Finance and Economics Discussion Series
Divisions of Research & Statistics and Monetary Affairs
Federal Reserve Board, Washington, D.C.

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2015-054

Please cite this paper as:
Gissler, Stefan (2015). "A margin call gone wrong: Credit, stock prices, and Germany's Black Friday 1927," Finance and Economics Discussion Series 2015-054. Washington: Board of Governors of the Federal Reserve System, http://dx.doi.org/10.17016/FEDS.2015.054.

A margin call gone wrong: Credit, stock prices, and Germany's Black Friday 1927

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February 15, 2015

Abstract

Leverage is often seen as villain in financial crises. Sudden deleveraging may lead to fire sales and price pressure when asset demand is downward-sloping. This paper looks at the effects of changes in leverage on asset prices. It provides a historical case study where a large, well-identified shock to margin credit disrupted the German stock market. In May 1927, the German central bank forced banks to cut margin lending to their clients. However, this shock affected banks differentially; the magnitude of credit change differed across banks. Using the strong connections between banks and firms in interwar Germany, I show in a difference-in-differences framework that stocks affiliated with affected banks decreased over 12 percent during 4 weeks. Volatility of these stocks doubled. Relating directly bank balance sheet information to asset prices, this paper finds that a one standard deviation decrease in lending to investors increased an affected stock's volatility by 0.22 standard deviations. These results are robust to the problem that banks' lending decisions may be influenced by asset prices. The Reichsbank threatened banks to cut their short-run funding. Using the differences in exposure towards this threat, an instrumental variable strategy provides further evidence that a sharp decrease in leverage may lead to stock price fluctuations.

1 Introduction

Leverage is often seen as villain in financial crises. Leverage of traders and financial intermediaries is procyclical and changes in credit are correlated with asset price movements (Adrian and Shin 2010). Further, leverage growth predicts excess returns in several asset classes (Adrian, Moench, and Shin 2010). In the recent crisis, sudden decreases in lending by financial intermediaries are regarded as one of the main culprits for fire sales and sharp increases in stock market volatility during 2008-2009 (Brunnermeier 2009). In frictionless markets, changes in lending to investors have no asset pricing implications.

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However, recent theories establish a direct link between changes in margin credit and stock price movements (Gromb and Vayanos 2002, Brunnermeier and Pedersen 2009). If investors cannot satisfy margin calls, a decrease in leverage may lead to fire sales. With downward-sloping asset demand, this induces price dislocations, which may reinforce further deleveraging.

There is growing support for the hypothesis that traders' and intermediaries' balance sheet conditions matter for asset pricing. Several empirical studies show a relationship between changes in margin credit and asset price movements. Broker-dealer leverage is a significant pricing factor for stock returns (Adrian, Etula, and Muir 2011). Changes in leverage of financial intermediaries are strongly correlated with stock market risk (Adrian and Shin 2010). However, it has proven difficult to establish a direct link between changes in credit and asset price movements. Leverage rarely varies exogenously; changes in credit are mostly endogenous decisions by financial intermediaries, other financiers, or investors. Further, when balance sheets are marked-to-market, changes in asset prices directly affect leverage.

In this paper I examine the asset pricing consequences of a large shock to financial intermediaries' margin lending. In May 1927, the German central bank forced banks to decrease credit for stock purchases given out to their clients. However, this shock affected only a subset of banks. Clients of the affected banks mostly had to unwind their positions to meet the margin calls. Using a particular bias in their portfolios, I am able to differentiate between firms mostly held by clients of affected banks or unaffected banks. I show in a difference-in-differences framework that deleveraging had large asset pricing implications. During the weeks following the shock on margin credit, stocks connected to affected banks declined 50 percent more than other stocks. They experienced negative cumulative returns of almost 400 percent (annualized). Further, return volatility of these stocks doubled. Connecting stocks directly with specific intermediaries and changes in their balance sheets, I find that mean daily returns were not affected by the cut in margin lending. However, a one standard deviation decrease in margin credit increased a stock's volatility by 0.22 standard deviations.

The historical setting is interwar Germany. During the mid-1920's, increasing stock market valuations went in lockstep with an increase in margin credit. Yet it were mainly the six large "Berlin banks" that enabled their clients to buy assets on credit. Margins could be as low as 10 percent. However, the rise of stock prices and margin credit drew the attention of the German central bank, the Reichsbank. Mostly for political reasons, its president, Hjalmar Schacht, campaigned against the banks' practices to constantly increase credit supply and to allow highly leveraged positions. This campaign culminated in the threat of the Reichsbank to cut short term funding for the Berlin banks. The threat was effective. On 12 May 1927, the Berlin banks issued a joint statement. Over the course of the following weeks, each bank would decrease their stock of margin credit by 25 percent

while issuing margin calls towards their clients. The consequences were immediate – 13 May 1927 became known as Black Friday. The stock market declined by 13 percent. The large shock initiated by the Reichsbank trickled down to investors. During the following weeks, banks increased the margins of their clients' portfolios. As most investors could not satisfy the margin calls, fire sales occurred. However, at a given bank these fire sales were concentrated on a special set of firms – firms that had a close relationship to the bank. Using evidence from the German Federal Archives to establish these bank-firm connections, I show that stocks differed in their reaction to the deleveraging: A firm's stock price declined stronger and fluctuated more if the firm was connected to a bank that experienced a larger credit crunch.

Figure 1 summarizes the main result. The left panel shows two stock price indices, one index composed of firms connected to the large Berlin banks, and another index of firms with no connection to these banks. Both indices are normalized to 12 May 1927. At this day, the Berlin banks issued their joint statement and both indices declined. However, over the course of the following month "large bank"-stocks declined more than 12 percent, while other stocks dropped less than 8 percent. Further, volatility almost doubled for firms connected to the Berlin banks. This is shown in the right panel, which plots volatility indices for both groups of firms. Stocks more exposed to fire sales had more negative returns and experienced larger fluctuations. This causal impact of deleveraging on return volatility is robust to several criticisms. The result still holds when controlling for attributes such as the number of underwriters or firm size. An instrumental variable strategy further shows that reverse causality does not drive the results.

This study is related to several strands of the literature. Several theoretical papers establish a causal link between margin requirements and asset price behavior (Gromb and Vayanos 2002, Brunnermeier and Pedersen 2009). Recent empirical studies provide suggestive evidence for this link. Leverage is pro-cyclical (Adrian and Shin 2010) and leverage growth has predictive power for excess returns (Adrian, Moench, and Shin 2010). I contribute to this literature by providing a clean empirical test that changes in margin credit led to increased volatility in interwar Germany. I further add to the literature on fire sales and price pressures. Coval and Stafford (2007) and other empirical studies show that in the short run, selling pressure leads to price dislocations. I complement these studies and add further evidence that an increase in selling volume leads to disturbances of asset prices. Historically, this study adds to the literature on stock markets in interwar Germany. I complement the study of Voth (2003) by providing a disaggregate look at the stock market crash in 1927.

The next section surveys the related literature. Section 3 describes the historical setting in more detail. It explains the economic situation as well as the banking industry in interwar Germany. Section 4 describes the data. Section 5 shows how the shock to margin lending affected stock price behavior. Section 6 refines the results. Section 7 concludes.

2 Related Literature

This study is related to several strands of the literature. It relates to the theoretical and empirical literature on margin credit and asset prices, commonality of returns, and the cyclicality of credit. Also, it adds to the literature on price pressure and asset fire sales. On the banking side, it adds to the literature on intermediary capital.

The connection between margin credit and asset prices received a lot of attention in the wake of the recent financial crisis. However, earlier theoretical papers already examined the causal effects of changes in margins on returns and volatility. In Gromb and Vayanos (2002) arbitrageurs cannot finance their arbitrage activity completely with own funds. Margin credit helps traders to pursue their investment strategies. In normal times, credit allows these traders to eliminate arbitrage opportunities and assets are traded at fair prices. Yet when margin constraints bind, arbitrageurs cannot eliminate price inefficiencies. Brunnermeier and Pedersen (2009) provide the microfoundations for binding margin constraints. In their model, financiers give credit to traders. The amount of credit depends on the volatility of assets and is determined by VaR constraints. When price volatility increases, financiers issue margin calls, which traders may be unable to satisfy. They are forced to sell their assets, which decreases asset prices and further diminishes a trader's wealth. Margin and wealth spirals occur. He and Krishnamurthy (2012) also develop a model where intermediary capital is scarce and relevant for asset pricing in crises times.

The importance of credit for asset prices is also stressed by several macroeconomic models. These theories focus mostly on the cyclical behavior of prices and credit to explain business cycle fluctuations. In Bernanke and Gertler (1989), asset prices influence the balance sheet capacity of borrowers. Kiyotaki and Moore (1997) show that collateral requirements change over the business cycle. These changes amplify shocks to the economy.

The relationship between credit or margin requirements and asset prices is the subject of various empirical studies. Earlier studies found no effect of changes in margin requirements on asset prices (Moore 1966, Officer 1973, Hsieh and Miller 1990). More recently, Adrian, Moench, and Shin (2010) find that leverage growth has predictive power for excess returns. Furthermore, Wall Street investment banks exhibit procyclical leverage (Adrian and Shin 2010). When asset prices and the corresponding balance sheet positions of banks rise, banks adjust their balance sheets and take on more debt – leverage increases. When asset prices decline, an opposite spiral emerges. Further, changes in leverage are correlated with increases in stock market risk.

These papers are related to a broader strand of the literature that investigates fire sales and price pressure. The theoretical literature on asset fire sales is large and summarized by Shleifer and Vishny (2011). Several empirical papers suggest that when traders

have to exogenously unwind their positions, prices react. Coval and Stafford (2007) show that prices decrease when mutual funds sell large positions. Over the medium run, prices reverse course and recover. Mitchell and Pulvino (2012) look at several markets around the times of the Lehman Brothers bankruptcy. When investments banks cut their lending to hedge funds almost completely, these arbitrageurs were unable to follow their typical investment strategies. A large increase in the CDS-bond spread followed, the convertible securities market seemed mispriced, and merger arbitrage opportunities arose for merger target stocks. Hendershott and Menkveld (2013) look at price pressure in the short run and find dislocations of prices on a daily basis. Investigating differences in stock returns during times of high selling pressure, Blume, MacKinlay, and Terker (1989) show that stocks included in the S&P 500 declined stronger than other stocks during the 1987 crash. But these stocks also showed a stronger reversal, leading to higher volatility. Explanations for these differences range from institutional trading to behavioral reasons such as greater visibility. Greenwood and Thesmar (2011) use mutual fund data to show that stocks are more "fragile" if their ownership base is more concentrated. Individual liquidity shocks cannot be cancelled out when only a few investors own a specific stock. But even a diverse ownership base can lead to fragility, if several investors experience correlated liquidity shocks. Anton and Polk (2014) show that common ownership of stocks by mutual funds can explain return commonality in the cross-section.

