerging in 1923.

Table 6: Banks, difference-in-differences for financial assets excluding loans issued by year and indicator

	all banks		*cantonal banks*		*all banks w/o cantonal banks*	
	dummy	ratio	dummy	ratio	dummy	ratio
leverage × year = 1917	−0.054	−0.039	−0.051*	−0.392	−0.094*	−0.055
	(0.035)	(0.120)	(0.028)	(0.273)	(0.054)	(0.145)
leverage × year = 1918	−0.028	−0.010	−0.028	−0.169	−0.068	−0.046
	(0.027)	(0.062)	(0.025)	(0.238)	(0.042)	(0.087)
leverage × year = 1919	−0.007	−0.014	−0.016	−0.204	−0.048	−0.039
	(0.025)	(0.042)	(0.021)	(0.196)	(0.039)	(0.063)
leverage × year = 1921	0.016	−0.014	0.016	0.013	−0.003	−0.040
	(0.015)	(0.034)	(0.020)	(0.171)	(0.020)	(0.035)
leverage × year = 1922	0.018	0.017	0.031	0.011	0.004	−0.018
	(0.023)	(0.065)	(0.032)	(0.302)	(0.030)	(0.068)
leverage × year = 1923	0.000	0.015	0.028	0.224	−0.031	−0.075
	(0.027)	(0.080)	(0.024)	(0.181)	(0.038)	(0.087)
Observations	467	467	162	162	305	305
Adjusted R^2	0.930	0.928	0.916	0.913	0.913	0.910

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Standard errors clustered at the firm level are in parentheses.

All estimates are relative to the reference year 1920.

6 Conclusion

We examine the impact of deflation on Swiss non-financial firms and banks through the debt-deflation channel by Fisher (1933); King (1994) during the post-First World War period. Our findings suggest that while macroeconomic indicators and firm bankruptcy rates reflect the adverse economic effects of the deflationary years of 1921 and 1922, we do not find empirical evidence that non-financial firms' leverage ratios at the onset of deflation influenced their balance sheet items financial performance.

We find heterogenous effects for banks, however. Issued loans as a share of assets of high-leverage banks increased by 2.2 percentage points in 1922 compared to their low-leverage counterparts. By providing liquidity during this period, banks may have mitigated the immediate effects of deflation on firms, particularly those with high leverage. This intermediary role may have came at a cost, though. In 1921 and 1922, profits as a share of assets of high-leverage banks fell by 0.7 to 1.8 percentage points respectively compared to low-leverage

banks, with especially pronounced declines for non-state backed banks. The equity-to-asset ratio of banks deteriorated by 5.5 to 6.2 percentage points.

Overall, highly-leveraged banks may have acted as effect intermediaries and absorbed part of the economic shock during the deflationary period. Such banks may have helped stabilize firms' access to credit, while their own financial fragility increased under the deflationary pressures. The observed behavior highlights a trade-off: while banks may shelter the non-financial sector at least partially from the adverse impacts of deflation, their own financial vulnerabilities could exacerbate systemic risks. Thus, our findings may be interpreted as highlighting the importance of targeted policies to safeguard financial institutions during deflationary periods.

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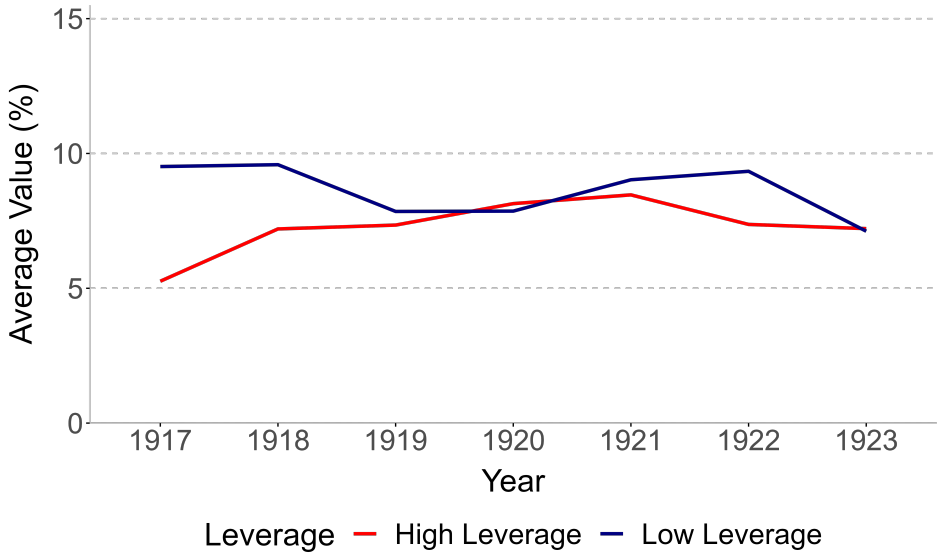
A Appendix

Table A.1: Summary statistics, balance sheet items

	Mean	SD	Min	Max
All non-financial firms				
Cash and cash equivalents-to-assets	0.079	0.107	0	0.605
Inventory-to-assets	0.190	0.171	0.001	0.727
Profits-to-assets	0.061	0.056	0	0.469
Equity-to-assets	0.505	0.181	0.052	0.965
All banks				
Financial assets-to-assets	0.435	0.304	0	1.000
Profits-to-assets	0.019	0.031	0	0.296
Loans-to-assets	0.522	0.303	0.001	0.948
Equity-to-assets	0.244	0.212	0.010	1.000
Cantonal banks				
Financial assets-to-assets	0.251	0.145	0.043	0.701
Profits-to-assets	0.007	0.003	0.001	0.016
Loans-to-assets	0.623	0.164	0.106	0.895
Equity-to-assets	0.121	0.052	0.042	0.339
Non-cantonal banks				
Financial assets-to-assets	0.533	0.320	0	1.000
Profits-to-assets	0.023	0.036	0	0.296
Loans-to-assets	0.443	0.355	0.001	0.948
Equity-to-assets	0.302	0.232	0.010	1.000

