An International Monetary Explanation of the 1929 Crash of the New York Stock Exchange

By Jean-Laurent Cadorel*

The crash of the New York Stock Exchange in October 1929 was a liquidity crisis caused by the removal of brokers' loans. Based on high-frequency data, this paper documents how the Bank of England's unexpected September discount rate rise attracted short-term international capital flows. The rate rise had such exceptional effects because it caused a reallocation of gold reserves, attracting gold from the Americas to Europe, threatening some Latin American countries' participation in the gold standard, depreciating the value of their debts in New York, and reducing bondholders' willingness to lend.

JEL: E44, E58, F32, G01, N20.

The cause of the Great Depression is one of the most studied topics in economic history. Explanations include the 1929 stock market crash (Mishkin 1978, Romer 1990), an autonomous decrease in consumption (Temin 1976) and accordingly a rise in savings (Degorce and Monnet 2020), a rise in tar-

* Paris School of Economics and EHESS, 48 Boulevard Jourdan, 75014, Paris, France (email: jean-laurent.cadorel@psemail.eu). Thanks to Pierre-Cyrille Hautcoeur, Angelo Riva, Eric Monnet, and seminar participants at the European Historical Economics Society conference (2019), the Economic History Association annual meeting (2020), the PSE Economic History seminar (2020), and the PSE Financial History seminar (2020) where versions of the ideas expressed here were presented. The author thanks the Data for Financial History team at the Paris School of Economics for its support and the European Business School for financial assistance. This work has been funded by a French government subsidy managed by the Agence Nationale de la Recherche under the framework of the Investissements d'avenir programme reference ANR-17-EURE-001.The author declares no other interests that relate to the research described in the paper.

iffs (Meltzer 1976, Crucini and Kahn 1996), debt-deflation (Fisher 1933), non-monetary effects of banking crises (Bernanke 1983), and most famously the failure of monetary policy to offset the decline in the money supply due to banking panics (Friedman and Schwartz 1963). Unfortunately, the literature on the Great Depression has been forced to debate the role of the crash in the Depression without an explanation of the crash. The lack of explanation is not due to a lack of studies. The literature has abundantly debated whether the stock market crash was due to a bubble bursting, but so far a convincing explanation is missing (White 1990, Klein 2001). The issue in discussing the role of the crash in the Depression without an explanation of the crash is the effect on the real economy may be confounded by a third variable explaining both the crash and the Depression.

Galbraith (1955) and Kindleberger (1978) explain the crash as a fire sale due to the sudden removal of brokers' margin loans based on qualitative evidence. This paper quantitatively documents the collapse of liquidity and traces the removal of speculative funds to an international monetary explanation. Faced with a dwindling gold reserve due to a negative trade balance and an overvalued pound, the Bank of England was forced to increase its discount rate in September 1929 and succeeded in attracting back to Europe international capital employed in New York. Capital and gold flowed back to core European countries and threatened the gold positions of countries on the periphery of the gold standard. As markets tested countries' ability to remain on the gold standard, some currencies lost their credibility. Consequently, these countries' debts floated in New York depreciated and investors likely to hold these debts removed liquidity from the market.

Specifically, I use three measures (proportion of stocks without bids, bid-ask spreads, and mispricings on cross-listed stocks) to show the New York Stock Exchange suffered from liquidity problems in the crash. These liquidity issues are due to liquidations on brokers' loans as intradaily stock returns dropped after margin call hours. Funds loaned on demand to brokers were shifted to demand deposits and subsequently removed. These results lend support to studies arguing brokers' loans were the cause of excessive speculation and their sudden removal caused the crash (White 1990, Rappoport and White 1993). I then turn to the gold standard to find an explanation for the sudden removal of liquidity.

Central bank archives provide evidence governors in New York and London coordinated contractionary monetary shocks to fight speculation in New York because the bubble was attracting international capital and the flows endangered Britain's participation in the gold standard. British monetary policy shocks in 1929 had large causal effects on NYSE stock returns as measured by heteroskedasticity-based estimators as in Rigobon and Sack (2004). Foreign balances were removed from New York banks and the dollar depreciated against major European currencies until it reached gold export points on the day of the crash. Gold left to Europe for the first time since June 1928. As fears the United States would start drawing gold on South America increased and as South America lost gold to Europe, Latin American currencies dropped against the dollar and those countries' gold-denominated debts depreciated strongly in New York. A number of Latin American countries would subsequently leave the gold standard and default on their debts. Some evidence is then given investors likely to hold these debts removed their loans to brokers, thus amplifying the liquidity crisis.

This work is the first to identify a causal variable which partly explains the 1929 crash. These facts change the usual historical account because the Federal Reserve Bank of New York's actions to fight speculation were not solely carried out in isolation and in opposition to the Board, but also in coordination with the Bank of England and in order to save the gold standard. Further, the Bank of England seems to have held a dominant role. By showing that the 1929 stock market bubble was considered a threat to the general operation of the gold standard and thus central bank governors accepted contractionary monetary shocks as a tool to maintain price stability, even at the cost of financial stability, I change the standard chronology of the Depression, following which no external constraint forced the United States to deflate in 1929 (Bernanke and James 1991).

The previous literature has mainly focused on whether the crash was only the bursting of a bubble as classical authors such as Galbraith (1955) and Kindleberger (1978) suggested; no consensus has emerged. Proponents of the bubble hypothesis include White (1990) who shows stock prices increased 40 percent faster than dividends without expectations of higher dividends. De Long and Shleifer (1991) also conclude investors were too optimistic by considering the discount or premium at which closed-end funds traded compared to their net asset value as indicators of individual investor sentiment. They find closed-end funds traded at premia before the crash and at a discount after the crash. Rappoport and White (1994) further show the call-loan implied volatility of American stocks surged more than a year before the crash suggesting stocks were particularly risky.

On the other side of the aisle, McGrattan and Prescott (2004) compute estimates of the fundamental values of stocks and argue stocks were not over-

valued unless firms had no intangible value and only tangible capital. Bubble tests (Santoni and Dwyer 1990) and price to earnings ratios (Sirkin 1975) also seem to indicate stocks were not overvalued. All previous papers pick a side in the bubble debate while this paper is agnostic on the presence of a bubble because a liquidity crisis does not require one. Further, these previous contributions adopt a national perspective, while this paper develops an international argument. This paper furthers Hamilton (1987) and Friedman and Schwartz (1963)'s arguments that contractionary monetary policy was at fault by adding an international perspective in which the Bank of England's leading of European monetary policy down the contractionary path was an aggravating factor.

On the theoretical front, the closest model would be Brunnermeier and Pedersen (2009)'s model of liquidity spirals where an initial shock leads to initial losses and reduces market liquidity as leveraged investors close capital-intensive positions, leading to further illiquidity. Though in the case of this crash, the shock is not exogenous to the stock market and instead an endogenous monetary one.

Economists looking to economic history to learn from past mistakes may find in this explanation of the crash an example of the risks of excluding financial stability from central bank mandates. Historians interested in economic tools to understand historical episodes may appreciate in this account the linking of two crises: the 1929 crash and the collapse of the gold standard. Far from being two separate crises, the bubble was a threat to Britain's participation in the gold standard and British monetary authorities were defending their commitment to the gold standard as early as February 1929. Economic historians, any combination of the previous two

or an entirely different third kind, may find some pleasure in a potential explanation of the largest stock market crash in U.S. financial history.

Section I of the paper presents evidence the crash was a liquidity crisis. Section II examines the international monetary explanation and carries out the identification strategy. Section III compares the contribution to the literature.

I. Evidence of a Liquidity Crisis

Following the First World War, the United States enjoyed a period of prosperity with high growth and record low unemployment. Economic prosperity translated to higher investment in financial markets through a variety of channels. Americans eager to invest their savings benefited from the democratization of financial innovations such as investment trusts which allowed them to diversify their investments. In the years preceding the crash, trusts raised record sums in equity. These sums were invested in securities, but also were very profitably employed to fund brokers' loans – speculative funds for margin lending. Corporations experienced increases in profits and some of the retained earnings funded loans to brokers. Banks witnessed increases in deposits over the years and therefore they could extend more loans, some of which found their way to brokers and ultimately speculators. As the stock market gained in value, it attracted ever more speculators from around the world. By 1929, 40 percent of trading accounts at firms member of the New York Stock Exchange were margin accounts.[1] As the demand for speculative funds increased, so did the rates on brokers' loans. Starting 1928, call loan rates increased to exceptional levels with remarkable volatility.

[1]Pecora Report, p. 9.

Suppliers of speculative funds, to the exception of New York City banks, suddenly withdrew their funds during the crash. In the week of the crash, loans to brokers by New York City bank clients (non-New York banks, investment trusts, foreign banks, corporations, and individuals) decreased by $2.1 billion. To give a sense of the scale of withdrawals, non-New York banks' supply of brokers' loans decreased by 2 percent of U.S. gross domestic product or 15 percent of all U.S. member bank demand deposits in a week. Stocks trading on the New York Stock Exchange simultaneously became less liquid assets as an increasing proportion of shares could not find buyers. The proportion of NYSE stocks without a bid increased tenfold from on average 1 to 2 percent during the year to 17 percent.