Further, this article is related to the literature on intervention in asset markets. Most papers focus on intervention in foreign exchange markets. A classical reference on intervention by central banks is Bagehot (1873).

On the historical side, the paper adds to the literature on German stock markets in the interwar period. Most literature on German stock markets investigates the period before WW I (Lehmann 2011, Burhop 2011). In one of the few studies on the interwar period, Voth (2003) looks at the Black Friday in an aggregate context. He claims that Schacht was wrong and the high stock price valuations in 1927 did not represent an asset price bubble. My study looks at the same episode, taking a disaggregate view on stocks and the banking sector. The next section explains this historical episode in more detail.

3 Historical background: The Black Friday of 1927 and the stock market in the interwar period

On the evening of 12 May 1927, the six largest German banks published the following statement:

> "The members of the union of Berlin banks and bankers (Stempelvereinigung) have come today to the agreement to slowly but noticeably decrease the funds available for stock purchases on credit. Therefore they will decrease the stock

of margin credit until the middle of the month by 25 percent and further afterwards. Against clients they will act in the same way." [1]

One day later, the German stock market lost 13 percent. This section provides a short overview of how this communique came about. The first part looks at the economic situation and the evolution of the stock market during the interwar period. Parts 2 and 3 describe banking in Germany and the evolution of banks' balance sheets. Part 4 describes the Reichsbank's view on increasing stock valuations and banks' lending policies. The last part explains the strong connections between banks and firms before WW II in Germany.

3.1 The economic situation of interwar Germany

Interwar Germany is often associated with political turmoil, austerity, and high unemployment. However, during the years after the hyperinflation, the outlook was far better. After 1924, the German economy began to recover. Chancellor Gustav Stresemann established a political and civic order, and a period of falling unemployment and increasing industrial production began. The "Golden Twenties" led to economic recovery, investment, and even a flourishing cultural scene. The recovery also affected the stock market. During the first years after the war, volume on the stock exchange had been low. Stock prices were at low levels and highly volatile, while interest rates were high and transactions in futures not allowed. As the outlook brightened, the high interest rates attracted foreign capital. In contrast to other central banks, the Reichsbank pursued a policy of high discount rates. Until February 1925, the discount rate was 10 percent and even during 1926 it still stood at 8 percent.[2] This policy was the main driver of foreign capital inflows. The American diplomat S.P. Gilbert saw these inflows even as a major cause of Germany's economic recovery. When interest rates started to decline and investors searched for higher yields, stock prices began to rise. A short recession during 1925 and the beginning of 1926 did not hinder this development and at the end of 1925, the aggregate stock market index stood at 99 percent (of its pre-WW I level). During 1926, it rose to 140 percent (November 1926) and even higher in 1927 (178 percent in April 1927).

The new confidence in stock markets increased the demand for margin credit. Already before WW I, margin credit was a major funding source for investors and a large part of banks' investment banking business. When an investor wanted to finance a trade, he had only to pay a fraction of the stock purchase with his own capital. A bank lent the rest

[1] "Die Mitglieder der Vereinigung von Berliner Banken und Bankiers (Stempelvereinigung) sind heute untereinander übereingekommen, die zu Report- und Lombardzwecken und zur sonstigen Beleihung von Effekten gewährten Gelder allmählich, aber erheblich herabzusetzen. Sie werden deshalb zunächst die börsenmässige Report- und Termingeldhergabe bis zur Medio-Liquidation um 25 Prozent vermindern und an den darauffolgenden Terminen weitere Einschränkungen vornehmen. Der Kundschaft gegenüber wird im gleichen Sinne verfahren werden."

[2] Interest rates set by other central banks were between 4 to 5 percent

and took the purchased securities as collateral. Investors were able to reach high levels of leverage; margin requirements could be as low as 10 percent. But during the period of hyperinflation, margin credit had come to a standstill and was a negligible part of banks' balance sheets. As the stock market recovered, margin credit slowly started to increase. Figure 2 shows the evolution of the stock market and margin credit between 1925 and 1928. During the bull market from 1926 to mid-1927, total margin credit increased from below 100 Million RM to almost 900 Million RM.

However, this increase was not evenly spread across banks; only a handful of banks accounted for a large part of it. Six private banks, all situated in Berlin, had in 1925 a combined level of stock market credit roughly equal to the level of other private banks with branches. During the following years the Berlin banks increased their margin lending on a large scale, whereas the "province banks" lacked behind significantly. At 31 October 1925, the total amount of margin credit was 303.5 Million RM. A third had been given out by the Berlin banks (101 Million RM). Total credit grew to 1413.9 Million RM (30 April 1927). The largest fraction of credit was given out by the Berlin banks. In 1927, their share grew to 892 Million RM, while combined credit at other private banks was only 200 Million RM. The right panel of Figure 3 shows these differences in margin lending between the Berlin banks and other, larger private banks. Berlin banks also differed from these banks by how their assets were financed. Leverage was almost double as compared to the province banks, as the left panel in Figure 3 shows.

However, differences existed even among Berlin banks. The next section takes a closer look at these banks.

3.2 The Berlin banks

Berlin banks were substantially different than their peers across Germany. However, they also differed amongst themselves. Danatbank's CEO for example sat on over 100 supervisory boards and pursued an aggressive expansionary strategy. The Berliner Handels Gesellschaft was on the other side of the spectrum, keeping their stock market activity at a minimum and only giving credit to low-risk borrowers. Leverage as well as margin lending reflected these strategic differences. Figure 4 depicts these differences. The left panel shows the evolution of the ratio of assets over equity for five of the Berlin banks between 1925 and 1928. During 1927, Danatbank's leverage was almost double Diskonto's leverage. The Danatbank has also been a very active lender for stock purchases, as the right panel shows. While in 1925 banks had comparable levels of margin lending, at the peak in May 1927 there were sizable differences between them. Again, Databank had given out almost double the amount of margin credit as compared to Diskonto.

While margin credit increased, other highly liquid positions on the banks' asset side deteriorated. An important measure of banks' liquidity was the ratio of cash and short-

term assets at the central bank over short-term liabilities. The average of this ratio across the large banks was 5.58 percent at the end of 1912. After the hyperinflation it had already decreased to 3.21 percent. In February 1927, it reached its low at 2.59 percent. Liquidity increased after the intervention of the Reichsbank and short-term assets over short-term liabilities increased to 4.02 percent until the end of June 1927. The continuous decline in this liquidity ratio was mainly driven by a decrease in banks' cash positions. Before WW I, banks held 112.31 Million RM in cash. At the end of 1925, this position had fallen to 66.9 Million RM. Between February 1927 and June 1927 it increased again from 78.6 Million RM to 126.8 Million RM.

Low on cash, banks started to rely heavily on a different source of short-term funding: Promissory notes. A promissory note is a promise of firm A to pay back a credit to firm B until a certain date. Firm B can use this promise to obtain cash at a bank. The bank takes over the promissory note, bearing the default risk of the debtor, firm A. Regularly, a bank was not the ultimate holder of a promissory note as it could redeem the note for cash at the central bank. The central bank accepted promissory notes from almost all industrial firms, which were the majority of the issuers.

The use of promissory notes by banks was inherently linked to margin credit. Investors used credit by banks to roll over their futures positions. At the Berlin stock exchange, futures were settled at the 15. and 30. of every month. If an investor was supposed to settle a long position at these dates, he often used bank credit. Banks took the bought stocks as collateral until the credit was due the following month. To obtain the liquidity needed to issue margin credits, banks redeemed promissory notes at the Reichsbank. This can be seen in Figure 5. The graph shows the evolution of promissory notes held by the Reichsbank. The series spikes twice a month, at the days when futures trades had to be settled. During the year before the Black Friday, promissory notes taken by the Reichsbank more than doubled. This reliability of banks on the Reichsbank made the large Berlin banks vulnerable.

Another source of vulnerability was the sudden stop in long-term foreign capital, which was initiated by the government. Up to the end of 1926, foreign owners of German bonds were not taxed by the German tax authority. But on 4 December 1926, the German government abolished this exemption – foreign holders of bonds had to pay German capital taxes. As a consequence, the inflow of long-term foreign capital declined from 137.9 Million RM (December 1926) to 13.7 Million RM (January 1927). Banks could no longer obtain long-term foreign funds and had to rely to an even greater extend on the central bank. The next section turn to this institution; an institution that criticized banks' lending policies and the evolution of the German stock market.

3.3 The Reichsbank and the shock to margin credit

The Reichsbank, and most prominently its president Hjalmar Schacht, had a specific position towards the stock market boom – the view that stocks were overvalued and that the high valuations were bad for the German economy. This view was based on three arguments (James 1986). First, Hjalmar Schacht believed that funds invested in the stock market would be unavailable for real investment. Second, the surge in the stock market would attract too much short-term foreign capital, a source of instability and uncertainty. And third, in the eyes of Schacht stock market valuations were too high and irrational and did not reflect the state of the German economy.

Already contemporaries criticized the first argument. Before and after the stock market crash, commentators in newspapers, speeches, and dissertations noted that the stock market boom did not harm real investment (see for example Benning (1929)). Their main argument against Schacht was that one's stock purchase is another one's stock sell. This free capital could be invested in the real economy. Schacht was not convinced by this argumentation and claimed that most revenues from stock sales would flow into luxuries. However, national accounts of the German Reich do not show an increase in the consumption of luxuries.

The second argument, the fragile nature of short-term foreign capital, was more substantial. However, the Reichsbank itself and the government were the source of the increased instability. Because of high interest rates at the beginning of the recovery, Germany attracted foreign investors. Initially, foreign capital inflows were both short-term as well as long-term. But the abolishment of the preferential tax treatment for bonds in foreign currency led to a sudden standstill of long-term foreign capital flows. Further, the withdrawal of foreign funds depleted the Reichsbank's position in foreign exchange (Figure 6). In January 1927, reserves in foreign exchange dropped over 60 percent. New capital inflows were almost exclusively short term, and the Reichsbank was afraid of further withdrawals.

There was no consensus among contemporaries whether Germany experienced a stock market bubble. In the eyes of Hjalmar Schacht, stocks were overvalued. The state of the German economy would be far from good and the stock market would only reflect irrational exuberance. Further, high stock market valuations did not fit well into his political agenda. He advocated lower reparation payments and argued that the current level of payments restricted the German economy. On 8 May 1927, he wrote in the newspaper *Muenchner Neueste Nachrichten* that he disagrees with the "false image of the currently high stock prices at German exchanges, on which the opinion of supposedly regained German strength is mainly based." After months of arguing against high valuations, banks suggested to raise interest rates. Hjalmar Schacht did not commit to such a policy and

instead focused on the large Berlin banks and their lending policies.[3] Looking at the level of the stock market, Voth (2003) argues that Hjalmar Schacht was already wrong in his premise of an existing stock market bubble.