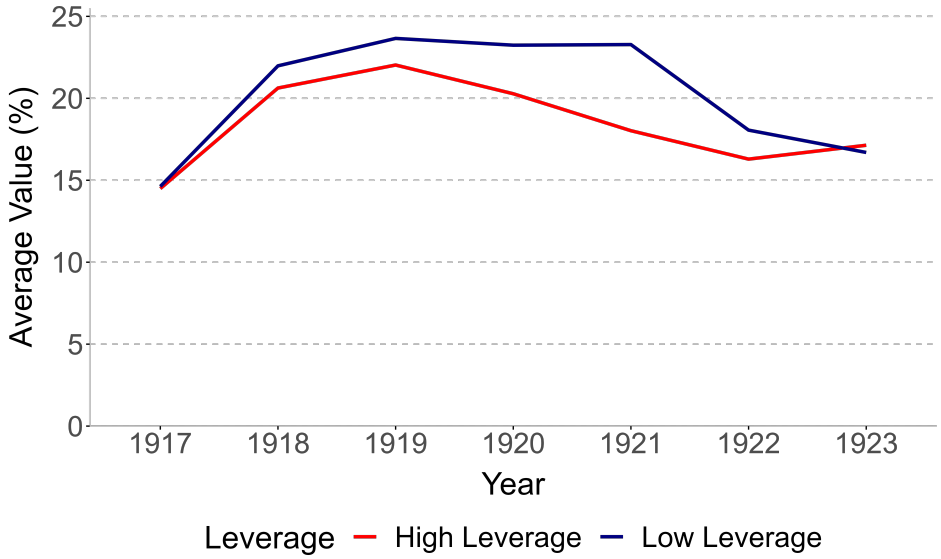
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations.

Figure A.1: Cash and cash equivalents as a share of all assets by leverage levels



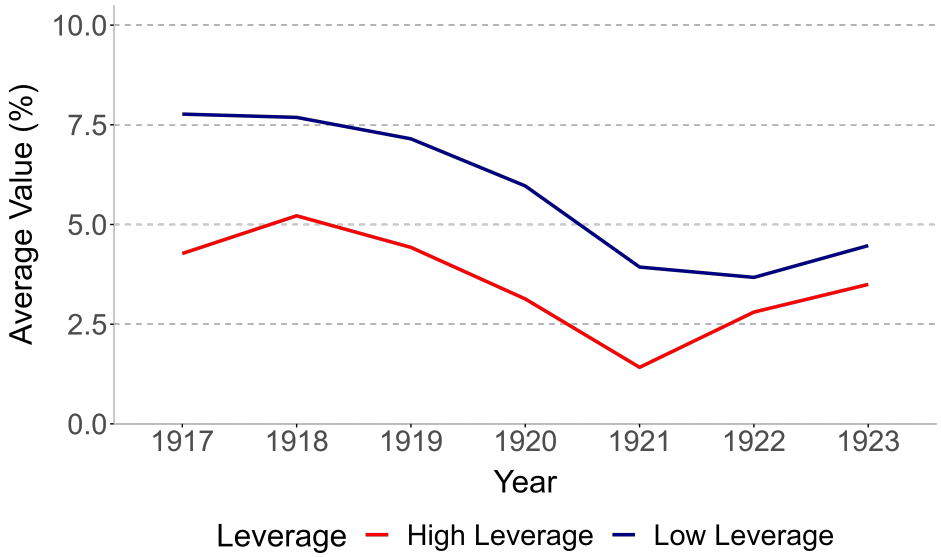
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Figure A.2: Non-financial firms, leverage level, inventory as a share of all assets by year



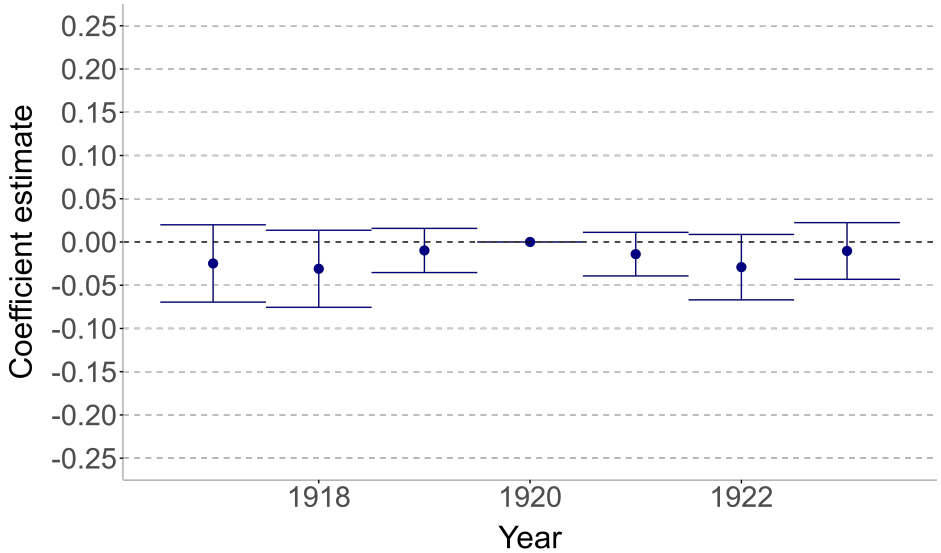
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations.