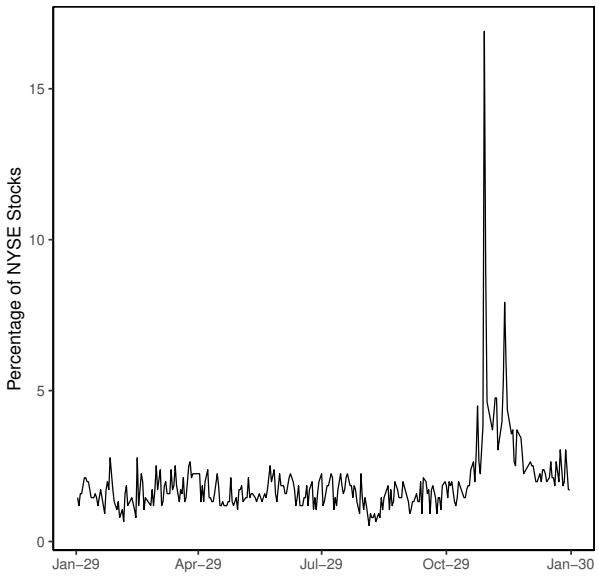

FIGURE 1. BIDLESS NYSE STOCKS IN 1929

Note: Proportion of stocks without a bid in 1929 in daily frequency.
Source: Data are from CRSP.

Bankers mentioned the stock market occasionally experienced "air pockets" those are "a perfectly empty no-bid market"[2] so the absence of bids was sufficiently abnormal to be noticed by market makers. The lack of liquidity was also reflected in the price of liquidity as the remaining 83 percent of stocks with bids saw bid-ask spreads increase on average from 3 percent of the mid-quote to 13 percent. Bid-ask spreads are used as a measure of the price of liquidity, as in Hameed, Kang and Viswanathan (2010).

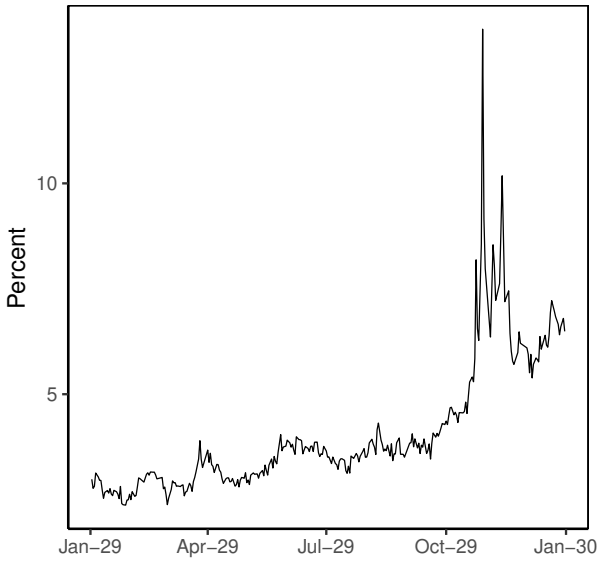

FIGURE 2. QUOTED BID-ASK SPREADS OF NYSE STOCKS IN 1929

Note: Proportional quoted bid-ask spreads are differences between ask and bid quotes divided by mid-quotes, which are the average of the bid and the ask quotes. The mean spread across all stocks is reported in daily frequency.
Source: Data are from CRSP.

[2]George Whitney (J.P. Morgan), Hearings before the Committee on Banking and Currency, United States Senate, 1933, part 2, p.542: "[financiers intervened to] prevent or to try to prevent having what the papers called air pockets. In other words, to have some bids — some basis upon which these very large bodies of loans which were then in existence and the loans by customers, would have some basis on which to stand, and not have a perfectly empty no-bid market, which is what existed periodically during this period."

Further quantitative evidence of an increase in demand for liquidity can be found thanks to mispricings. Under stressful conditions and during liquidity shortages, asset mispricings may occur (Pasquariello 2014), as arbitrageurs may lack the liquidity to eliminate arbitrage opportunities. One of the simplest arbitrage opportunities lies in cross-listings. A stock trading on two exchanges should have the same price. Comparing closing prices of stocks cross-listed on the NYSE and on regional exchanges, in Boston and Chicago, reveals significant mispricings during the crash up to an average difference of 8 percent across 30 stocks. Stocks listed on the NYSE suffered closing prices lower than their regional counterparts.

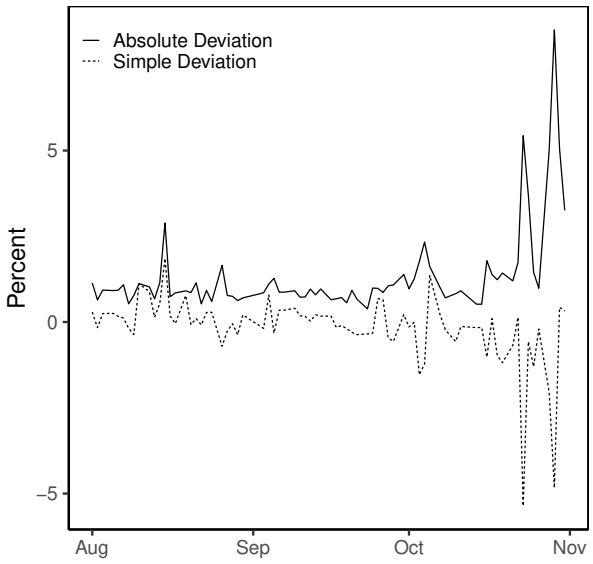

FIGURE 3. MISPRICINGS ON THE NYSE AUGUST TO OCTOBER 1929

Note: Average simple or absolute difference between NYSE and regional closing prices in percent of NYSE prices across 30 cross-listed stocks on the NYSE and either in Boston or Chicago, in daily frequency.
Source: Data are from CRSP for NYSE stocks and from the New York Times for Boston and Chicago.

The three measures of liquidity provided therefore agree there was a large decline in liquidity. The next question is whether the liquidity crisis can be attributed to brokers' loans. Intradaily returns on 80 of the most active stocks on crash days compared to non-crash days allows us to attribute the liquidity crisis to brokers' loans because investors had to respond to margin calls at specific times and intradaily returns on crash days decreased after margin call hours: bankers "came to look for the hours of 11:15 and 2:15 with a great deal of anxiety, because those were the hours when margin calls have to be responded to in the general practice of stock-exchange houses, so right after that we would get the immediate reflection of that call."[3]

Intradaily returns on 80 of the most active NYSE stocks indicate stocks on crisis days dropped mostly after margin call hours. The onset of the crash is mainly remembered through three days: Black Thursday Oct. 24th, Black Monday Oct. 28th, and Black Tuesday Oct. 29th. On the first of these crash days, stocks opened at negative 2 percent and declined 3 percent after the first margin call to the lowest level for the day. On Black Monday, stocks opened at negative 1 percent and declined 7 percent in an hour after the second margin call. On Black Tuesday, stocks opened at negative 7 percent, dropped from negative 5 to negative 11 percent after the first margin call, and collapsed a further 4 percent after the second margin call. In other words, brokers generally observed market trends in the morning and in the afternoon before calling clients to top up their accounts and the largest declines occurred after these calls were made. In contrast, there were no such intradaily movements after margin call hours on non-crash days.

[3]George Whitney (J.P. Morgan), Hearings before the Committee on Banking and Currency, United States Senate, 1933, part 2, p.542.

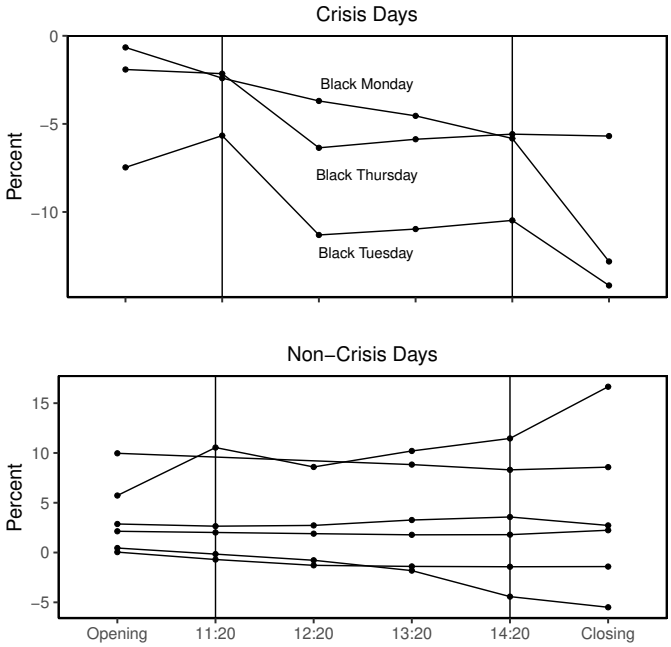

FIGURE 4. INTRADAILY RETURNS OF 80 NYSE STOCKS IN THE FORTNIGHT OF THE CRASH

Note: The average return across 80 of the most active NYSE stocks in percent of the previous day's closing price is reported by the hour from Monday, October 21st to Friday, November 1st, 1929. Vertical solid lines at margin call hours. Crises days are Black Thursday, October 24th, Black Monday, October 28th, and Black Tuesday, October 29th. *Source:* Data are from the Chicago Daily Tribune.