The Reichsbank's position towards high stock market valuations together with the large banks' low short-run liquidity culminated in an unofficial threat. The Reichsbank warned the largest private banks: If the banks would not cut their margin lending by at least 25 percent, the Reichsbank would not redeem their promissory notes anymore. This threat was effective and on 12 May banks declared to cut their margin credit by 25 percent over the coming weeks. This large shock on credit had immediate consequences. On 13 May, later known as the "Black Friday", the whole stock market tumbled. The average decrease was 13 percent, but some stocks did far worse. In the following weeks, stocks declined further. The large shock on lending was transmitted to investors. The Berlin banks did not prolong the credit used to buy stocks and forced investors to liquidate their positions. Transaction tax revenues, a proxy for volume, increased during May and June, but dropped sharply afterwards.[4] Other German banks did cut their stock market credit on a much smaller scale. The empirical section will use these differences across banks. However, to establish a link between changes in margin credit and asset price movements, the margin cuts at the Berlin banks must affect different stocks than the margin cuts at other banks. The next section describes how I establish a relationship between banks and stocks.

3.4 Germany before WW II: Bank-firm connections and the stock market

The Economist described the German banking system in 1911 like this:

> "The German banks have a much wider sphere of action than our English deposit banks. Besides doing the same kind of business they are stock, bill, and exchange brokers and dealers, banker-merchants, trust, financial, and promoting companies, etc. What may be described as their chief merit and defect is their intimate connection with German industrial life...Not only have the banks promoted most of the industrial joint-stock companies, and retain part of their share capital, but their managing directors remain members of the board of these companies..." *(The Economist, 21 October 1911)* [5]

[3] Schacht could not be convinced that margin credit was still low compared to historical standards. At the end of 1910, the six Berlin banks had given out 1074.2 Mio RM of margin credit (Benning 1929)

[4] Benning (1929), page 146

[5] While this quote stems from before WW I, it was valid until WW II. The *Wall Street Journal* wrote on 5 May 1931 that "Bank heads hold directorships in scores of companies, and the banks themselves retain holdings in shares they have issued".

German universal banks had very strong firm connections – a bank's CEO sat on the supervisory board of a firm, a bank was a firm's main creditor, and when a firm wanted to go public, its connected firm was the natural choice as underwriter. On the stock market, the connection between a firm and a bank did not end with a public equity offering. A bank held an inventory of stocks of connected firms and actively intervened in the stock market in case of order book imbalances. The bank therefore was a stock's main liquidity provider and soothed price fluctuations due to order imbalances. When it came to investment advice to their clients, banks would strongly suggest to invest in firms they made markets in. These firms were backed by the same institution a client had picked in the first place. When in stocks connected to the same bank, clients also faced more liquid markets. Banks not only made markets at the Berlin stock exchange, but also matched trades internally.

Clients financed a large part of their stock purchases with margin credit. The lending bank took the purchased stocks as collateral. Since banks had better information in stocks of connected firms and also market power in these stocks, taking on stocks of connected firms as collateral was less risky than taking on other stocks. This informational advantage gave banks further incentives to bias their investment advice strongly towards affiliated firms.

This bias in clients' portfolios allows me to establish differences in selling pressure across stocks. Clients of the large Berlin banks held mostly stocks of firms affiliated with the Berlin banks. When these banks issued their margin calls, most of their clients could not satisfy them. They were forced to liquidate their investments and large amounts of stock came to the market. Short of cash, banks were in no position to intervene in the market on a large scale. Stocks not connected to the large Berlin banks did experience much lower selling pressure induced by margin calls. This is the main identifying assumption to establish a direct relationship between a cut in margin credit and asset price movements. The next section describes the data used to show this relationship.

4 Data and descriptive statistics

The main data are daily stock prices and underwriter prospectuses to establish bank-firm connections. I use two samples: the full sample and the single-underwriter sample. The full sample consists of daily stock prices for 147 firms between February 1,1927 and July 1, 1927. Most of these firms had one or two large underwriters, while some firms had up to 6 Berlin banks as underwriters. Same parts of the analysis make use of a sub-sample, which consists of 98 firms that had a single underwriter. Prices are digitalized from newspaper scans of the *Berliner Börsen Zeitung*. Bank-firm connections are established with IPO and SEO prospectuses held at the German National Archives in Berlin. The archives hold firm-specific files of over 300 publicly listed firms before WW II and I select all firms still active

in 1927. Bank balance sheet data are taken from the newspaper *Vossische Nachrichten*, which published banks' balance sheets for the Berlin banks every two months. Aggregate data (monthly stock market index, aggregate margin credit data for all big banks) are taken from the *Statistische Jahrbücher für das Deutsche Reich*.
Table 3 summarizes firms' characteristics. Most firms are from the manufacturing sector, although they differ in size. While the mean share capital in the lowest size quartile is 1.33 Million RM, the mean share capital is 108.63 Million RM in the largest quartile. These differences are not perfectly reflected in the number of underwriters. Share capital and the number of underwriters are positively correlated, however, this correlation is far from perfect (0.5). The mean number of underwriters is below 1.5 for all but the biggest firms.

Table 4 summarizes firms with only one large underwriter. It provides mean and median share capital for each bank-specific portfolio. The largest portfolio in the sample is the Deutsche Bank portfolio. Most portfolios are similar in median share capital, with the Commerzbank being an exception. Mean share capital differs more and ranges from 11.95 Million RM for the BHG to almost 20 Million RM for the Danatbank portfolio.[6]

5 Margin credit and asset price behavior

When the Berlin banks were forced to change their lending policies, they issued margin calls to their clients. They did not roll-over the majority of stock market debt and increased margins, the proportions investors had to pay out of their own wealth. Most of their clients could not satisfy these margin calls. However, other banks were less affected as they were not subject to the threat of the Reichsbank. This section looks at the asset pricing implications of such a large change in lending policy. The first section shows that stocks affiliated with large banks became more volatile. The second part takes a closer look at this general result. The behavior of returns and volatility differed also across firm size and the number of underwriters.

5.1 Deleveraging and stock price movements: Summary statistics

After the Berlin banks had issued their joint statement, stocks experienced differences in selling pressure. This section provides a first glance at the consequences of these differences. It provides summary statistics for stocks that were connected to Berlin banks and other stocks.

Figure 1, already introduced in a previous section, shows that when the Berlin banks issued their margin calls, stocks of affiliated firms declined. Over the following weeks, the

[6]While there were six big banks in 1927, balance sheet data are not available for the *Berliner Handels Gesellschaft*. This limits my single underwriter sample for most part of the analysis to the five banks *Commerzbank, Deutsche Bank, Discontogesellschaft, Darmstaedter-und Nationalbank (Danatbank)* and *Dresdner Bank*.

stock price of a firm connected to a large underwriter declined on average more than 12 percent until the end of June. Firms that were not connected to a large underwriter were less affected. Such stocks declined on average only 8 percent. These differences in behavior did not occur immediately when the Berlin banks issued their statement. At 13 May, both groups declined equally. But over time, the differences became visible. Further, volatility spiked for affected firms. During the following two months, Berlin-bank-affiliated stocks were more volatile than other stocks.

These results can also be seen in Table 5. The table provides mean daily returns, the standard deviation of returns, mean firm-specific return volatility, and measures for order book imbalances before and after 12 May. Mean daily returns decline for both groups of firms after 12 May. Volatility declines for firms without a connection to Berlin banks. However, volatility almost doubles for firms connected to a large underwriter. As these banks cut their margin lending, asset prices of firms connected to them started to fluctuate. The next section will control for several factors that may influence this result and show that this basic finding is robust to several criticisms.

5.2 Baseline results

The simple descriptive statistics can neither account for differences across firms nor for differences across time. To properly address the question whether a change in lending policy had asset pricing implications, I use a difference-in-differences approach. The baseline specification is given by

$$y_{it} = \beta(Bank_i * May_t) + \gamma_{it} + \epsilon_{it} \tag{1}$$

y_{it} is the value of the dependent variable for firm i at time t. $Bank_i$ is a dummy that is 1 if firm i is connected to a large bank and 0 otherwise, May_t is a dummy that is 1 after the margin call at 12 May and 0 before, and γ_{it} is a vector if firm and time dummies to account for level differences. Table 6 reports the results for volatility and returns as dependent variables. The first two columns look at firm-specific return volatility. The regressions confirm the graphical evidence: Stocks connected to Berlin banks fluctuated more after 12 May. Compared to non-large bank firms before May 1927, volatility increases by 0.31 standard deviations. Using a regression without fixed effects, $var_{it} = \beta_1(Bank_i * May_t) + \beta_2 May_t + \beta_3 Bank_i + \epsilon_{it}$, β_1 has the largest impact on the outcome variable. Its standardized coefficient is 0.16, whereas the standardized coefficient for β_2 (β_3) is -0.02 (0.004). The increase in volatility is robust to including firm- and time fixed effects (column 2).

The stock price indices showed that stocks connected to large banks had lower cumulative returns during the weeks following 12 May. However, we cannot find a significant impact on daily returns. Not accounting for fixed effects, mean daily returns were -180 percent in annualized returns for the whole sample before May. The further decline in

May is not significantly larger for firms connected to the Berlin banks.

Table 7 turns to order book imbalances. German newspapers did not report volume data or bid-ask spreads. They did, however, report the existence of order book imbalances. This information is used in Table 7. Columns 1 and 2 use an indicator for excess supply as dependent variable. This indicator is 1 if there existed a supply order imbalance for stock i at day t and 0 otherwise. Columns 3 and 4 employ a similar indicator to analyze demand order book imbalances. With respect to supply order imbalances, stocks did not differ according to their bank affiliation. However, there are significant differences in demand order book imbalances. Stocks connected to Berlin banks did have on average less demand imbalances. Further, during the crisis period, the decline in imbalances is significantly less pronounced than for other firms; the coefficient of the interaction term is positive. However, this result is driven by stocks of smaller firms. When observations are weighted by the size of firm share capital, the interaction term becomes insignificant (column 5).

The strong deleveraging of the Berlin banks had asset pricing implications. Stocks of affiliated firms fluctuated more as banks put pressure on their clients. However, even within the two groups, some firms experienced larger selling pressure than others. The next section addresses these additional differences.