Figure A.3: Non-financial firms, profit as a share of balance sheet total by year



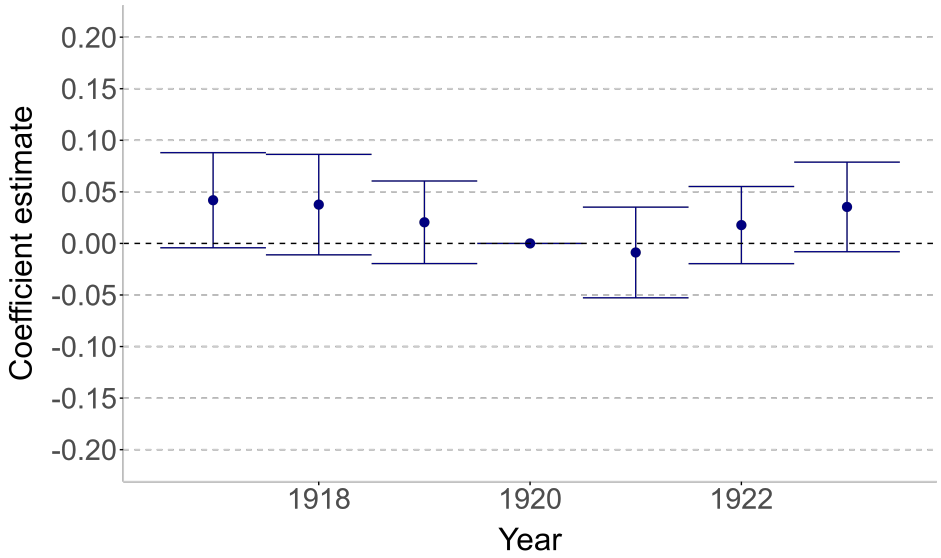
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations.

Figure A.4: Non-financial firms, difference-in-differences, leverage dummy, cash and cash equivalents by year



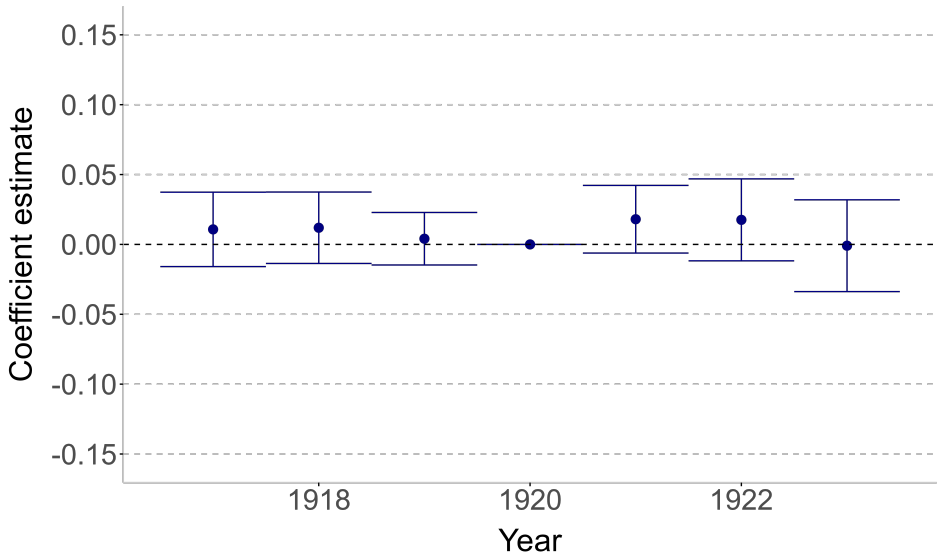
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations. The bars represent 95% confidence intervals.

Figure A.5: Non-financial firms, difference-in-differences, leverage dummy, inventory by year



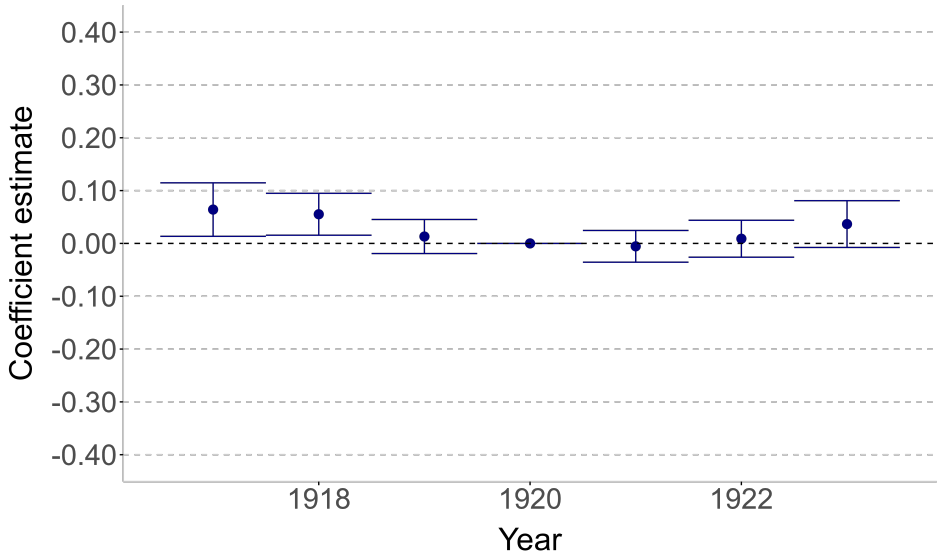
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations. The bars represent 95% confidence intervals.

Figure A.6: Non-financial firms, difference-in-differences, leverage dummy, profit or loss by year



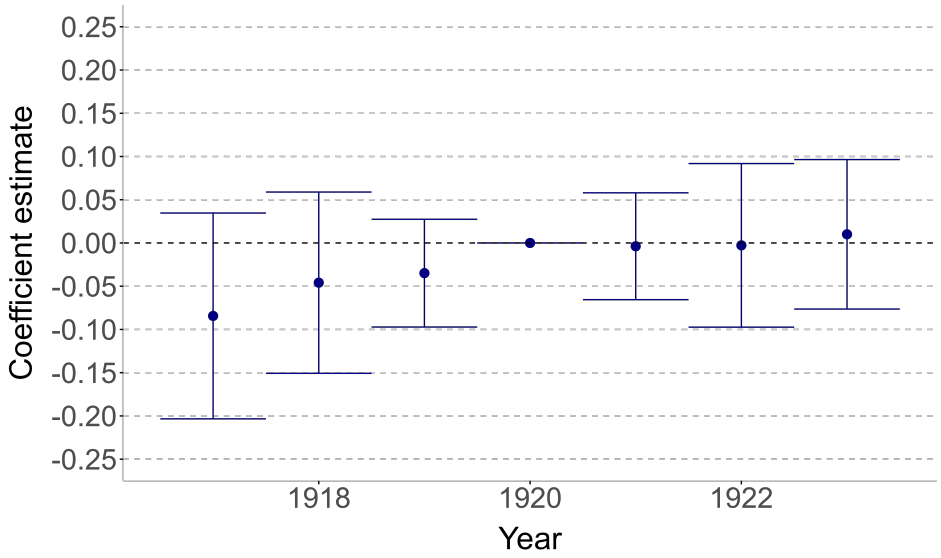
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations. The bars represent 95% confidence intervals.