The final step in this section is to ask how much of the decline in stock returns does the decrease of liquidity explain. One approach is to perform repeated cross-sections on crash days, regressing daily returns on bid-ask spreads or on changes in bid-ask spreads. Both the level and the first difference of bid-ask spreads yield significantly negative effects on stock returns. The interpretation changes slightly depending on the measure: using the level of bid-ask spreads and finding a negative coefficient suggests stocks with low liquidity suffered lower returns, while using the change in bid-ask

spreads and finding a negative coefficient suggests stocks which experienced a larger decline in liquidity suffered lower returns. Coefficients of the change in bid-ask spreads are an order of magnitude larger than their standard errors and explain about a fifth of the variance in stock returns on crash days, with a single variable. Another satisfying result is the size and statistical significance of the effect grows with the decrease in liquidity and with the increase in the severity of the stock market decline, so as the stock market crashed more and as the liquidity problem became more significant, larger increases in the price of liquidity were indeed more associated to larger declines. As the average increase in bid-ask spreads was of more than 4 percent on Black Tuesday,[4] the coefficient found suggests liquidity problems as measured by bid-ask spreads were responsible for 3.1 percent of the 12.8 decline.

A limitation of this exercise is, as pointed out previously, bid-ask spreads only reflect liquidity problems that are priced by market makers. A significant number of stocks did not enjoy a bid at all, and are thus excluded from the sample. If anything, stocks which became truly illiquid in the sense there were no bids and no transactions likely experienced a sharper loss of value, and thus the coefficient found is likely to be an underestimate of the true size of the liquidity problem's effect on NYSE stock returns. Taken together, the three measures and repeated cross-sections quantitatively confirm Galbraith (1955)'s qualitative account of fire sales during the crash. The next section turns to the gold standard to explain the liquidity crisis.

[4]The average increase of bid-ask spreads on all stocks with a bid and an ask was of 5.1 percent on Black Tuesday, yet to correlate returns to spreads, realized prices are also needed, and the average increase in spreads of stocks with both a spread and a return was only of 4.3 percent.

TABLE 1—CROSS-SECTION OF STOCK RETURNS AND BID-ASK SPREADS

	Dependent variable: Daily Returns					
	Constant	Bid-Ask	Δ Bid-Ask	N	R^2	F Statistic
Black Thursday	−3.611	−0.262		642	0.073	50.26
	(0.403)	(0.037)				
	−4.408		−0.390	642	0.146	109.7
	(0.325)		(0.037)			
Black Monday	−7.714	−0.150		639	0.022	14.11
	(0.489)	(0.040)				
	−7.615		−0.518	639	0.189	148.6
	(0.389)		(0.043)			
Black Tuesday	−9.922	−0.284		530	0.037	20.48
	(1.161)	(0.063)				
	−9.748		−0.721	530	0.252	177.7
	(0.877)		(0.054)			

II. International Monetary Forces

While the United States enjoyed a prosperous decade following World War I, European countries suffered from monetary and political instabilities. European countries attempted to return to the gold standard and stabilize their currencies at pre-war parities – those are exchange rates against gold. Britain succeeded at restoring its pre-war parity at the cost of a large deflation, a surge in unemployment, and an overvalued pound. France did not follow the deflationary route as it was constrained by a higher price level and a large monetary overhang (Bordo and Hautcoeur 2007). Instead, France devalued its currency and returned to the gold standard at a lower gold parity. The result of the overvaluation of the pound in gold terms was that the British trade balance was in deficit and Britain was dependent on capital inflows to offset the trade balance deficit. As international investors flocked to New York to profit from the remarkable rates on brokers' loans, the Bank of England was forced to resort to discount rate increases to keep attracting capital inflows and to avoid a balance-of-payments crisis.

Simultaneously, war reparation negotiations stoked political instability in Europe. Gustav Stresemann, German foreign minister, and Aristide Briand, French Premier, found a compromise with other major nations in the Young Plan, which rescheduled reparation payments and was agreed in August 1929. Both statesmen represented more than centrist figures, they were convinced internationalists, pacifists, and Europeans. On October 3rd, 1929, Stresemann died of a stroke and was replaced by Julius Curtius, a fervent opponent to Stresemann's diplomatic methods. For instance, Curtius was credited with an attempt to create a customs union with Austria which was denounced by the Entente Powers as a first attempt to incorporate Aus-

tria (Elz 2009). Two days before Black Thursday, October 24th, 1929, the Briand government was unexpectedly dismissed by an opportunistic alliance of the radical left with the right-wing hardliners because Briand would not provide details of the Young Plan's implementation. Speculators therefore provided liquidity in a politically unstable context of international imbalances, with monetary authorities willing to defend the monetary system even, as the following paragraphs show, at the cost of financial stability.

Starting February, 1929, Britain faced outflows of gold to the United States and outflows to Germany and France began in July. Funds were said to flow to the United States for speculative purposes while outflows to France were attributed to French commercial banks removing their sterling balances from London.[5] Funds were attracted to the United States partly for the exceptional rates available on the call loan money market. Some of the funds also found their way to the stock market. The Bank of England's dire situation led its Committee of Treasury to question as soon as August, 1929, "what steps should be taken to preserve the life of the Gold Standard".[6] Ultimately, the Bank of England resorted to increase its discount rate from 5.5 to 6.5 percent on September 26, 1929.

The governor of the Bank of England, Montagu Norman, believed, as soon as February 1929 that the gold standard was at risk and thus contractionary monetary shocks were justified. While visiting New York in February 1929 Norman sent a confidential telegram to his colleagues in London: "with 1929 comes threats of such New York imports as would require high or penal Bank Rates elsewhere as a protection. In other words a scramble for gold

[5]Letter from Goldenweiser (Director of Research and Statistics at the Federal Reserve Board) to Gardner, 16 September 1929, C. S. Hamlin Scrap Book, Volume 195, FRBoard Members, Box 362, Folder 7, p.50.

[6]Bank of England, Committee of Treasury Minutes, August 20, 1929, p.155.

is threatened. This threat arises from credit position in United States as shown particularly by abnormal Call and Time Rates which rates appear to be due to Stock Exchange speculation. Harrison wisely ignores speculation as such but for months past has worried about credit position hoping that steady pressure would have been corrective. All in vain. Moment has come for action which I think must be unexpected and cooperative."[7] Norman was noted for his resolute character as Governor Harrison of the Federal Reserve Bank of New York reported to other governors that Norman told him "if he [Norman] had been in charge of the F.R. Bank of N.Y., he would have increased discount rates, if necessary, up to 12% to break the stock market."[8] Harrison could also be described as a hawkish governor as he admitted to the Board of Governors the increases in discount rates he demanded "would check expansion on the stock market by breaking the market."[9]

On Black Thursday, Norman sent a confidential telegram to Harrison: "Recent liquidation in your Stock Market and reduction in call money rates have been satisfactory and have helped to re-establish international position. Result of our 6.5% rate has been satisfactory and omitting normal South African Gold we anticipate adequate arrivals within two months."[10] One week after the crash, Norman recognized the rate's effect: "the Governor stated that the raising of the Bank Rate to 6.5% on the 26th September had almost immediately achieved its purpose and seemed largely to have contributed to the changes that had taken place on the New York Stock

[7]Bank of England archives, Series OV32-5, February 4, 1929. Norman means unexpected by financial markets and cooperative between central banks.

[8]C. S. Hamlin Diaries, Box 30, Volume 16, Reel 18, p. 22, June 28, 1929.

[9]Charles S. Hamlin Papers, Scrap Book, Volume 195, Box 362, Folder 6, p. 36, Conference of Board and Governors, April 4, 1929.

[10]Bank of England archives, Series OV32-5, October 24, 1929.