5.3 Returns and volatility: Further differences across stocks

Given the same shock, selling pressure often differs across stocks. If demand is downward-sloping, these differences have asset pricing implications. Greenwood and Thesmar (2011) show that stocks are more fragile if their ownership base is either more concentrated or when liquidity shocks are correlated across investors. In these cases, selling pressure increases because liquidity shocks are less likely to cancel out across investors. The larger the affected fraction of a stock's ownership base, the larger is the price impact. For example, if several mutual funds experience the same shock, stocks commonly owned by several funds start to co-move (Anton and Polk 2014).

The previous section showed that selling pressure was larger for stocks affiliated with the Berlin banks. This section takes a closer look at the differences across stocks before and after 12 May 1927. Besides a large bank connection, which further characteristics determined the selling pressure after the margin calls? The first part of this section looks at firm size, while the second part looks at the number of underwriters. Both characteristics measure indirectly which proportion of stockholders was affected by the margin calls. The larger this proportion was, the more these stocks declined over the following weeks. Further, the impact on volatility increased as well.

5.3.1 Firm size

Firm size affects how widespread stocks are held. Stocks of larger firms are often assumed to be safer and to have smaller information asymmetries. The stock market in interwar Germany was no exception. Stocks of large companies like Siemens were widely held as safe investments. Even banks that did not act as underwriter for these firms often accepted them as collateral. Clients of Berlin banks held them in their portfolios even if the bank had no direct affiliation. Firm size therefore proxies for how many owners of a stock were affected by margin calls of the large banks. Larger firms experienced stronger selling pressure.

Figure 7 shows how returns and return volatility differed for firms of different size. Firm size is measured by share capital and the graph plots mean stock price indices and mean volatility indices for each size quartile. Looking at returns, the impact of the margin calls increases with firm size. On the day of the stock market crash, firms in the first size quartile decreased on average 2.26 percent. The same day, firms in the largest size quartile decreased 11.83 percent. These differences persisted over time. One month after the announcement of the Berlin banks, small firms had declined on overage 8.32 percent since 12 May. The largest firms had experienced a mean cumulative return of 15.04 percent.

Not only did stocks of large firms decline stronger, they also fluctuated more. The second panel of Figure 7 shows mean firm-specific return variance for the four size quartiles. Before 12 May, a commonly known characteristic can be seen: Larger firms are more stable; smaller firms fluctuate more. However, this finding turns after 12 May. At the onset of the crisis, stocks of large firms start to fluctuate heavily. Mean volatility for larger firms doubles in the period after 12 May compared to the weeks before. Mean volatility for firms in the first size percentile decreases slightly from 0.001 to 0.0009.

After 12 May, large firms lost their characteristic as safer investments. Although their "ownership base was disperse", in the words of Greenwood and Thesmar (2011), most owners were affected by the Berlin banks' margin calls. As a consequence, these stocks reacted sharper on impact and fluctuated stronger during the crisis period. The next section turns to another proxy for the impact of the margin call on stockholders.

5.3.2 Number of large underwriters

The previous section argued that larger firms were used more often as collateral because they were considered to be safer investments. This observation is not specific to interwar Germany and even applies to todays markets. However, other characteristics exist to proxy the impact of the margin call on stockholders. One characteristic is specific to the close bank firm connections in pre-WW II Germany: the number of large underwriters. The fraction of stockholders connected to a large bank increased if a firm had more than

one large underwriter. Figure 8 plots stock price and volatility indices depending on the number of large underwriters. Looking at the returns directly after 12 May, no large differences can be observed. On impact, stocks connected to no large underwriter had the same negative returns as stocks connected to one or more underwriters. During May and June 1927, however, differences emerged. As large underwriter banks started to send out their margin calls to individual investors, prices of stocks connected to these banks slipped. One month after the shock, prices had declined on average 14 percent for firms with two or more large underwriters. During the same period, firms with no large underwriters saw negative returns of only 7.3 percent. Further, after the Reichsbank's intervention volatility was increasing in the number of underwriters (right panel).

Firm size and the number of underwriters both allow us to proxy the fraction of the ownership base hit by margin calls. However, these measures are correlated. Although the correlation is far from perfect, the two graphs just described may still pick up the same mechanism.[7] Larger firms had more underwriters; the number of underwriters may only reflect this fact. Can each characteristic on its own explain differences in asset price behavior? To disentangle the effects, I run the following regression:

$$y_{it} = \beta May_t * Charac_i + \gamma_{it} + \epsilon_{it} \tag{2}$$

where y_{it} is either the return or return volatility of stock i at day t. Volatility is the variance of returns measured over the period $t-5$ to t. May_t is a dummy that is one after 12 May 1927 and 0 otherwise and γ is a vector of controls that includes firm dummies and a constant. $Charac_i$ describes a firm characteristic, which can be a vector of size dummies, or a vector of underwriter dummies. Table 8 reports the results. The effects of size and the number of underwriters on returns and volatility are estimated alone or jointly (columns 3 and 6). Whereas Figures 7 and 8 showed cumulative returns, daily returns did not significantly differ across firm size or the number of underwriters after 12 May. The exception were the largest firms. However, volatility was strongly influenced by firm size or the number of underwriters. Volatility was significantly larger for firms in size quartile 3 and 4 during May and June 1927 (column 4). The same holds true for firms with one or more large underwriters (column 5). Estimated jointly, both effects have explanatory power. Nevertheless, the coefficients for firm size decrease only slightly, whereas decreases in the underwriter coefficients are more pronounced.

This section showed that the behavior of stocks differed along several dimensions. The initial argument used only differences across stocks based on whether they were connected to a large bank or not. Additionally, firm size and the number of underwriters can explain part of the behavior of asset prices after 12 May 1927. Both characteristics are proxies for the fraction of the ownership base affected by the credit squeeze. However, so far we have only looked at stock-specific characteristics. I cannot rule out that these characteristics

[7] In the sample, firm size and the number of underwriters have a correlation coefficient of 0.5.

are further correlated with other, unobservable variables that affected selling pressure. To address this problem, the next section turns to the intermediaries themselves. It investigates whether differences in lending policies affected asset prices and which balance sheet positions can explain lower returns or higher volatility. Linking changes in margin credit directly to asset price behavior shows that the results obtained in the baseline regressions are not driven by other differences between large bank firms and other firms.

6 Balance sheets and asset price behavior

Aggregate intermediary balance sheet variables have strong predictive power for excess returns (Adrian, Moench, and Shin 2010). This section links asset price behavior directly to changes in margin credit at individual banks. The first part shows that stocks fluctuated more if they were connected to a bank that sharply cut its margin lending. Part 2 turns to order book imbalances. The last part shows that the baseline results are robust to the problem of reverse causality.

6.1 Margin credit, returns, and volatility

The analysis so far showed that a contraction in credit led to higher volatility in interwar Germany. The baseline results use the differences between two groups of firms: Firms connected to large underwriter banks and firms with no connection to these banks. Differences in asset price behavior are then attributed to different deleveraging between Berlin banks and other banks. Berlin banks had to change their lending policies and stocks related to these banks became more volatile. However, other characteristics influenced returns and volatility as well; Berlin bank related firms may be inherently different from other firms. This section turns to a more homogeneous sample: Firms that are affiliated with a single Berlin bank. To identify how margin credit affected asset prices, I now use only differences in lending policies between the Berlin banks. For example, Diskonto Gesellschaft decreased its margin credit by 41.56 percent during May and June. In the same period, Commerzbank cut its credit by only 15.63 percent. In terms of absolute decrease, Deutsche Bank experienced the largest decline – 67.29 Million RM. Did these differences induce different asset price behavior for affiliated firms?

Table 9 provides a first look at the single underwriter sample. It reports the results of the following regression:

$$y_{ibt} = \beta May_t + \alpha + \epsilon_{ibt} \tag{3}$$

where y_{ibt} is the daily stock returns of stock i connected to bank b at day t in the upper panel of the table. In the lower panel the dependent variable is return volatility. May is a dummy that is 1 after 12 May and 0 otherwise. The regression is estimated for each bank-portfolio b separately.

Daily returns were only significantly lower during May for firms connected to Deutsche Bank. For all stocks, volatility was higher during May and June than before. However, the increase in volatility differs across bank-portfolios. Stocks connected to the Commerzbank saw the lowest increase in volatility. The shock of 12 May had a much larger impact on stocks connected to Deutsche Bank and Diskonto Bank. The strength of the coefficients correlates with the level of deleveraging a bank experienced.

A panel framework can address this hypothesis properly. It allows us to control for differences across bank portfolios and common factors. Further, since each stock is connected to a single bank, the change in credit can be directly used in the regressions. The specification is given by

$$y_{ibt} = \beta_1 May_p * Credit_{bp} + \gamma + \epsilon_{ibt} \tag{4}$$

and the results are reported in Table 10. y_{bit} is either daily returns or volatility. $Credit_{bp}$ is specific for bank b during period p, which are bi-monthly intervals. $Credit_{bp}$ is either the total amount of margin credit outstanding by bank b during p (columns 1 and 3) or the absolute change in margin credit (columns 2 and 4). γ includes several controls. All regressions control for firm- and time-fixed effects.

As in the larger sample, daily returns did not change significantly across firms connected to different banks (columns 1 and 2). Neither the level of credit nor its change had a significant impact on returns. Volatility, however, was significantly affected by banks' credit policies (columns 3 and 4). Over the whole sample, the overall level of stock market credit had a negative impact on return volatility. A one standard deviation increase in the level of stock market credit decreased a stock's return volatility by 0.25 standard deviations. This effect was not significantly different after 12 May. The impact of a change in the level of credit did have a significant impact on return volatility during the crisis period (column 4). A negative change in the level of credit led to larger volatility. During May and June, a stock saw a 0.22 standard deviation increase in volatility if the change of credit decreased by one standard deviation on the affiliated bank's balance sheet.

6.2 Credit and order book imbalances

The volume on the Berlin stock exchange increased sharply during May and June 1927.[8] So far we saw that the increase in volume did not lead to significantly higher order book imbalances. However, when comparing only non-Berlin bank firms with Berlin bank firms, we may average out differences within the latter group. Table 11 shows the frequencies of order book imbalances before and after 12 May for each bank-specific portfolio. The table provides a more detailed view on the behavior of order book imbalances. Excess supply decreased for firms connected to banks with small decreases in margin credit (Commerzbank,

[8]No direct volume data is available. However, income from monthly transaction taxes increased during May and June 1927.

Dresdner Bank). If a firm was affiliated to banks with large credit cuts, the frequency of excess supply increased (Deutsche Bank, Danatbank). These differences across banks are confirmed in Table 12. Instead of returns or volatility, the frequency of order book imbalances is now used as dependent variable. The overall level of margin credit had a negative impact on the frequency of supply order imbalances and a positive impact on demand order imbalances. During the large deleveraging of some banks, however, the relationship changes. Stocks connected to more active lenders were more likely to be in excess supply. Further, the absolute change in margin credit had a significant impact on the probability of excess supply during the crisis period (column 2).