Figure A.7: Non-financial firms, difference-in-differences, leverage dummy, equity by year



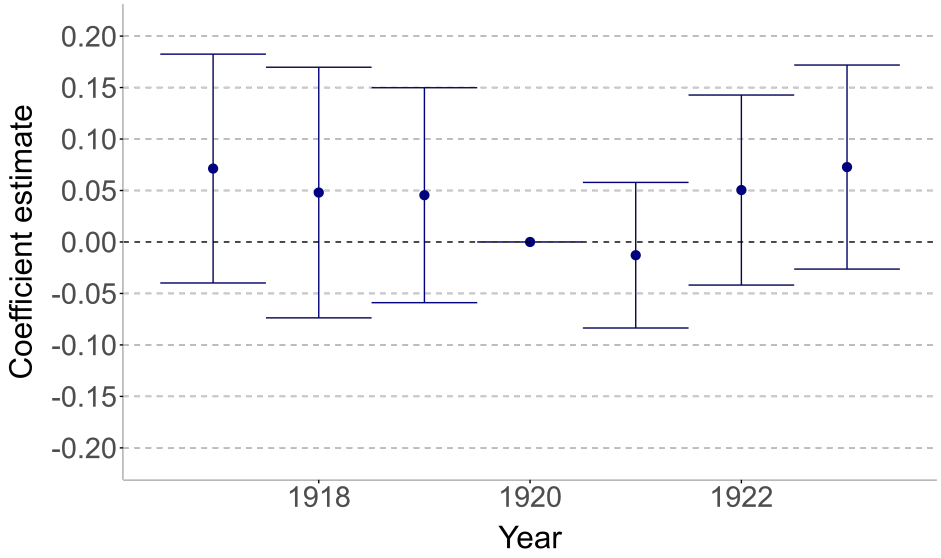
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations. The bars represent 95% confidence intervals.

Figure A.8: Non-financial firms, difference-in-differences, leverage level, cash and cash equivalents by year



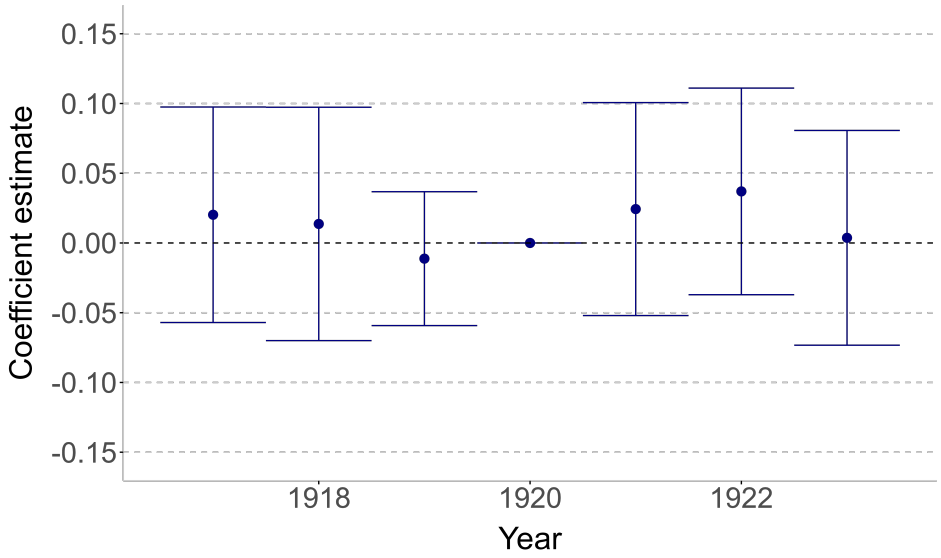
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations.

Figure A.9: Non-financial firms, difference-in-differences, leverage level, inventories by year



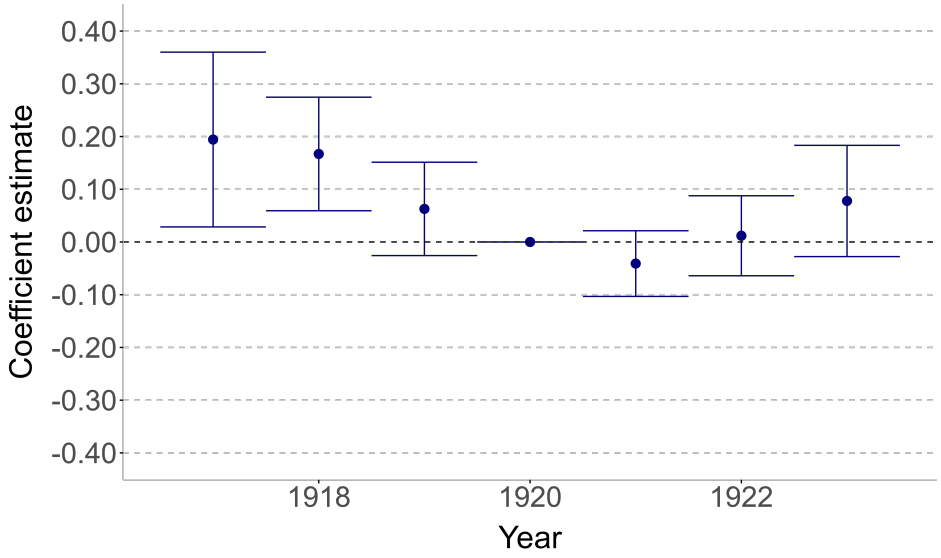
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations.