Market".[11] Harrison telephoned Norman on October 31 he was "well satisfied with the course events from the point of his position and prestige: he thinks the Market are through now. No failures are likely among the Banks and perhaps none amongst the small houses. New York is likely to go down a whole per cent. to-day and he does not fear that there is any danger of a new bull movement resulting: he thinks the Market will be dead for the time being and will settle down at a low level."[12]

For two central bank governors to be *satisfied* by a stock market crash is odd. Norman and Harrison are satisfied with the stock market crash because they believe the liquidation means the end of speculative flows to the United States, a reallocation of funds to Europe, therefore the end of European gold exports and thus the continued operation of the gold standard. Norman indeed maintained that "a period of high or penal Bank Rates in Europe in order to defend gold reserves against high Call and Time Rates with relatively low Bank Rates here [in the United States] might indeed prove to be threat to gold standard everywhere."[13] Therefore, Norman, though willing to use high discount rates in Europe to attract gold back to Europe, did not consider this would solve the problem unless rates on brokers' loans fell in the United States, in particular fell back in line with discount rates. Norman thus thought NYSE stocks were in a bubble fueled by brokers' loans, abundant because expensive, expensive because risky. Smaller European central banks followed the move.[14]

[11]Bank of England, Committee of Treasury Minutes, October 30, 1929, p.176, first partially mentioned in Sayers (1976, p. 299).

[12]Bank of England Archives, Series G1/423, October 31, 1929. First noticed by Clay (1957, p.360).

[13]Bank of England Archives, Series OV32/5, February 7, 1929, Norman to Lubbock.

[14]Denmark and Norway increased their discount rate by 0.5 percent and Sweden increased its rate by 1 percent on September 27, Austria also increased its rate by 1 percent on September 28, and Estonia increased its rate by 0.5 percent on October 3.

American stock exchanges started falling slightly before the Bank of England raised its rate. Stock exchanges in New York, Chicago, and Boston followed the same path over the course of October which may suggest a common factor. In one week, from Tuesday 22nd to the next, the New York, Chicago, and Boston stock exchanges respectively lost 25, 19, and 15 percent of their August values.

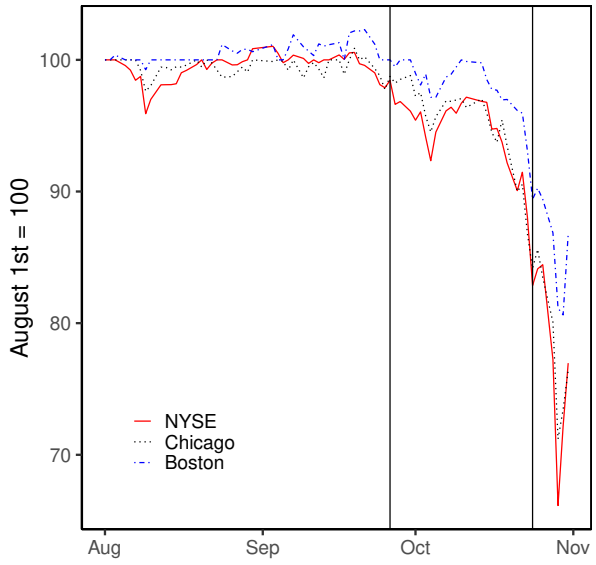

FIGURE 5. STOCK PRICES ON THE NYSE, IN CHICAGO, AND IN BOSTON, AUGUST TO OCTOBER 1929

Note: Stock price indices rebased to 100 on August 1st, 1929. First vertical line at September rate rise, second vertical line on Black Thursday.
Source: Data are from the Center for Research in Security Prices, Commercial and Financial Chronicle (1929), and the New York Times (1929).

Figure 6 shows there is further an immediate change in the aggregate behaviour of stock prices: there is an increase in comovement between stocks prices, within each stock exchange. As stock prices were shown to be falling in Figure 5, Figure 6 implies more stocks started falling. In other words, fol-

lowing the Bank of England's discount rate rise American stocks all started falling together. These figures are correlation coefficients unconditional on stocks' volatilities. Forbes and Rigobon (2002) show unconditional correlation coefficients between stock markets may increase during periods of crises simply because of higher volatility and a similar argument holds within markets (Ronn, Sayrak and Tompaidis 2009). Appendix A1 shows the increase in unconditional correlations corresponds to an increase in the volatility of NYSE returns, as measured by simple standard deviations and by estimates of conditional volatility from a GARCH(1,1) model.

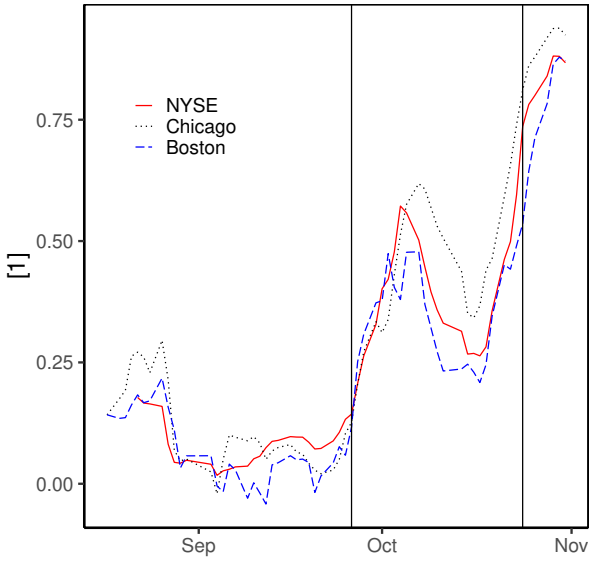

FIGURE 6. STOCK PRICE COMOVEMENT ON AMERICAN EXCHANGES, AUGUST TO OCTOBER 1929

Note: Median stock price cross-correlations are in daily frequency by exchange, unitless, and over rolling windows of 15 trading days. Vertical lines on September 26 and October 24, 1929.
Source: Data are from the Center for Research in Security Prices, the Commercial and Financial Chronicle (1929), and the New York Times (1929).

Inferring causality requires dealing explicitly with the endogeneity of monetary policy to asset prices. British monetary policy is determined by American stock prices because the rate rises are designed to fight capital flows to the United States which threaten the Bank's commitment to the gold standard. Increases in American stock prices may cause European capital flows to the United States to increase, either indirectly because of higher rates on call loans due to an increase in the perceived risk of stocks or directly because European capital is attracted by stock exchange speculation, and then increased capital outflows lead the Bank of England to raise rates. Ordinary least squares cannot be used to estimate British monetary policy's effects in an event-study approach. A direct estimation would underestimate the size of the effect because of the opposite sign of the reverse causality channel (and indeed a direct estimation does reduce the size of coefficients as well as increase the standard error).

Following Rigobon and Sack (2004), a simplified system of equations encapsulating these issues is:

$$\Delta i_t = \beta \Delta s_t + \gamma z_t + \varepsilon_t \tag{1}$$

$$\Delta s_t = \alpha \Delta i_t + z_t + \eta_t, \tag{2}$$

where Δi_t is the change in short-term London market rates, Δs_t is the change in American stock prices,[15] z_t are common shocks, and ε_t and η_t are individual shocks, respectively the monetary policy and stock price shocks. The

[15]See Ehrmann, Fratzscher and Rigobon (2011) for an example of identification by heteroskedasticity in an international setting. Adding structural equations for other international variables endogenous in daily frequency such as American interest rates, British equity prices, or the exchange rate then requires adding identifying restrictions which may be implausible.

parameter of interest is α, while β and γ being different from zero respectively reflect the simultaneity of the variables and the presence of omitted variable bias. The identification of parameter α by changes in unconditional heteroskedasticity in daily-frequency data as proposed by Rigobon and Sack (2004) relies on finding a subset of dates where the variance of the policy shock σ_ε increases such that the covariance between stock prices and interest rates changes, while the variances of the other shocks σ_η and σ_z remain constant. In words, the relative importance of monetary policy shocks must increase to identify α. Monetary policy dates are such a set of dates.

In 1929, the Bank of England's Court of Directors decided on Thursday mornings whether to change the Bank's discount rate. The information became public on Thursday mornings by announcement on the London Stock Exchange's electric signboards. The identification assumptions mean that any change in the covariance between market rates in London and American stock returns on Thursdays compared to other non-policy days of the week are explained by an increase in the variance of British monetary policy shocks. British equivalents to Federal funds futures did not exist in this period thus restricting the available identification schemes. Another benefit is the Court decided weekly thus providing a larger sample than the only 5 effective changes of the policy rate during the year.

This identification scheme by heteroskedasticity with exogenous dates of volatility changes can be implemented in a standard instrumental variables setting. Two valid instruments are $w_i = \{\Delta i_t, t \in T'\} \cup \{-\Delta i_t, t \in T\}$ and $w_s = \{\Delta s_t, t \in T'\} \cup \{-\Delta s_t, t \in T\}$, where T' is the set of policy dates and T is a set of non-policy dates with the same number of dates. Rigobon and Sack (2004) prove these instruments are valid as each instrument is cor-

related with the explanatory variable and uncorrelated with the structural shocks in the estimated equation z and η.[16] Under the assumptions mentioned previously, the IV estimators $\widehat{\alpha}^{i}_{het}$, $\widehat{\alpha}^{s}_{het}$, and $\widehat{\alpha}^{all}_{het}$ all asymptotically yield the same true parameter value α. Therefore, the model is overidentified and Sargan-Hansen tests of overidentifying restrictions can be performed. Rejecting the null hypothesis implies at least one of the assumptions is invalid: either the structural parameters are unstable across policy and non-policy dates, or the stock market or common shocks are heteroskedastic.