This section refined the baseline results and confirmed the negative impact of changes in margin credit on return volatility. But, even in the absence of mark-to-market, the results may still be prone to problems of reverse causality. Higher asset prices could have influenced banks lending decisions. The next section addresses this criticism.

6.3 IV strategy

When intermediaries account for their assets in real time (mark-to-market), changes in asset prices and changes in margin credit may reinforce each other (Brunnermeier and Pedersen 2009). A decrease in prices can lead to a further tightening of credit constraints and additional fire sales may follow. In the context of 1927 Germany, the problem of real time accounting is not present. Nevertheless, rising asset prices may still have influenced banks' lending decisions. The previous results may be biased due to the problem of reverse causality. Further, the previous section used daily returns, whereas banks' balance sheet variables vary at a lower frequency. Within a given two-month balance sheet period, we do not exactly know when the decrease in credit occurred.

I address the latter problem by aggregating all variables on a bi-monthly basis. The following analysis uses mean daily returns and mean firm-specific volatility as dependent variables. Means are taken over the periods where balance sheet variables change.

To address the problem of reverse causality, I use the Reichsbank's threat against the Berlin banks in a two-stage least squares specification. Berlin banks were heavily dependent on promissory notes. Each bank held a large portfolio of such notes. In times of liquidity needs, they could redeem these claims at the Reichsbank in return for cash. However, the Reichsbank's willingness to redeem large amounts of promissory notes started to decrease during the run-up to the crisis. Although never stated officially, historians agree that Schacht started to threaten private banks: Not cutting margin lending would come at the price of not having access to the Reichsbank's liquidity. The threat worked. I will instrument the absolute change in margin credit during balance sheet period s by the level of a bank's promissory notes portfolio in period $s-1$. Further, the interaction term of change in margin credit with the May dummy is instrumented by the interaction of the

lagged promissory portfolio and the May dummy. For this to be a valid instrument, the level of a bank's promissory notes portfolio cannot influence future asset price movements of affiliated firms except through the Reichsbank's threat. Each bank held promissory notes of a large spectrum of industrial firms. While the previous owners of these notes were mainly bank-affiliated firms, the debtors were not. It is therefore reasonable to assume that a portfolio composed of debts of different firms did not directly influence future asset price movements of bank-affiliated firms.

The first stage regressions are given by

$$Change_{bs} = \beta_1 Notes_{b,s-1} + \beta_2 Notes_{b,s-1} * May_s + \gamma_{bs} + \epsilon_{ibs} \tag{5}$$

$$Change_{bs} * May_s = \beta_3 Notes_{b,s-1} + \beta_4 Notes_{b,s-1} * May_s + \gamma_{bs} + \epsilon_{ibs} \tag{6}$$

$$\tag{7}$$

where $Change_{bs}$ is the change in bank b's margin lending during the bi-monthly period s and $Notes_{b,s-1}$ is the stock of promissory notes of bank b during period $s-1$. The vector γ_{ibs} includes time fixed-effects and bank fixed effects. The instruments are relevant. β_1 in the first regression has a t-statistic of 9.68 and the coefficient on the interaction term in the second regression, β_4, has a t-statistic of -21.21. In both regressions the null hypothesis of an F-test about the relevance of the instruments can be easily rejected.

The results for the second stage are obtained by the regression

$$var_{ibs} = \beta_1 \widehat{Change}_{bs} + \beta_2 (\widehat{Change_{bs}} * May_s) + \gamma_{ibs} + \epsilon_{ibs} \tag{8}$$

where $\widehat{Change}_{bs}$ and $\widehat{Change_{bs}} * May_s$ are obtained in the first-stage. Table 13 reports the results. In the first column, daily stock returns are the dependent variable in the second stage. The results obtained in the OLS regressions are confirmed – changes in margin credit did not significantly affect daily returns. Further, larger negative changes in May did not have a significant influence neither. Turning to volatility (Column 2), both coefficients of interest are significant. The absolute change in margin credit had a positive effect on volatility. But during the downturn in May, a large unwinding of credit increased volatility as well.

This section showed that the results obtained using OLS are robust to the critique of reverse causality. Using the threat of the Reichsbank against the Berlin banks as an instrument, changes in margin credit still significantly affect return volatility.

7 Conclusion

Do tighter lending standards induce fire sales, price dislocations, and worsen financial crises (Gromb and Vayanos 2002, Brunnermeier and Pedersen 2009)? This article provides a historical case study where a large change in lending standards induced stock market

volatility. When the German central bank forced some banks to size down their margin lending, stocks connected to the affected banks declined significantly more than other stocks during the following weeks. Return volatility of these stocks doubled.

In the absence of marking-to-market, this study is a lower bound of the impact of deleveraging on asset prices. However, this historical case cannot answer the severeness of second round effects, asset price spirals, and margin spirals. The recent crisis has shown the importance of a more detailed knowledge of these issues, for academics as well as policy makers. Further quantitative studies can guide regulation regarding capital buffers and intermediaries' balance sheet capacity.

Before being appointed as head of the Federal Reserve, Janet Yellen said that "it is important for the Fed, as hard as it is, to try to detect asset bubbles when they are forming."[9] Yet the experience of 1927 shows that more research is needed to understand the interaction of asset market intervention, bank balance sheets, and macroeconomic outcomes. Adrian, Moench, and Shin (2010) provide first insights in the co-movement of banks' balance sheets and macroeconomic dynamics. The results presented here show the importance of a financial sector in quantitative macroeconomic models. Adopting regulators' and policy makers' toolkit to incorporate a financial sector poses a challenge for future research. An emerging literature takes on this challenge (see, for example, Brunnermeier and Sannikov (2014)) and future research in this direction will be important to avoid the mistakes of 1927.

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A Tables

Table 1: **Balance sheets: Berlin banks and other banks.** This table provides an overview of various bank balance sheet variables for the Berlin banks and province banks. All variables are in Million RM. Equity in the last line is defined as share capital plus reserves.

	Feb 1925	Feb 1926	Feb 1927	Oct 1927
Berlin Banks				
N	6	6	6	6
Total assets	4472.6	5466.2	7447.4	8560
Stock market credit	53.2	164.8	896.1	556.2
Promissory notes	883.5	1243.9	1486.8	2083.3
Share capital	452	452	509	527
Reserves	170.3	177.7	213.4	261.3
Assets/Equity	7.19	8.68	10.31	10.86
Provincial banks				
N	75	80	79	74
Total assets	1543	2197.4	3275.4	3569.6
Stock market credit	33.7	43.6	198.3	107.2
Promissory notes	287.3	362.8	408	461.3
Share capital	281.1	318.8	367.7	395.5
Reserves	58	77.5	101.7	106.4
Assets/Equity	4.55	5.54	6.98	7.11

Table 2: **Berlin banks' balance sheets.** This table provides an overview of various bank balance sheet variables at different points in time. The table reports on the asset side the stock of promissory notes, the value of the stock portfolio, and stock market credit. On the liabilities side, share capital is reported. Liquidity is the ratio of short-term assets over short-term liabilities. All variables are in Million RM.

				Change (in percent)	
	30.4.1925	30.4.1927	30.6.1927	30.4.25-30.4.27	30.4.27-30.6.27
Deutsche Bank					
Promissory notes	320.76	410.38	167.52	27.94	-59.18
Stock portfolio	12.88	28.88	26.95	124.22	-6.68
Stock market credit	3.03	198.7	131.41	6457.76	-33.87
Share capital	150	150	150	0.00	0.00
Liquidity	0.039	0.045	0.047	16.34	4.92
Disconto Gesellschaft					
Promissory notes	149.56	248	275.06	65.82	10.91
Stock portfolio	5.18	10	10.22	93.05	2.20
Stock market credit	0.73	113.68	66.43	15472.60	-41.56
Share capital	100	135	135	35.00	0.00
Liquidity	0.020	0.038	0.034	92.03	-10.80
Dresdner Bank					
Promissory notes	198.39	291.52	262.8	46.94	-9.85
Stock portfolio	12.36	26.09	25.47	111.08	-2.38
Stock market credit	13.22	171.1	115.12	1194.25	-32.72
Share capital	78	100	100	28.21	0.00
Liquidity	0.032	0.020	0.036	-37.42	79.63
Danatbank					
Promissory notes	203.8	268.15	270.94	31.58	1.04
Stock portfolio	18.24	19.64	22.13	7.68	12.68
Stock market credit	16.55	182.89	123.8	1005.08	-32.31
Share capital	60	60	60	0.00	0.00
Liquidity	0.031	0.027	0.034	-12.08	23.53
Commerzbank					
Promissory notes	106.33	169.34	165.9	59.26	-2.03
Stock portfolio	14.91	15.83	15.42	6.17	-2.59
Stock market credit	27.56	155.68	131.35	464.88	-15.63
Share capital	42	60	60	42.86	0.00
Liquidity	0.030	0.018	0.038	-38.16	106.37

Table 3: **Descriptive statistics (Full sample).** This table provides descriptive statistics related to firms' share capital. For the total sample as well as for each share capital quartile the table provides the mean, the standard deviation, and the median capital. The table also states the mean number of large underwriters for the total sample as well as for each size quartile. All variables are in Million RM.

	Total	Size quartiles			
		1st	2nd	3rd	4th
Share capital					
Mean	31.88	1.33	4.57	13.85	108.63
St.Dev.	114.19	0.50	1.64	4.95	213.23
Median	7.50	1.30	4.32	12.68	50.00
No. of underwriter					
Mean	1.41	0.97	1.22	1.44	2.00
N	145	37	36	36	36

Table 4: **Descriptive statistics (Single underwriter sample).**This table provides the mean and median share capital and its standard deviation for firms within a bank-specific portfolio. A firm is connected to a bank if the bank is the single underwriter. All variables are in Million RM.

	(1) BHG	(2) Commerz	(3) Deutsche	(4) Diskonto	(5) Danat	(6) Dresdner
Share capital						
Mean	11.95	15.72	16.01	13.79	19.82	15.42
Stan.Dev.	11.91	24.25	21.64	14.74	26.54	33.86
Median	9.20	2.50	7.50	7.55	7.50	6.00
N	3	13	27	16	19	21

Table 5: **Summary statistics before and after margin call.** This table provides summary statistics of the main variables. The variables are differentiated along two dimensions: Whether a firm is connected to a large Berlin bank (*Large bank*) or not (*No large bank*) and whether the period is before or after the margin call. The period before the margin call is from February until 12 May, the period after the margin call is from 13 May until 28 June. The statistics provided are mean daily returns, the standard deviation of daily returns within the large bank or non-large bank sample during the given period, mean volatility (where firm-specific volatility is measured as the variance of returns in a 5 day rolling window), mean supply order book imbalances (*Excess supply*), and mean demand order book imbalances (*Excess demand*).