Figure A.10: Non-financial firms, difference-in-differences, leverage level, profit as a share of balance sheet total by year



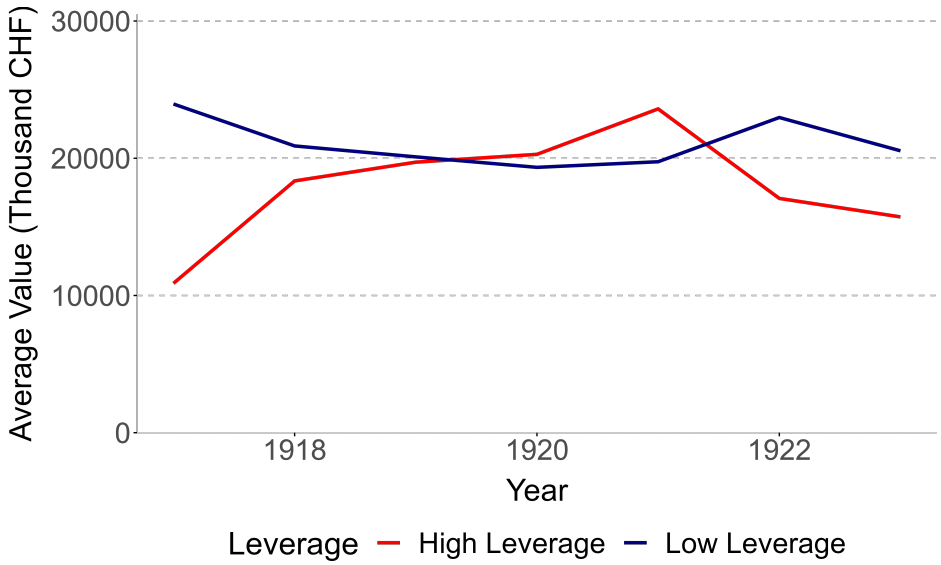
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations.

Figure A.11: Non-financial firms, difference-in-differences, leverage level, equity as a share of balance sheet total by year



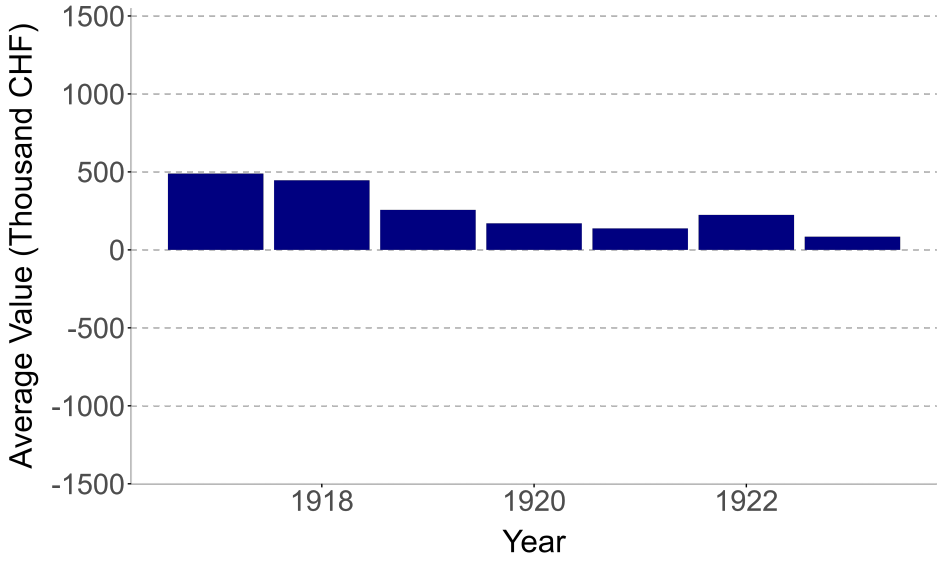
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations.

Figure A.12: Banks, average asset values excluding loans issued by year



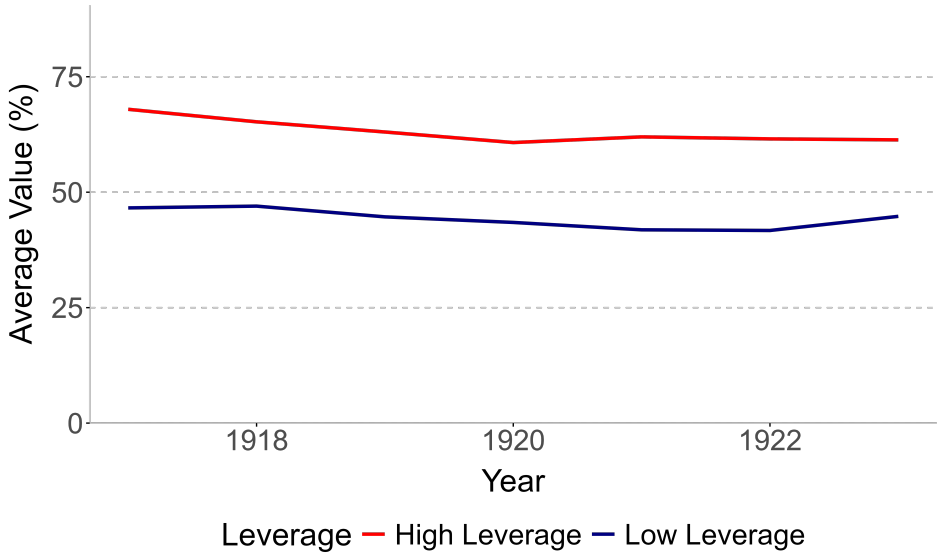
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations.