Table 2 reports the point estimates obtained with two instruments via two-step GMM, controlling for American and British inflation and changes in unemployment, industrial production, housing, and changes in British public debt and trade balance. The estimates are significant, large economically, and correctly signed at all maturities for Bank bills. The usual interpretation of the coefficients would be a 1 percentage point increase in British monetary policy as measured by changes in Bank bills at various maturities causes a 5.8 to 8.2 percent negative daily return on the NYSE in 1929. As no lagged values were included, the effect is instantaneous, a single day return, rather than a cumulative effect as in a impulse response function. The size of the effect is thus large as in comparison stocks on the NYSE dropped 5, 7, and 11 percent respectively on Black Thursday, Monday, and Tuesday. The tests for overidentifying restrictions indicate the model's assumptions cannot be rejected.

The significant causal effect found should not, in itself, be taken as definitive proof the Bank of England caused the crash, rather it is evidence British

[16]The authors show these instruments can be combined into one matrix: $W_t = w_i \cup w_{s_1} \cup \cdots \cup w_K$, which is another valid instrument and provides an estimator using all possible instruments, $\widehat{\alpha}^{all}_{het} = (\widehat{\Delta i}' \Delta i)^{-1}(\widehat{\Delta i}' \Delta s)$, where $\widehat{\Delta i} = W_t(W_t'W_t)^{-1}W_t'\Delta i$.

TABLE 2—RESPONSE OF NYSE STOCK RETURNS TO BRITISH MONETARY POLICY IN 1929 (LONDON MONEY MARKET RATES INSTRUMENTED BY HETEROSKEDASTICITY).

	$\widehat{\alpha}^{i}_{het}$		$\widehat{\alpha}^{all}_{het}$		O.I. restrictions test	
	Coef	Std Dev	Coef	Std Dev	J-test	P-value
Overnight	0.884	(2.387)	0.877	(2.589)	0.034	0.853
Short Periods	−2.596	(1.099)	−2.354	(0.910)	0.130	0.717
Bank Bills 2mo	−7.014	(1.533)	−6.821	(1.378)	0.205	0.650
Bank Bills 3mo	−5.921	(1.096)	−5.781	(1.014)	0.160	0.688
Bank Bills 4mo	−8.167	(2.852)	−7.965	(2.732)	0.253	0.614
Bank Bills 6mo	−8.075	(2.195)	−7.906	(2.141)	0.308	0.578
Observations	88		88			

Note: The first four columns report the point estimates and standard deviations of the coefficient of interest with the latter in parentheses obtained by applying a two-step GMM estimator. The final two columns report the J-test statistic and associated p-value of the over-identifying restrictions test. Each row reports the estimates using an alternative measure of London money market rates.

monetary policy decisions in 1929 had large causal effects on NYSE stock returns. Indeed, I cannot test whether one interest rate rise had a causal effect, but I can test whether all 1929 interest rate decisions had causal effects, which is a distinct yet related statement. The main message from these regressions and the evidence provided is instead there were central bank governors driven by their desire to defend the gold standard who coordinated their actions to fight speculation,[17] including with contractionary monetary shocks, and these shocks had significant causal effects. The September dis-

[17]See appendix A2 for evidence of coordination.

count rate rise was a monetary shock, not in the sense that investors did not expect a rise, they did expect a rise as the Bank of England's declining stock of gold was public information, but the timing of the interest rate rise was a surprise because the Bank of England had refused to raise the rate in the previous months while war reparation negotiations were ongoing. Further, London money market rates had not risen in anticipation such that effectively the rate rise was not priced in. All London money market rates immediately increased by the full percentage point.

Turning to potential transmission channels, the traditional interest rate channel can be ruled out as output would take longer to respond than the month under consideration in this paper. Changes in monetary policy expectations can be dismissed because the yield curve inversion from a negative to a positive slope was not driven by a rise in long-term rates (Cecchetti 1988). The exchange rate channel is unlikely because the foreign exchange movements could only be small under the gold standard and, despite fears of its demise, the gold standard still held such that the value of dollar deposits did not fall significantly because of the exchange rate. Further, the discount rate rises were signals of monetary authorities' determination to defend the standard. The value of dollar deposits relative to the pound may fall instead because rates on sterling deposits are indexed on the Bank rate, however the largest London clearing banks' deposits did not increase.[18] New York banks however did experience a decrease in the quantity of short-term foreign funds managed. Foreign funds represented 20 percent of New York City member banks' short-term funds and decreased by 20 percent over the following months.

[18]Federal Reserve Bulletin, February 1930, p.76.

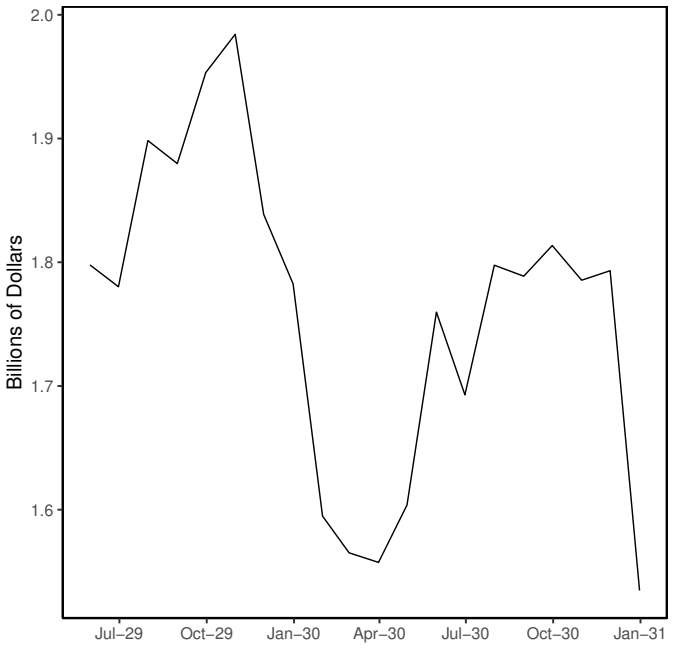

FIGURE 7. NEW YORK CITY MEMBER BANKS' FOREIGN DEPOSITS AND LOANS MAY 1929 – DECEMBER 1930

Note: New York member banks' foreign deposits and loans on foreign funds are reported in monthly frequency.
Source: Data are from the Confidential Report to the Federal Reserve Board, Eugene Meyer Papers, Foreign Funds in NY, 1929-33, Subject File, Box 120, Folder 8, p.3-11. Source begins in May 1929.

The interest rate rise immediately stopped British gold exports to France, Germany, and the United States, and the Bank of England's stock of gold slightly rebounded. The pound did not appreciate but instead the dollar depreciated against major European currencies. The depreciation of the dollar was hence before the stock market crash and not after, which suggests there was an international reallocation before the crash. The dollar depreciated by 0.5 percent of gold parity and reached a gold point against the franc, such that the dollar could not fall lower against the franc.

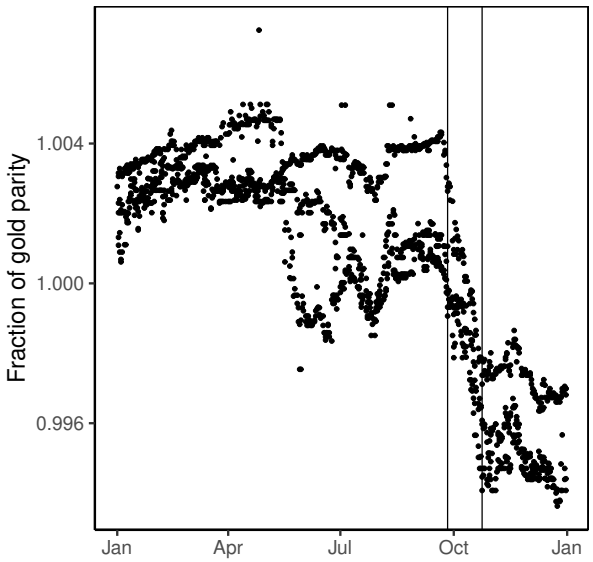

FIGURE 8. MARK, POUND, OR FRANC PER DOLLAR IN LONDON, PARIS, NEW YORK, OR BERLIN IN 1929

Note: Exchange rates are in daily frequency and expressed as a fraction of gold parity, the first vertical line is on September 26, 1929, and the second vertical line is on October 24, 1929. Two financial centers per pair.
Source: Data are from Bank of France archives (series 1377200101).