		Before margin call	After margin call
Returns			
	Large bank	-0.0005	-0.0037
	No large bank	-0.0029	-0.0055
Returns, St.Dev			
	Large bank	0.026	0.041
	No large bank	0.028	0.032
Volatility			
	Large bank	0.00072	0.00138
	No large bank	0.00068	0.00056
Excess Supply			
	Large bank	0.13	0.12
	No large bank	0.12	0.1
Excess Demand			
	Large bank	0.36	0.3
	No large bank	0.43	0.26

Table 6: **Baseline regression: Variance and returns.** This table provides the results for the following regression: $y_{it} = \beta(Bank_i * May_t) + \gamma_{it} + \epsilon_{it}$, where y_{it} is the value of the dependent variable for firm i at time t. $Bank_i$ is a dummy that is 1 if firm i is connected to a large Berlin bank and 0 otherwise, May_t is a dummy that is 1 after the margin call at 12 May (13 May 1927-30 July 1927) and 0 before (1 February 1927-12 May 1927), and γ_{it} is a vector of firm and time dummies. The dependent variables are the return variance calculated as the variance of returns in a 5 day rolling window in columns 1 and 2, and daily returns in columns 3 and 4. Robust standard errors are reported.

	(1) Variance	(2) Variance	(3) Returns	(4) Returns
May*Bank	0.000778***	0.000684***	-0.000620	-0.00141
	(0.000103)	(0.0000963)	(0.00321)	(0.00314)
May	-0.000117		-0.00260	
	(0.0000880)		(0.00310)	
Bank	0.0000442		0.00236	
	(0.0000628)		(0.00174)	
Constant	0.000681***	0.00120***	-0.00292*	0.0127**
	(0.0000591)	(0.000256)	(0.00170)	(0.00566)
Firm FE	No	Yes	No	Yes
Time FE	No	Yes	No	Yes
N	11273	11273	9107	9107
R^2	0.020	0.230	0.002	0.277

Table 7: **Baseline regression: Order book imbalances.** This table provides the results for the following regression: $y_{it} = \beta(Bank_i * May_t) + \gamma_{it} + \epsilon_{it}$, where y_{it} is the value of the dependent variable for firm i at time t. $Bank_i$ is a dummy that is 1 if firm i is connected to a large Berlin bank and 0 otherwise, May_t is a dummy that is 1 after the margin call at 12 May (13 May 1927-30 July 1927) and 0 before (1 February 1927-12 May 1927), and γ_{it} is a vector of firm and time dummies. The dependent variables are a dummy that is 1 if excess supply existed and 0 otherwise (columns 1 and 2), and a dummy that is 1 if excess demand existed and 0 otherwise (columns 3 and 4). Robust standard errors are reported.

	(1) ExcSupply	(2) ExcSupply	(3) ExcDemand	(4) ExcDemand	(5) ExcDemand
May*Bank	0.0101	0.0101	0.108***	0.108***	-0.00137
	(0.0239)	(0.0230)	(0.0357)	(0.0334)	(0.0765)
May	-0.0214		-0.168***		
	(0.0228)		(0.0343)		
Bank	0.0161		-0.0694***		
	(0.0176)		(0.0266)		
Constant	0.120***	0.0704	0.433***	-0.0756	-0.0146
	(0.0168)	(0.0527)	(0.0256)	(0.0586)	(0.0955)
Firm FE	No	Yes	No	Yes	Yes
Time FE	No	Yes	No	Yes	Yes
N	9996	9996	9996	9996	9860
R^2	0.001	0.126	0.006	0.214	0.229

Table 8: **Firm size and number of underwriters.** This table provides the results for the following regression: $y_{it} = \beta May_p * Charac_i + \gamma_{ipt} + \epsilon_{it}$ where y_{it} is the return of stock i at day t or return volatility measured over the period $t-5$ to t. May_p is a dummy that is 1 after 12 May 1927 (13 May 1927-30 July 1927) and 0 before (1 February 1927-12 May 1927) and γ is a vector of controls that includes firm dummies and a constant. $Charac_i$ describes a firm characteristic. This variable is either a dummy for each firm size quartile (*Size 1,2,3,4*) or a vector of dummies whether firm i has 0, 1, or more large underwriters (*1UW, 2+UW*).

	Returns	Returns	Returns	Volatility	Volatility	Volatility
May*Size 2	0.000979		0.00129	0.000225		0.000170
	(0.00145)		(0.00160)	(0.000240)		(0.000258)
May*Size 3	0.00141		0.00167	0.00112***		0.00106***
	(0.00156)		(0.00167)	(0.000365)		(0.000378)
May*Size 4	0.00248*		0.00264*	0.000779***		0.000689***
	(0.00141)		(0.00154)	(0.000242)		(0.000257)
May* 1 UW		-0.00185	-0.00258		0.000601***	0.000304
		(0.00176)	(0.00196)		(0.000165)	(0.000230)
May*2+ UW		-0.000232	-0.00138		0.000909***	0.000512**
		(0.00172)	(0.00185)		(0.000177)	(0.000249)
Constant	-0.0234***	-0.0268***	-0.0243***	0.00179***	0.000980***	0.00249***
	(0.00293)	(0.00241)	(0.00297)	(0.000268)	(0.000227)	(0.000278)
Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes	Yes	Yes
N	8970	9107	8970	11106	11273	11106
R^2	0.276	0.277	0.277	0.236	0.230	0.237

Table 9: **Bank-specific regressions: Returns and volatility.** This table provides the results for estimating the regression $y_{ibt} = \beta May_t + \alpha + \epsilon_{ibt}$, where y_{ibt} is the daily stock return of stock i connected to bank b at day t in the upper panel of the table. In the lower panel the dependent variable is return volatility measured as average firm-specific return variance (5 day rolling window). May is a dummy that is 1 after 12 May (13 May 1927-30 July 1927) and 0 before (1 February 1927-12 May 1927). The regression is estimated for each bank-portfolio b separately. Standardized coefficients are reported.

	(1) Commerz	(2) Deutsche	(3) Diskonto	(4) Danat	(5) Dresdner
Returns					
May	-0.039	-0.057**	-0.011	-0.054	-0.027
	(0.00253)	(0.00187)	(0.00230)	(0.00200)	(0.00191)
N	968	2026	1003	1307	1665
R^2	0.010	0.025	0.010	0.010	0.023
Variance					
May	0.036*	0.161***	0.174***	0.147***	0.106***
	(0.000133)	(0.000164)	(0.0000898)	(0.0000852)	(0.000103)
N	1174	2451	1248	1597	2011
R^2	0.174	0.109	0.144	0.109	0.142

Table 10: **Credit and stock prices.** This table provides the results for the regression $y_{ibt} = \beta_1 CredMeasure_{bs} + \beta_2 CredMeasure_{bs} * May_p + \gamma_{ibt}$, where y_{ibt} is the return of stock i connected to bank b at day t (columns 1 and 2) or return variance (columns 3 and 4). May_p is a dummy that is 1 after 12 May (13 May 1927-30 July 1927) and 0 before (1 February 1927-12 May 1927). The variable $CredMeasure_{bs}$ is the level of margin lending by bank b during the bi-monthly period s in columns 1 and 3 and the absolute change of credit in columns 2 and 4. Robust standard errors are reported.

	(1) Returns	(2) Returns	(3) Volatility	(4) Volatility
Credit	0.0000234		-0.0000145***	
	(0.0000508)		(0.00000353)	
May*Credit	-0.0000497		0.00000119	
	(0.0000344)		(0.00000195)	
Credit Change		-0.0000116		0.00000517
		(0.0000867)		(0.00000603)
May*(Credit Change)		0.0000743		-0.0000192***
		(0.0000832)		(0.00000629)
Constant	-0.0220***	-0.0205***	0.00272***	0.00105***
	(0.00498)	(0.00629)	(0.000498)	(0.000236)
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
N	6969	6969	8481	8481
R^2	0.247	0.247	0.210	0.210

Table 11: **Order book imbalances.** This table provides the frequency of order book imbalances. Order book imbalances are measured by the price tags quoted in the official stock price list.

Bank	Exc.supply		Exc.Demand	
	Before 12 May	After 12 May	Before 12 May	After 12 May
Commerz	0.13	0.12	0.25	0.31
Deutsche	0.12	0.21	0.40	0.31
Diskonto	0.13	0.11	0.31	0.36
Danat	0.11	0.14	0.28	0.31
Dresdner	0.13	0.12	0.33	0.36

Table 12: **Credit and order book imbalances.** This table provides the results for the regression $y_{ibt} = \beta_1 CredMeasure_{bs} + \beta_2 CredMeasure_{bs} * May_p + \gamma_{ibt}$, where y_{ibt} is excess supply or excess demand of stock i connected to bank b at day t. May_p is a dummy that is 1 after 12 May (13 May 1927-30 July 1927) and 0 before (1 February 1927-12 May 1927). The variable $CredMeasure_{bs}$ is the level of margin lending by bank b during the bi-monthly period s in columns 1 and 3 and the absolute change of credit in columns 2 and 4. Robust standard errors are reported.

	(1) ExcSupply	(2) ExcSupply	(3) ExcDemand	(4) ExcDemand
Credit	-0.00160***		0.00291***	
	(0.000431)		(0.000552)	
May*Credit	0.000969***		-0.000951**	
	(0.000303)		(0.000401)	
Credit Change		-0.000490		0.00261**
		(0.000864)		(0.00114)
May*(Credit Change)		-0.00207***		0.00158
		(0.000763)		(0.000979)
Constant	0.269***	-0.00340	0.186*	0.676***
	(0.0826)	(0.0352)	(0.109)	(0.0585)
Firm FE	Yes	Yes	Yes	Yes
Time FE	Yes	Yes	Yes	Yes
N	10584	10584	10584	10584
R^2	0.099	0.099	0.216	0.215

Table 13: **IV results.** This table provides the results for the second stage regression $y_{ibs} = \beta_1 abs.CreditChange_{bs} + \beta_2 abs.CreditChange_{bs} * May_s + \gamma_{ibs}$, where y_{ibs} is the daily return of stock i connected to bank b during the bi-monthly period s (column 1) or return volatility (column 2). May_p is a dummy that is 1 for May and June. The variable $abs.CreditChange_{bs}$ is instrumented by $Prom.notes_{b,s-1}$, which is the level of promissory notes of bank b during the previous period. The interaction term $abs.CreditChange_{bs} * May_s$ is instrumented by $Prom.notes_{b,s-1} * May_s$. The instruments are relevant and the first-stage t-statistics are 9.68 and -21.21, respectively.