Figure A.13: Banks, average total profit by year



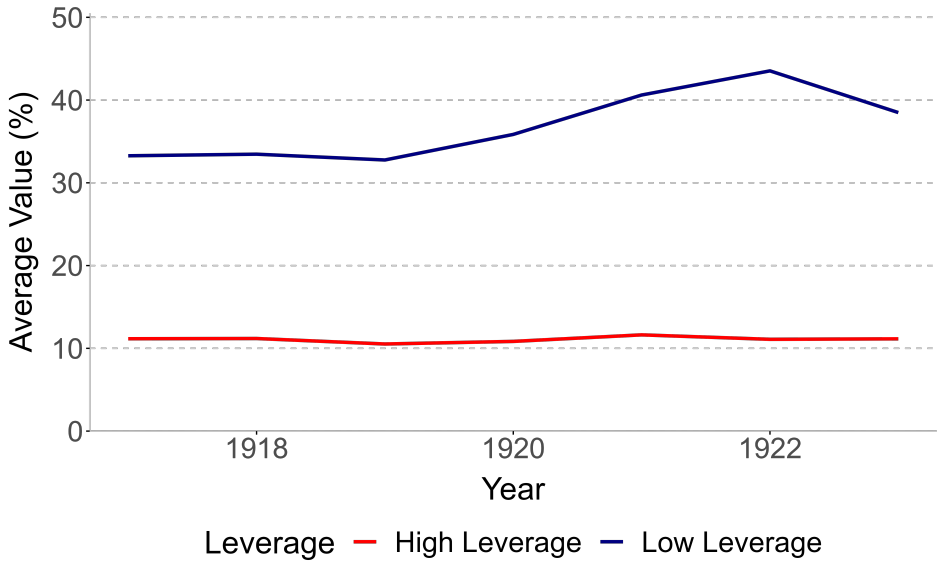
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations.

Figure A.14: Banks, average loans issued by year



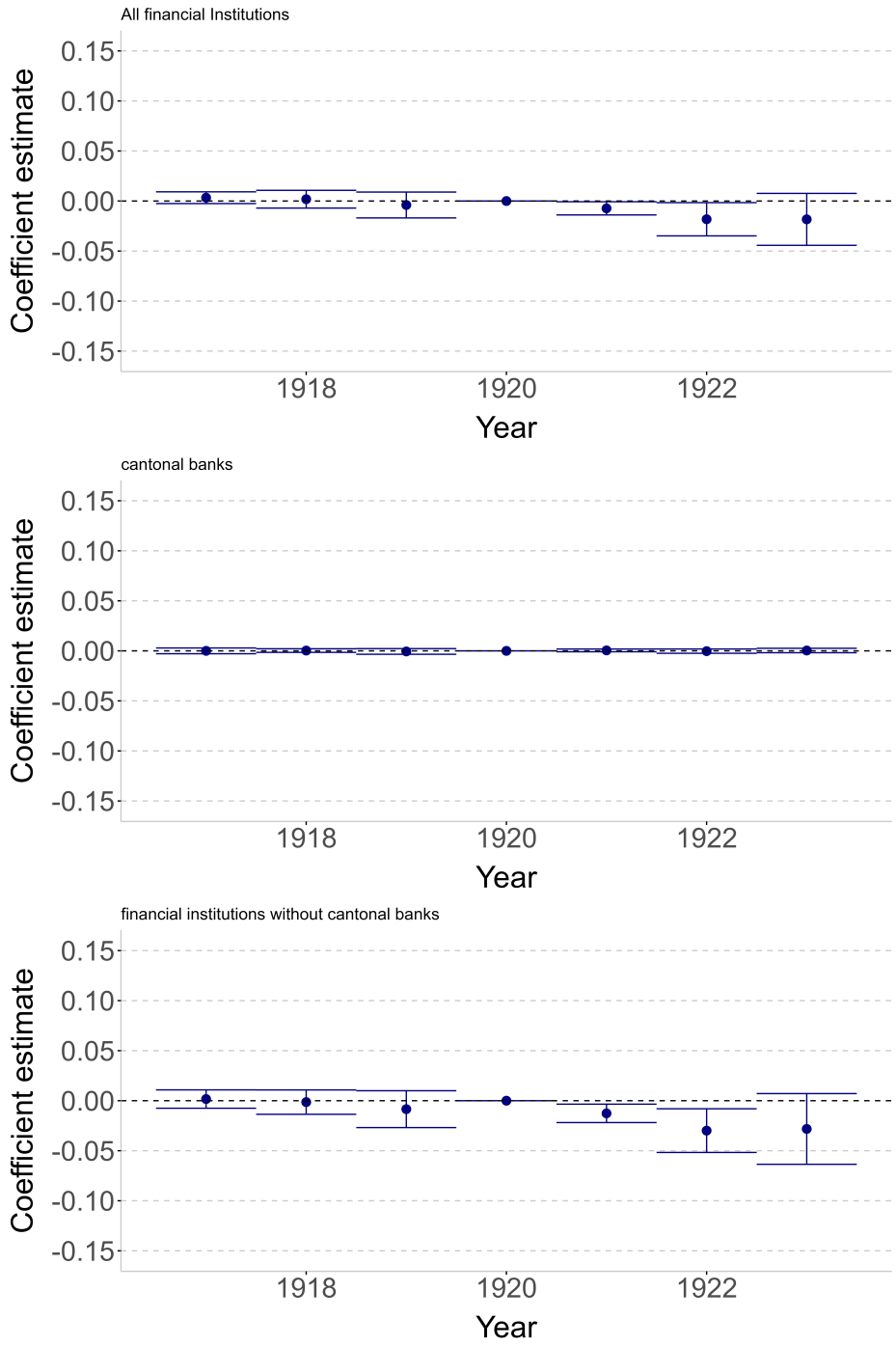
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations.