Under the interwar gold standard regime, the gold value of a currency was fixed by its government and the central bank had to convert currency for gold on demand. This led exchange rate parities to reflect mint prices and the market exchange rate could then fluctuate within a band centered on gold parity whose bounds are the points at which it became profitable for an investor to move gold from one country to another. The stabilization mechanism of the gold standard was as follows: when a currency depreciates beyond a gold point, it becomes profitable to bring local currency to the local central bank, redeem gold, send the gold to a foreign country, redeem foreign currency from the foreign central bank, and buy the local currency

back. The gold standard brings buying pressure to weak currencies. The stability of the exchange rate rests on the credibility of the central bank to provide gold on demand and on the willingness of international investors to carry out the stabilizing trade (or the central bank could do the trade itself and earn a profit but lose gold). In practice, banks would purchase gold from monetary authorities in the United States at a certain dollar price, ship it to Europe, sell the gold to an European monetary authority receiving local European currency, and exchange the European currency back into dollars at the cable rate (Officer 1993). The dollar reached a gold point against the franc on Black Thursday and the first shipment of American gold to a major European country since June 1928 took place in the following week.

While core gold standard countries attracted gold back to Europe from America, countries on the periphery of the gold standard suffered capital outflows. In Latin America, Argentina, Brazil, Paraguay, and Uruguay were forced off the gold standard in 1929. Peru enacted foreign exchange restrictions on its local banks. These countries started losing gold to Europe and the fear that United States would start drawing gold endangered their participation in the gold standard.

The exchange rates of these Latin American countries dropped during the crash. Latin American exchange rates depreciated by 2 percent of gold parity in a few days, well beyond their gold points against the dollar. Multiple Latin American currencies depreciated because the credibility of their country's commitment to the gold standard was questioned in the face of international capital movements. Consequently, bonds of countries on the periphery of the gold standard also depreciated. South American bonds were issued and priced assuming the countries would stay on the gold stan-

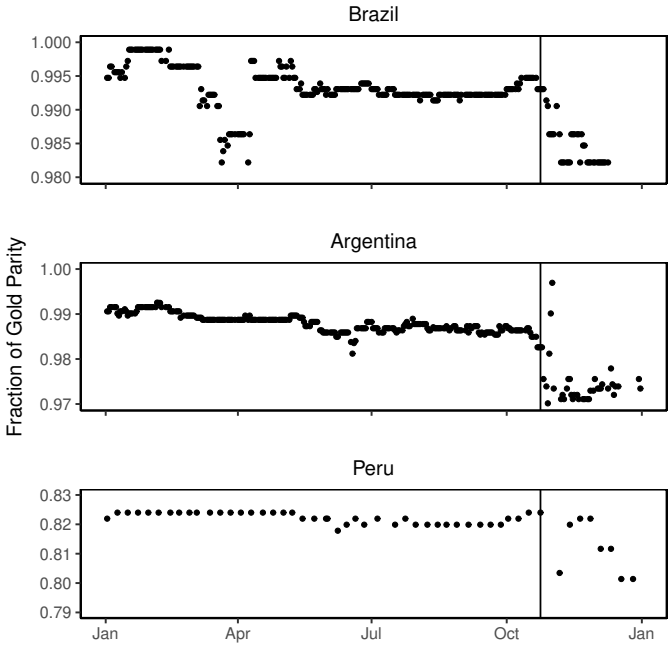

FIGURE 9. EXCHANGE RATES OF SELECTED LATIN AMERICAN COUNTRIES AGAINST THE DOLLAR IN 1929

Note: The exchange rates in New York are reported in daily frequency and in fraction of gold parity, which is simply dividing the spot rate by the gold parity rate. Modified vertical axes. Vertical line on Black Thursday, October 24, 1929.
Source: Data are from the Bank of France archives (series 1377200101).

dard and benefit from exchange rate stability. International monetary instability brought currency and default risk to gold-denominated bonds. South American bonds depreciated 8 percent in three weeks and Central and Eastern European bonds depreciated 6 percent. Central and Eastern European countries would leave the gold standard in 1931.

As the decline was widespread across countries and regions, foreign bonds do not seem to have depreciated because of local factors. Previous literature on the Latin American debt crisis emphasizes the unexpected worsening of the terms of trade and abrupt cessation of capital inflows (Alejandro 1984).

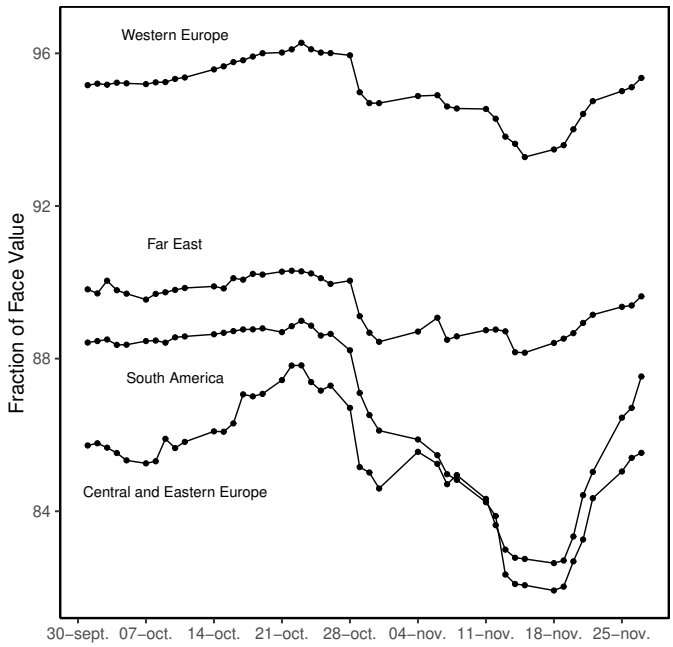

FIGURE 10. PRICE AVERAGES OF FOREIGN BONDS TRADING ON THE NYSE OCTOBER TO NOVEMBER 1929

Note: The average prices of foreign bonds quoted on the NYSE in fraction of their face value are reported in daily frequency by region from October to November 1929.
Source: Data are from the New York Times.

British monetary policy can affect the terms of trade of Latin American countries directly by reducing British demand for all products including imports from Latin America (and Britain was a major trade partner), indirectly by reducing other countries' demand for Latin American products if the other countries also raised rates, or by increasing the cost of export financing which heavily relied on London bills.

A second transmission channel is then that lenders of speculative funds may also have been holders of foreign debts and the threat of large capital losses on periphery bonds may have decreased lenders' willingness to extend credit. Instead of both lending on margin and holding foreign debts, lenders

may have decided to reduce their exposure to both when faced with international monetary instability. The ideal identification strategy would regress changes in the supply of brokers' loans on the change in value of foreign bonds held in portfolio over time at the supplier level.

Lacking both portfolios and supplies of brokers' loans at the investor level, the next best alternative is to use assumptions and proxies. Given clients of New York City banks removed 2 percent of U.S. GDP in brokers' loans in a week and the same amount appeared in demand deposit accounts, the exceptional change in demand deposits in the week of the crash may be assumed to reflect the removal of brokers' loans shifted by suppliers to cash. A proxy of investor exposure to foreign debt is the extent to which a bank participated in floating foreign debts because an underwriting bank partly offers its stake to its clients. Both deposit and underwriting figures are then available at the bank level.

New York City banks participating in at least one foreign government loan underwriting between 1926 and 1929 experienced on average a 19 percent rise in deposits in the week of the crash, while banks which did not underwrite a foreign government loan experienced on average a 3.5 percent weekly rise which suggests clients of banks underwriting foreign government loans disproportionately fled to cash. To the extent the exceptional influx of deposits corresponds to the exceptional outflow of brokers' loans (2 percent of GDP), the removal of brokers' loans and so the crash may be attributed in particular to the behaviour of these banks' clients. Clients could remove loans to brokers by physically going to the money desk at the stock exchange but it was most common to simply ask banks to do so, in which case

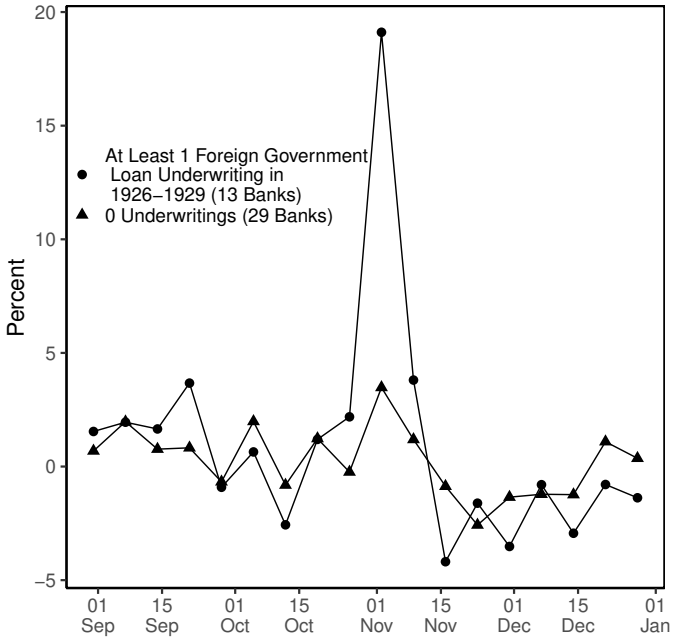

FIGURE 11. GROWTH RATE OF DEPOSITS OF NEW YORK CITY BANKS SEPTEMBER TO DECEMBER 1929

Note: The average weekly growth rate of deposits of New York City banks are reported in percent separating banks into two groups depending on whether banks participated in at least one foreign government loan underwriting in the previous three years.
Source: Data are from the Commercial and Financial Chronicle.

banks would immediately credit demand deposit accounts.[19] Underwriting banks are often large banks so the large percent rise is not driven by a small denominator. As no trend is obvious either before or after the shock, a cross-section is sufficient.