	(1) Returns	(2) Volatility
abs.CreditChange	-0.0000461	0.0000916*
	(0.000276)	(0.0000535)
May*(abs.CreditChange)	0.0000622	-0.0000832**
	(0.000210)	(0.0000393)
Constant	0.00181	0.00108
	(0.00844)	(0.000829)
Firm FE	Yes	Yes
Balancedate FE	Yes	Yes
N	267	264
R^2	0.611	0.550

B Figures

Figure 1: **Returns and volatility.** This figure plots stock price indices and return volatility for two groups of firms. The "Non large banks" group is composed of firms that do not have a connection to a large Berlin bank. The "large bank" group is composed of firms that have a connection to at least one large Berlin bank. All stock price indices are normalized to 100 at 12 May 1927. Volatility is calculated as the average firm-specific return variance using a 5 day rolling window.

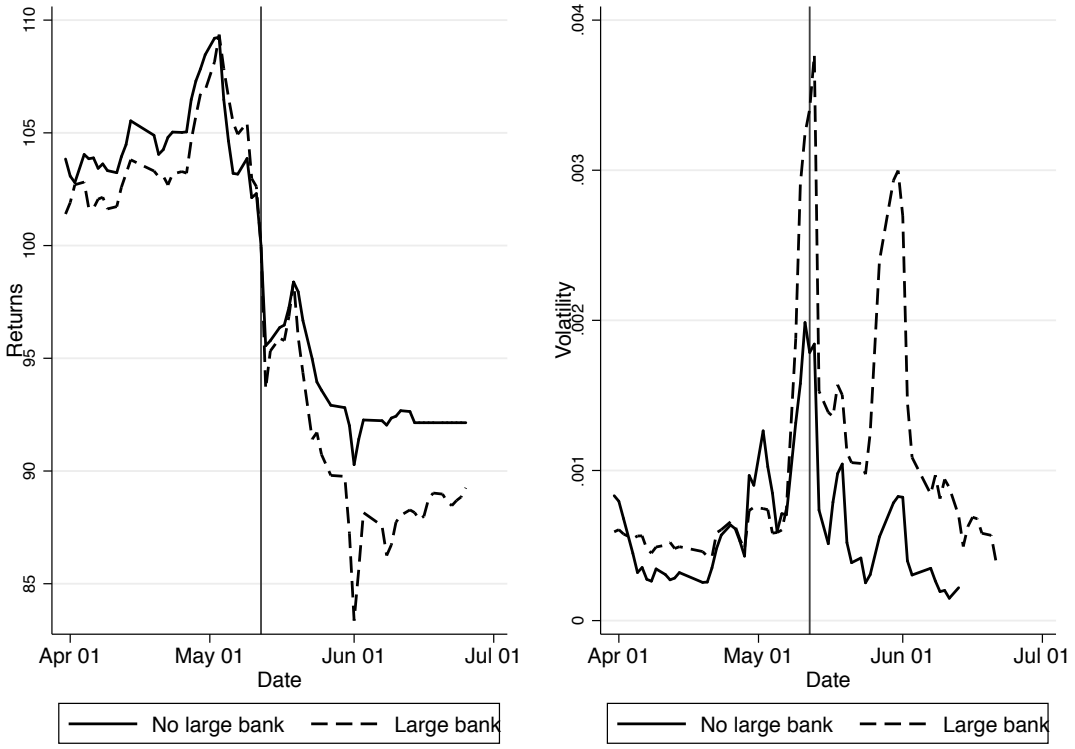

Figure 2: **Stock market credit and the overall stock market.** This figure plots a stock market index and the overall position of banks' margin lending between January 1925 and January 1928. The vertical line represents 12 May 1927. The aggregate data are taken from the statistical yearbooks of the German Reich.

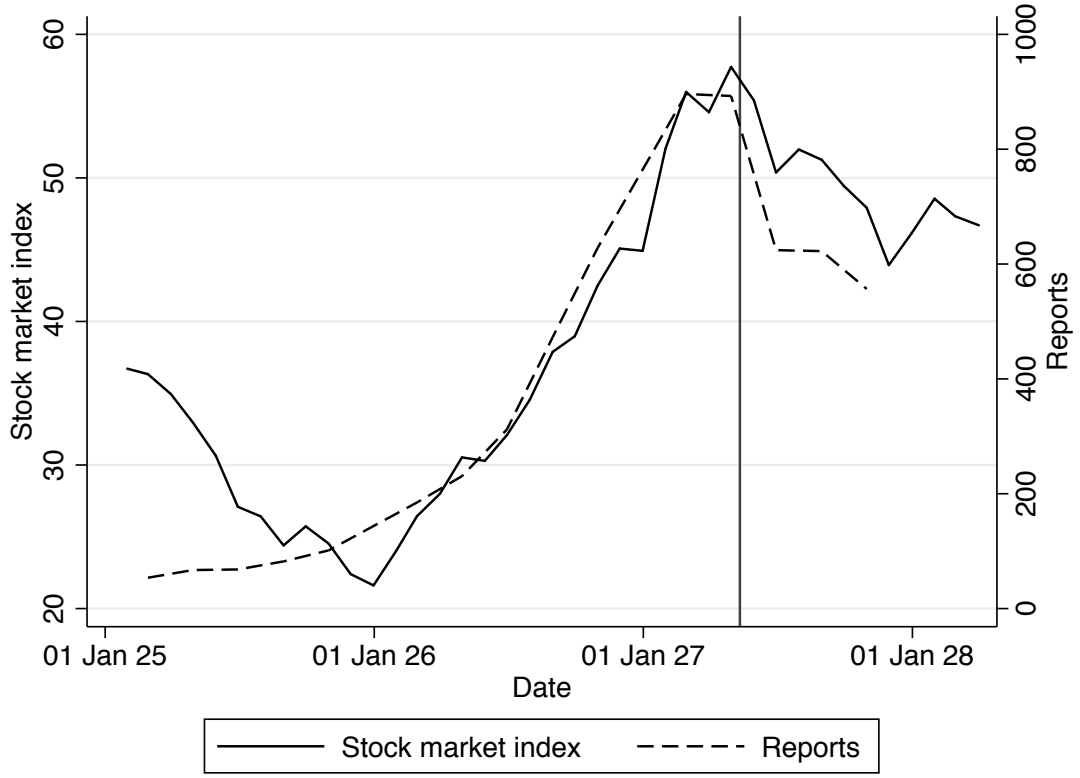

Figure 3: **Berlin banks and province banks.** This figure plots the ratio of assets over equity and the level of margin lending for two groups of banks, the Berlin banks and province banks. The left panel shows the ratio of assets over equity for both groups. The right panel shows the level of margin lending by both groups.

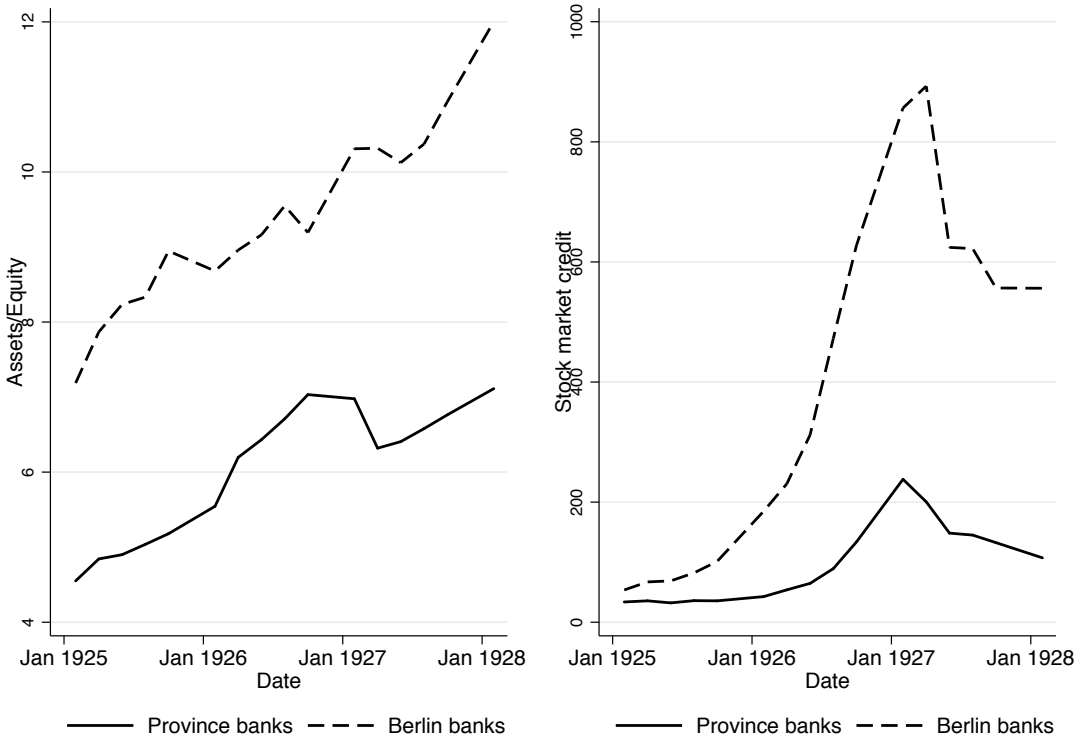

Figure 4: **Leverage and margin lending by Berlin banks.** This figure plots the ratio of assets over equity and the level of margin lending each of the Berlin banks. The left panel shows the ratio of assets over equity for each bank. The right panel shows the level of margin lending by each bank.