Figure A.15: Banks, average equity by year



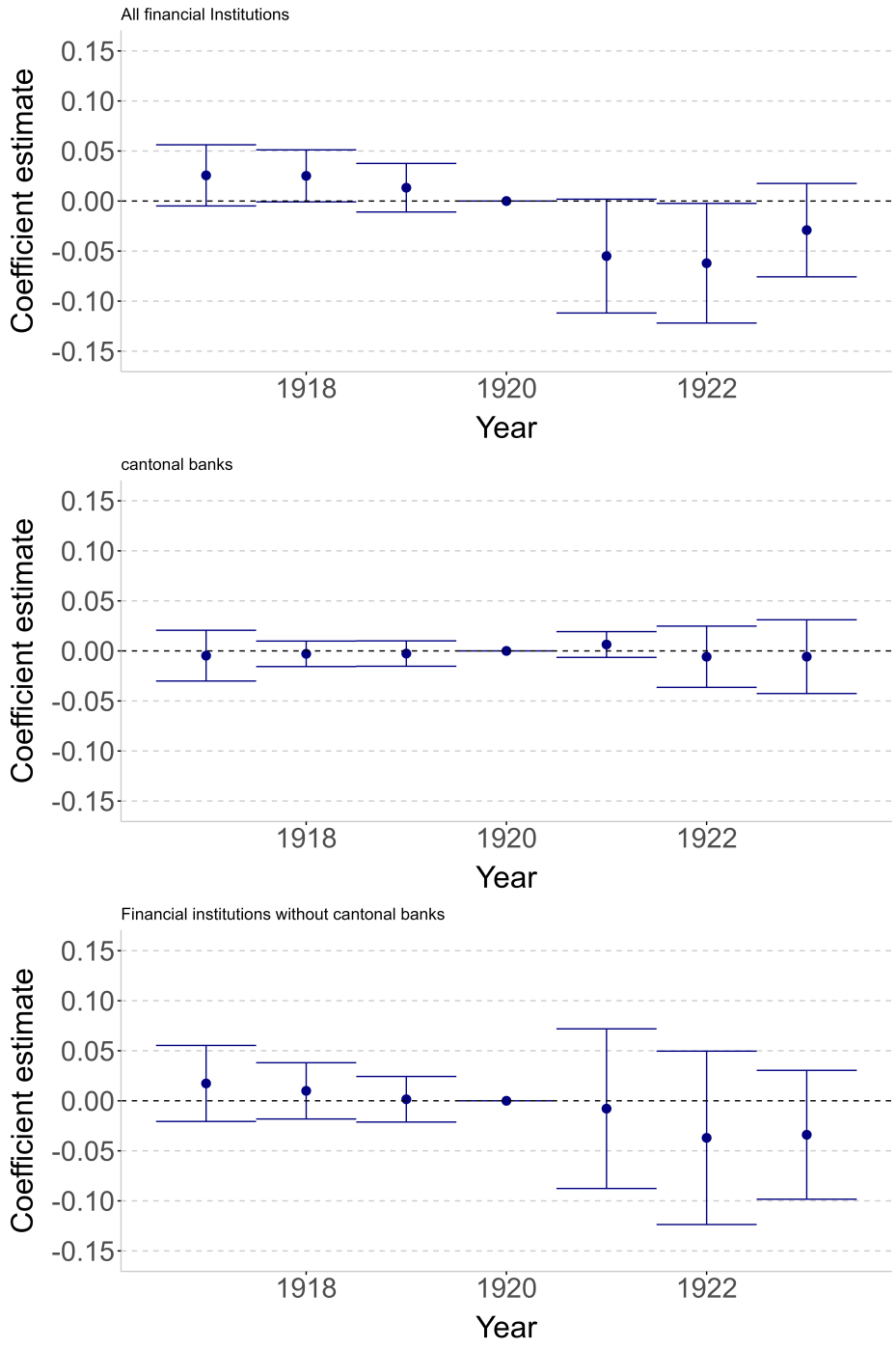
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations.

Figure A.16: Banks, difference-in-differences, leverage dummy, profit by year and bank type



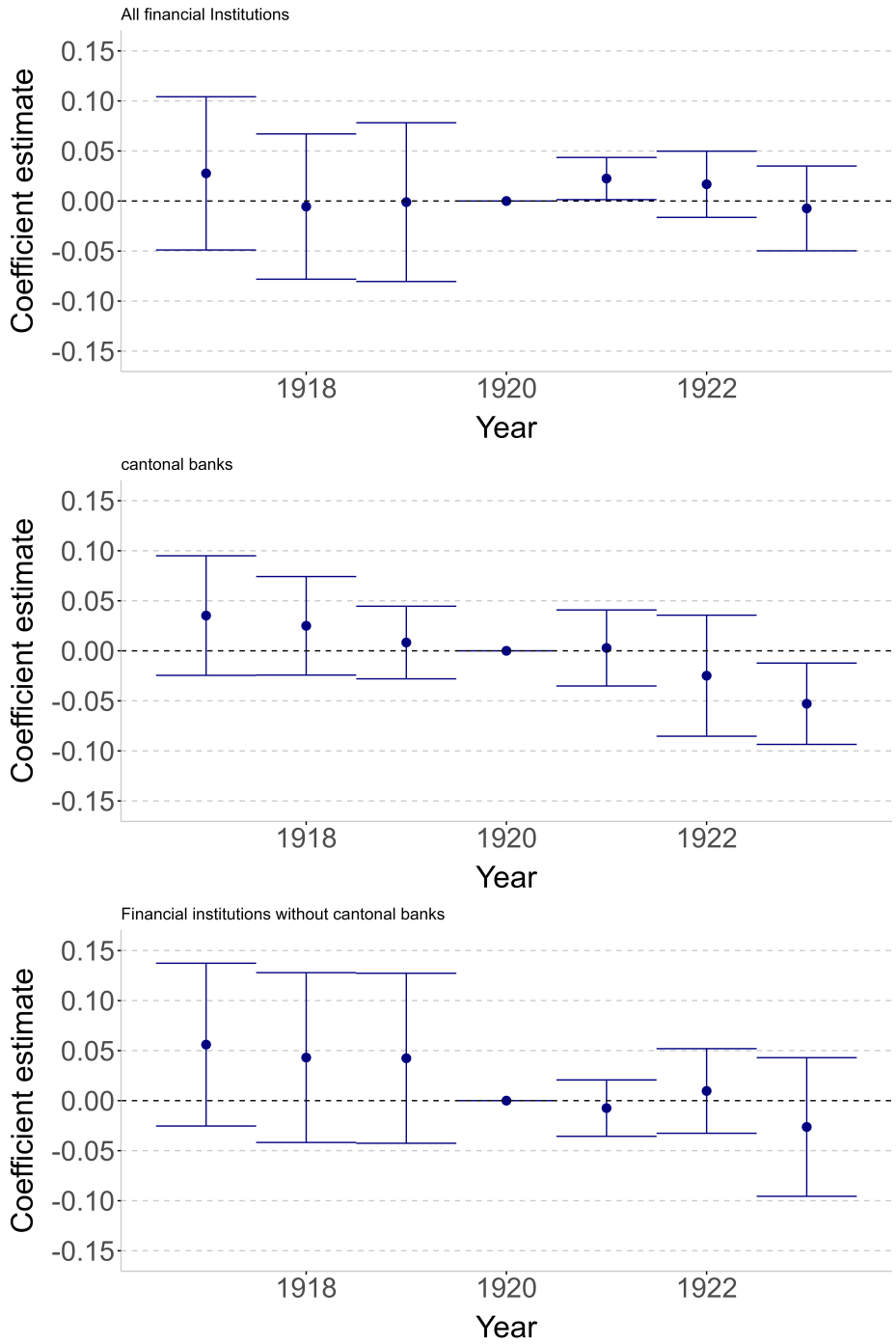
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations. The bars represent 95% confidence intervals.