The cross-section of New York City banks' weekly deposit growth reveals participation in at least one foreign government loan underwriting in the past three years is associated to a 13.2 percent weekly increase in bank deposits during the first week of the crash after controlling for size (total

[19]B. Anderson, Chase National Bank, Hearings on the Banking Act 1935, p. 444.

assets), leverage (debt-to-equity), loan value (loans-to-assets), and liquidity (cash-to-assets), which are all insignificant. Undoubtedly, many variables are omitted which are unavailable in contemporary newspapers' balance sheet extracts allowing this estimation.

TABLE 3—CROSS-SECTION OF NEW YORK CITY BANKS' DEPOSIT GROWTH RATES

Dependant Variable	ΔDeposits (%)
Constant	17.266
	(10.308)
Dummy:	13.269
At least one foreign government	(5.034)
loan underwriting in 1926-1929	
Total Assets ($m)	0.002
	(0.005)
Debt-to-Equity	−0.484
	(0.779)
Loans-to-Assets	−17.801
	(11.662)
Cash-to-Assets	−2.404
	(13.401)
Observations	42
R^2	0.3717
Adjusted R^2	0.2844
Residual Std. Error	11.44 (df = 36)
F Statistic	4.259 (df = 5; 36)

Note: The weekly growth rate of New York City banks and trusts' deposits in the week of the crash is regressed on balance sheet variables obtained from contemporary newspapers including the Wall Street Journal, the New York Times, the Commercial and Financial Chronicle, and local newspapers.

Replacing the dummy variable with a continuous variable such as the number of underwritings or the amounts underwritten yields no significant result. One interpretation is then perhaps the coefficient captures the sophistica-

tion of investors: international investors in more international banks may have removed brokers' loans more because they had a better understanding international capital movements would force periphery countries off the standard. Another interpretation is simply the number of underwritings or amounts underwritten are a bad proxy for the size of holdings in a continuous setting as investors may simply buy or sell on the secondary market. Without individual portfolios, I cannot distinguish between the two possibilities. Admittedly, these coefficients lack a causal design but this approach may be the best available given the available data and speed of the crash.

III. Comparison to the Previous Literature

One contribution of this paper is to quantitatively confirm classical authors' qualitative account of the crash. Galbraith (1955)'s methods were criticized because he relied excessively on contemporary newspapers. Modern students of economics turning to Galbraith's book for an explanation of the greatest stock market crash in U.S. history may be disappointed by what appears to be a lack of rigor. In this regard, this paper fills a gap in the literature by providing a more robust and quantitative examination of Galbraith (1955)'s thesis the crash was a liquidity crisis caused by margin calls on brokers' loans.

Galbraith was right, but the second section shows his book missed a significant part of the story as it ignored the role of the gold standard in the crash. Galbraith and Kindleberger did not write specifically about the role of the international monetary system and of short-term foreign funds in the 1929 crash, but both had the intuition foreign funds were involved as they mentioned the role of foreign funds in brokers' loans placed by New York

City banks. White (1990) also focused on brokers' loans in a domestic perspective and he does mention the Bank of England's discount rate rise as a possible factor, though noting the quantity of brokers' loans did not decrease following the rate decision. While this point stands, a counter-argument is it took nearly a month for exchange rates to reach a gold point and for Latin American exchange rates to collapse. The timings of the collapse in Latin American exchange rates, the dollar's gold point against a major European currency, and the removal of brokers' loans then do coincide.

Concerning the previous literature on the presence of a bubble, this paper remains agnostic because the evidence is mixed. The fact that markets reacted quickly to macroeconomic monetary developments lends support to the hypothesis fundamentals did matter, as McGrattan and Prescott (2004), Santoni (1987), and Sirkin (1975) argued. Financial markets were to some extent clairvoyant as bond markets sold off bonds of periphery countries which would default years later and foreign exchange markets sold off currencies of countries leaving the standard in the following months. However, stock market investors are different from bond investors and foreign exchange operators. The latter may be more sophisticated than stock market investors such that responding to fundamentals in one market does not imply the stock market also advanced on fundamentals. Additionally, the argument can be made that selling periphery currencies contributed to countries leaving the gold standard and depreciated the value of the associated bonds such that markets were not particularly clairvoyant and instead beliefs were self-fulfilling.

Concerning the relation between the stock market crash and the Great Depression, this paper fills an important gap as it provides an explanation

for the crash which is related to an explanation of the Depression: faulty contractionary monetary policy aimed at defending the gold standard and price stability at the cost of financial stability. Monetary policy does appear to be a confounder of the crash's effect on the Great Depression. One strand of the literature emphasizes the uncertainty channel (Romer 1990) by which uncertainty about future incomes due to the crash led to precautionary savings. International monetary instability, foreign funds leaving New York, and Latin American countries leaving the gold standard, might have been a part of the uncertainty. Arguably, the average consumer is unlikely to perceive international monetary forces but then the average consumer is not the one engaging in significant precautionary savings. Measuring the degree to which the source of uncertainty was international and monetary is left for further research.

More generally, this paper fits in a larger corpus of works arguing the gold standard caused the Depression. Temin (1989) argues structural flaws in the interwar gold standard made an international monetary contraction and deflation almost inevitable, while leaving the gold standard early was associated to a faster recovery from the Depression (Eichengreen and Sachs 1985). Rather than simply arguing the Bank of England committed a policy mistake, the more important argument is that the gold standard caused the crash as the Federal Reserve Bank of New York and the Bank of England were forced to increase discount rates to safeguard Britain's participation. The counterfactual, the road not taken, might have been to let the pound depreciate to its market price, decreasing Britain's purchasing power, but making British exports more competitive and restoring Britain's trade balance. Consequently, Latin American countries might not have been able

to return to the gold standard and thus their bonds might have priced in currency risk right at issuance, resulting in higher yields to maturity at issuance, thereby potentially reducing the amount of debt issued by Latin American governments, and thus contractionary monetary shocks in Britain might not have induced exchange rate and foreign debt instability.

IV. Conclusion

Most people outside academic economics tend to associate the 1929 crash and the Great Depression. In response, economists have separated the two phenomena and asked did the crash cause the Great Depression? Unfortunately, we have had to hold this debate without knowing what caused the crash. This paper has documented that the gold standard, a common culprit in explanations of the Depression, was also involved in the crash. As Britain faced the problem of exiting the gold standard as early as 1929, the Bank of England raised its discount rate and attracted short-term international capital flows from the Americas back to Europe. The return of gold and capital endangered Latin American countries' participation in the gold standard and caused capital losses to owners of Latin American debt in New York. These bondholders likely decreased lending to speculators and caused a liquidity crisis.

These findings raise important questions about the political economy of central bank mandates. Could the 1929 crash have been avoided had the Bank of England's mandate included financial stability? How much flexibility should central banks exercise in interpreting their mandates? 90 years later, the Great Depression and the 1929 crash still yield valuable insights.

REFERENCES

Alejandro, Carlos F. Diaz. 1984. "Latin America in the 1930s." In *Latin America in the 1930s*. 17–49. Springer.

Bernanke, Ben, and Harold James. 1991. "The Gold Standard, Deflation, and Financial Crisis in the Great Depression: An International Comparison." In *Financial Markets and Financial Crises*. 33–68. University of Chicago Press.

Bernanke, Ben S. 1983. "Nonmonetary Effects of the Financial Crisis in Propagation of the Great Depression." *American Economic Review*, 73(3): 257–276.

Bordo, Michael, and Pierre-Cyrille Hautcoeur. 2007. "Why Didn't France Follow the British Stabilisation after World War I?" *European Review of Economic History*, 11(1): 3–37.

Brunnermeier, Markus K., and Lasse Heje Pedersen. 2009. "Market Liquidity and Funding Liquidity." *The Review of Financial Studies*, 22(6): 2201–2238.

Cecchetti, Stephen G. 1988. "The Case of the Negative Nominal Interest Rates: New Estimates of the Term Structure of Interest Rates during the Great Depression." *Journal of Political Economy*, 96(6): 1111–1141.

Clay, Henry. 1957. *Lord Norman.* Macmillan & Company.