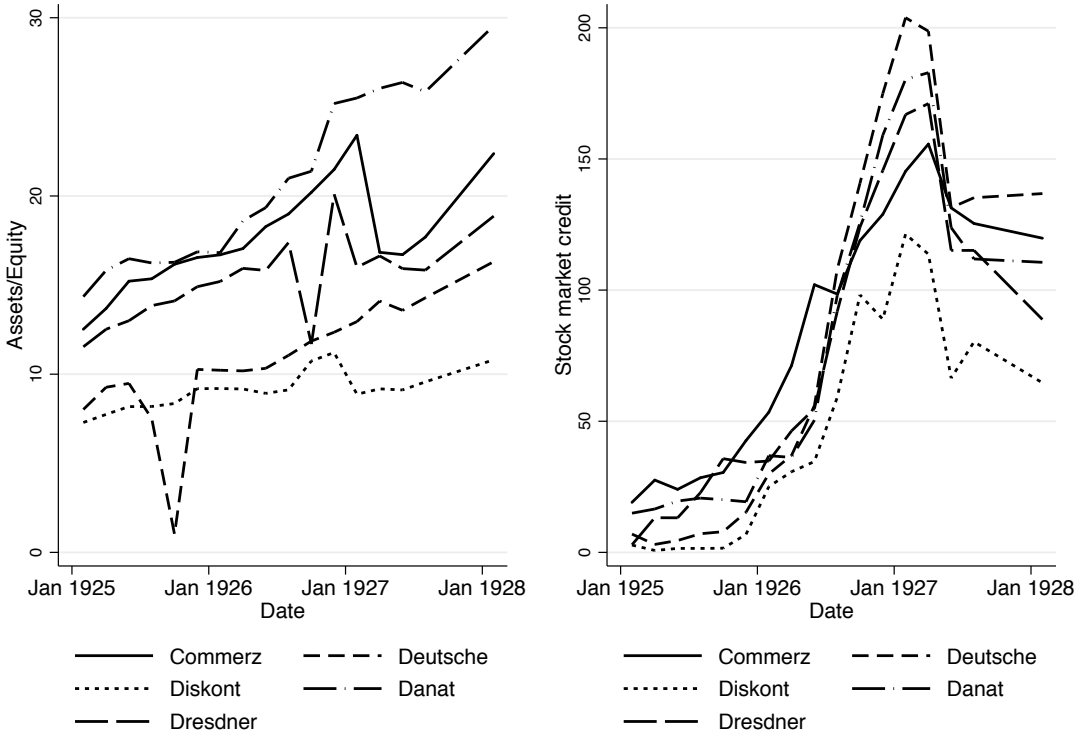

Figure 5: **The Reichsbank's promissory notes portfolio.** This figure plots the evolution of the promissory notes held by the Reichsbank between January 1926 and July 1928. The vertical line marks 12 May 1927. No data are available between November 1927 and March 1928. The data are taken from the statistical yearbooks of the German Reich.

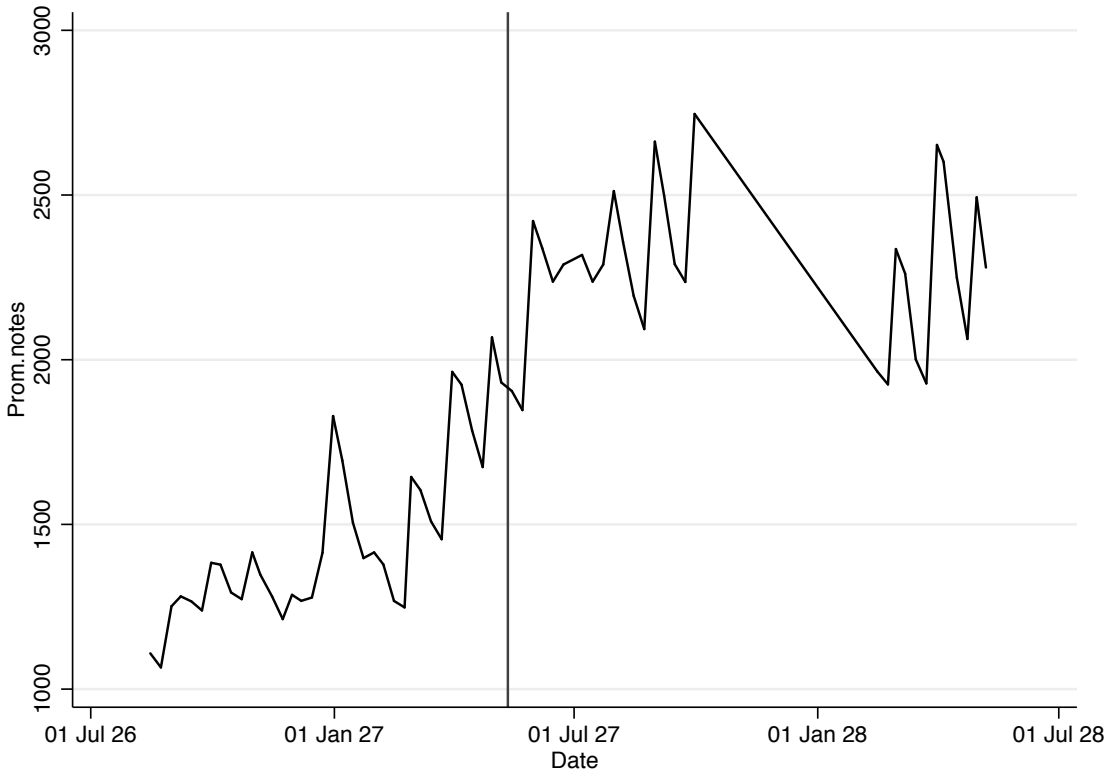

Figure 6: **The Reichsbank's foreign exchange.** This graph shows the evolution of the foreign exchange in the hands of the Reichsbank as stated in the Reichsbank's balance sheets. The vertical line marks 12 May 1927. No data are available between November 1927 and March 1928. The data are taken from the statistical yearbooks of the German Reich.

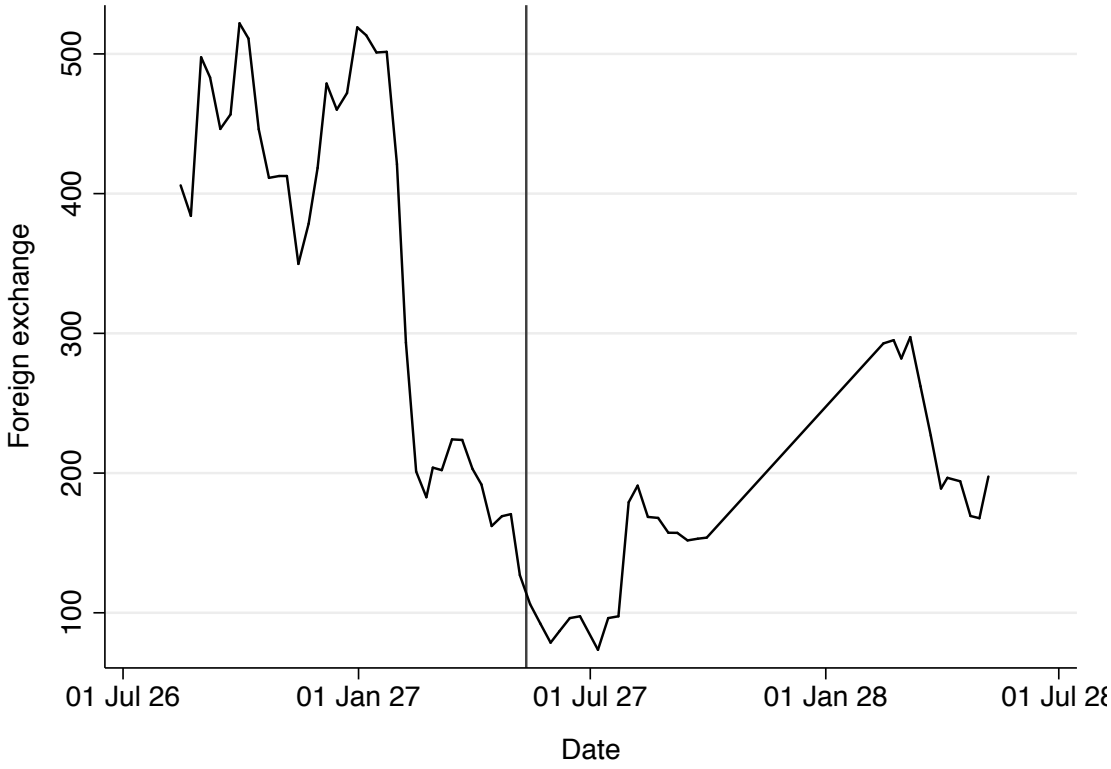

Figure 7: **Differences by size.** This figure plots stock price indices and return volatility for firm size quartiles. Firm size is measured by share capital. All stock price indices are normalized to 100 at 12 May 1927. Volatility is calculated as the average firm-specific return variance using a 5 day rolling window.

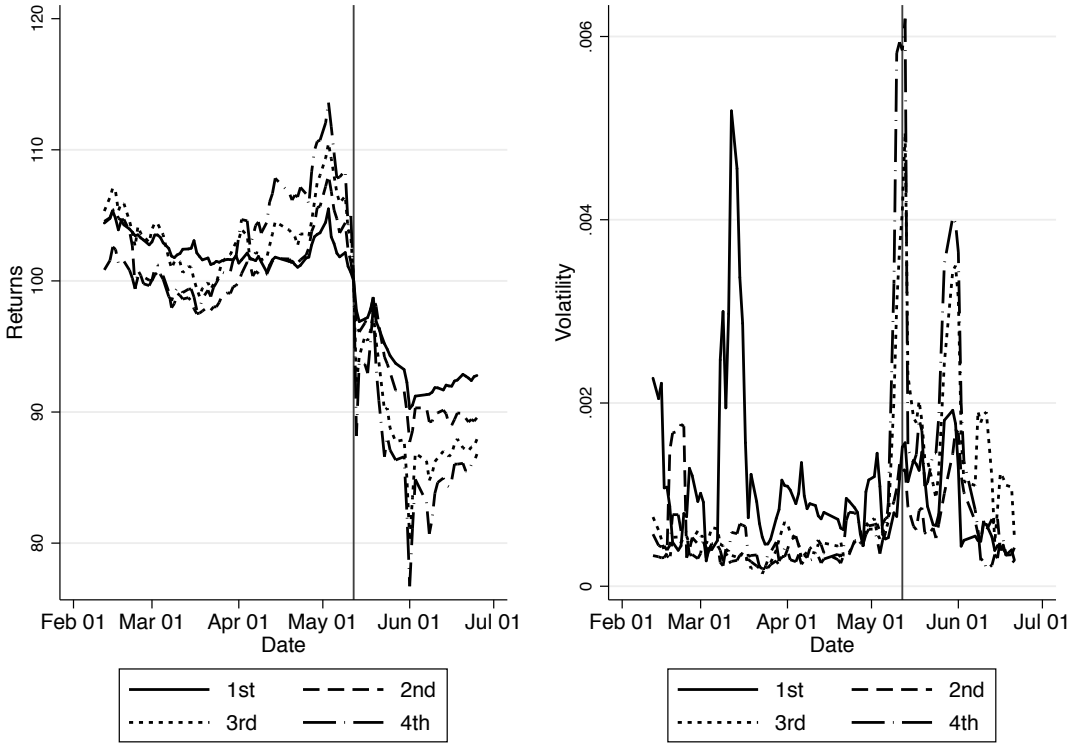

Figure 8: **Differnces by number of underwriters.** This figure plots stock price indices and return volatility for different number of large underwriter banks. The index of underwriter banks is 0 if a firm has no large underwriter, 1 if it has one large underwriter, or 2 if it has two or more large underwriters. All stock price indices are normalized to 100 at 12 May 1927. Volatility is calculated as the average firm-specific return variance using a 5 day rolling window.