Figure A.17: Banks, difference-in-differences, leverage dummy, equity by year and bank type



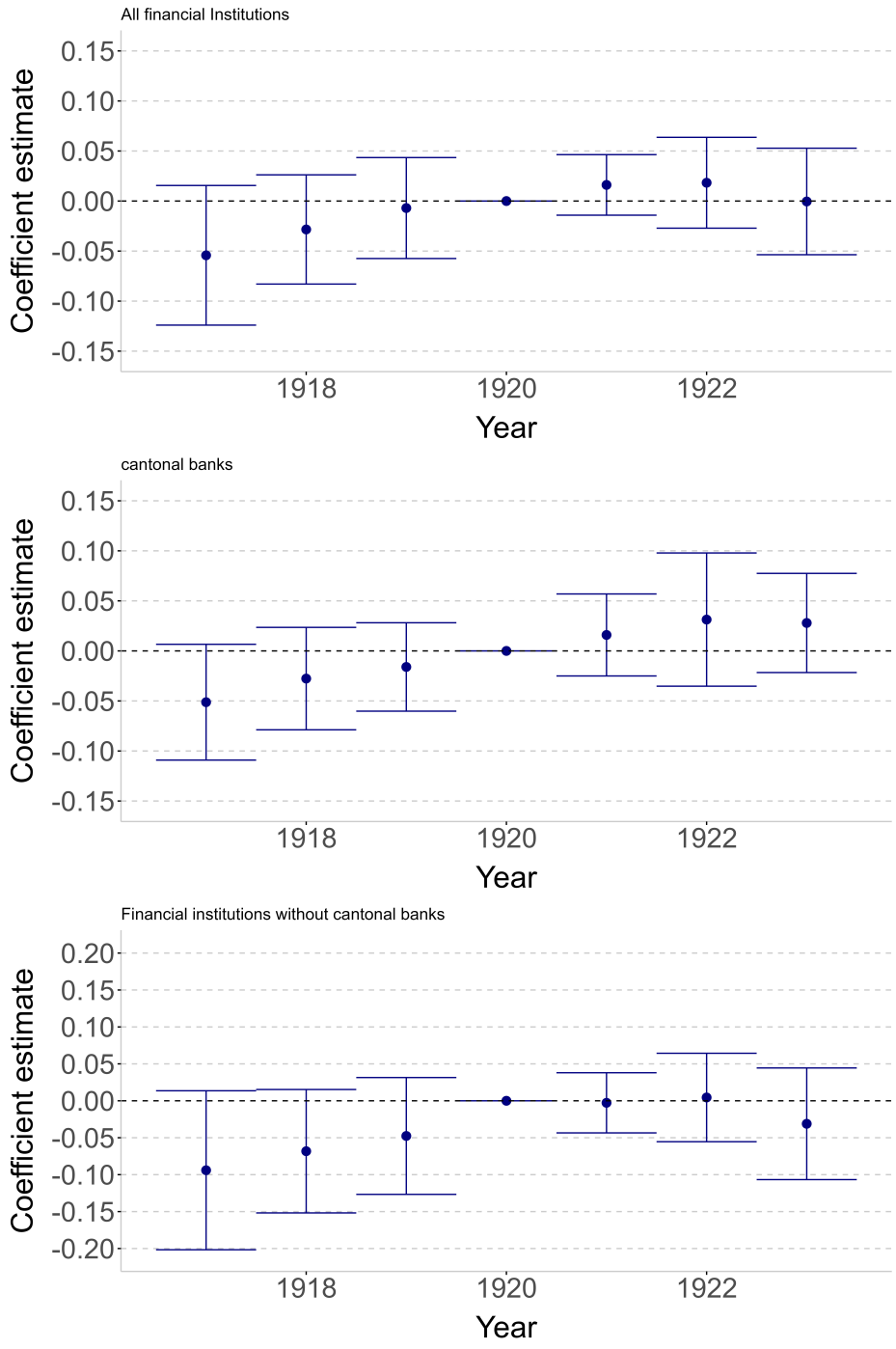
Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations. The bars represent 95% confidence intervals.

Figure A.18: Banks, difference-in-differences, leverage dummy, issued loans by year and bank type



Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations. The bars represent 95% confidence intervals.

Figure A.19: Banks, difference-in-differences, leverage dummy, financial assets by year and bank type



Data source: Steiger (1918, 1919, 1920, 1921, 1922, 1923, 1924) and own calculations. The bars represent 95% confidence intervals.