Crucini, Mario J., and James Kahn. 1996. "Tariffs and Aggregate Economic Activity: Lessons from the Great Depression." *Journal of Monetary Economics*, 38(3): 427–467.

Degorce, Victor, and Eric Monnet. 2020. "The Great Depression as a Saving Glut." Center for Economic Policy Research DP 15287.

De Long, J. Bradford, and Andrei Shleifer. 1991. "The Stock Market Bubble of 1929: Evidence From Closed-End Mutual Funds." *The Journal of Economic History*, 51(3): 675–700.

Ehrmann, Michael, Marcel Fratzscher, and Roberto Rigobon. 2011. "Stocks, Bonds, Money Markets and Exchange Rates: Measuring International Financial Transmission." *Journal of Applied Econometrics*, 26(6): 948–974.

Eichengreen, Barry, and Jeffrey Sachs. 1985. "Exchange Rates and Economic Recovery in the 1930s." *The Journal of Economic History*, 45(4): 925–946. Publisher: Cambridge University Press.

Elz, Wolfgang. 2009. "Foreign Policy." In *Weimar Germany. Oxford Short History of Germany*, 50–77. Oxford University Press.

Fisher, Irving. 1933. "The Debt-Deflation Theory of Great Depressions." *Econometrica*, 337–357.

Forbes, Kristin J., and Roberto Rigobon. 2002. "No Contagion, Only Interdependence: Measuring Stock Market Comovements." *The Journal of Finance*, 57(5): 2223–2261.

Friedman, Milton, and Anna Jacobson Schwartz. 1963. *A Monetary History of the United States: 1867 - 1960.* Princeton:Princeton University Press.

Galbraith, John Kenneth. 1955. *The Great Crash, 1929.* Boston:Houghton Mifflin Harcourt.

Hameed, Allaudeen, Wenjin Kang, and S. Viswanathan. 2010. "Stock Market Declines and Liquidity." *The Journal of Finance*, 65(1): 257–293.

Hamilton, James D. 1987. "Monetary factors in the Great Depression." *Journal of Monetary Economics*, 19(2): 145–169.

Kindleberger, Charles P. 1978. *Manias, Panics, and Crashes: a History of Financial Crises.* New York:Basic Books, revised and enlarged, 5th ed. 2005.

Klein, Maury. 2001. "The Stock Market Crash of 1929: A Review Article." *The Business History Review*, 75(2): 325–351.

McGrattan, Ellen R., and Edward C. Prescott. 2004. "The 1929 Stock Market: Irving Fisher Was Right." *International Economic Review*, 45(4): 991–1009.

Meltzer, Allan H. 1976. "Monetary and Other Explanations of the Start of the Great Depression." *Journal of Monetary Economics*, 2(4): 455–471.

Mishkin, Frederic S. 1978. "The Household Balance Sheet and the Great Depression." *The Journal of Economic History*, 38(4): 918–937.

Officer, Lawrence H. 1993. "Gold-Point Arbitrage and Uncovered Interest Arbitrage Under the 1925-1931 Dollar-Sterling Gold Standard." *Explorations in Economic History*, 30(1): 98–127.

Pasquariello, Paolo. 2014. "Financial Market Dislocations." *The Review of Financial Studies*, 27(6): 1868–1914.

Rappoport, Peter, and Eugene N. White. 1993. "Was There a Bubble in the 1929 Stock Market?" *The Journal of Economic History*, 53(3): 549–574.

Rappoport, Peter, and Eugene N. White. 1994. "Was the Crash of 1929 Expected?" *The American Economic Review*, 84(1): 271–281.

Rigobon, Roberto, and Brian Sack. 2004. "The Impact of Monetary Policy on Asset Prices." *Journal of Monetary Economics*, 51(8): 1553–1575.

Romer, Christina D. 1990. "The Great Crash and the Onset of the Great Depression." *The Quarterly Journal of Economics*, 105(3): 597–624.

Ronn, Ehud I., Akin Sayrak, and Stathis Tompaidis. 2009. "The Impact of Large Changes in Asset Prices on Intra-Market Correlations in the Domestic and International Markets." *Financial Review*, 44(3): 405–436.

Santoni, Gary, and Gerald P. Dwyer. 1990. "Bubbles vs. Fundamentals: New Evidence from the Great Bull Markets." In *Crises and Panics: The Lessons of History.* , ed. Eugene N. White. Homewood, IL.

Santoni, Gary J. 1987. "The great bull markets 1924-29 and 1982-87: speculative bubbles or economic fundamentals?" *Federal Reserve Bank of St. Louis Review*, 69(9): 16–29.

Sayers, Richard S. 1976. *The Bank of England 1891-1944.* Cambridge University Press.

Sirkin, Gerald. 1975. "The Stock Market of 1929 Revisited: A Note." *Business History Review*, 49(2): 223–231.

Temin, Peter. 1976. *Did Monetary Forces Cause the Great Depression?* Norton.

Temin, Peter. 1989. *Lessons from the great depression.* MIT Press.

White, Eugene N. 1990. "The Stock Market Boom and Crash of 1929 Revisited." *Journal of Economic Perspectives*, 4(2): 67–83.

V. For Online Publication

A. *Measures of the volatility of NYSE stock returns in 1929.*

The rise in stock price comovements is associated to a rise in volatility as measured by the standard deviation of NYSE stock returns in a rolling window or by fitting a GARCH model and extracting the conditional standard deviation. NYSE stocks thus experienced an increase in volatility.

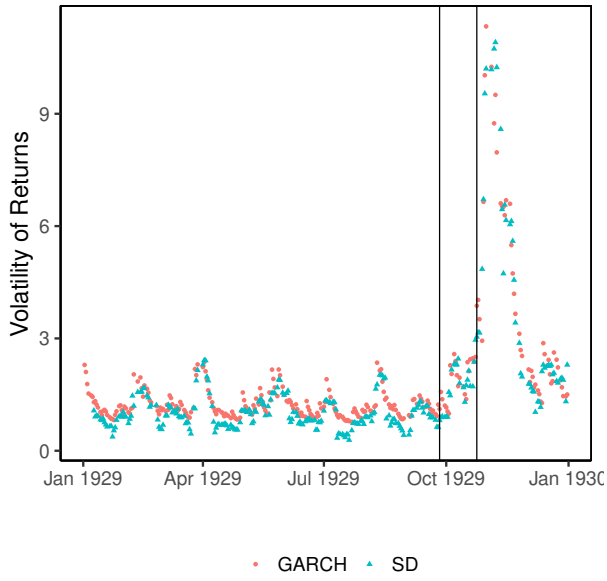

FIGURE 12. HISTORICAL VOLATILITY OF NYSE DAILY RETURNS AND ESTIMATES OF CONDITIONAL VOLATILITY FROM A GARCH(1,1) MODEL IN 1929

Note: Historical volatility is measured using a simple standard deviation on a 7-day window. The first vertical line is the Bank of England's discount rate rise on September 26, while the second one is Black Thursday, October 24, 1929.
Source: Measures are calculated using data from the Center for Research in Security Prices.

The following table reports the estimates for the GARCH model. All coefficients are significant and most importantly β_1 measuring the serial dependence of volatility is close to 0.7 which is a large figure and indicates

there are volatility clusters as can be seen in the previous graph. In words, conditional on high volatility in time $t-1$, volatility in the present period t persists at a relatively similar level and does not decay immediately. This is evidence of heteroskedasticity which confirms the impossibility of using ordinary least squares. The identification scheme, by heteroskedasticity, is thus particularly appropriate.

TABLE 4—GARCH(1,1) ESTIMATES FOR NYSE STOCK RETURN VOLATILITY IN 1929

	Estimate	Std. Error	t-value	p-value
μ	0.186	0.071	2.609	0.009
ω	0.164	0.070	2.331	0.020
α_1	0.305	0.086	3.534	0.000
β_1	0.680	0.069	9.901	$\leq$ 2e-16

Note: The model estimated is $r_t = \mu + \sigma_t \nu$, $\nu \sim N(0,1)$, $\sigma_t^2 = \omega + \alpha_1 r_{t-1}^2 + \beta_1 \sigma_{t-1}^2$ AR(1)/GARCH(1,1) and ARMA(1,1)/GARCH(1,1) models similarly yield significant coefficients for the GARCH parts and insignificant ARMA coefficients.

B. Evidence of monetary policy coordination in 1929

Central bank governors organized direct gold loans to avoid the export of European gold to the United States and Norman and Harrison actively engaged in foreign exchange interventions specifically to block British gold exports to the United States. Norman and Harrison blocked cruisers from reaching their gold points, on a boat by boat basis, by supporting the pound at strategic moments.

A normal practice between central bank governors in 1929 was to give advance notice of monetary policy decisions. Before the February discount rate rise and while visiting the New York Federal Reserve Bank, Norman instructed his deputy governor to warn the other European central bank

governors as "it will be helpful for them to increase their rates along with London."[20] Lubbock, the deputy governor, proceeded to send telegrams to the German, Dutch, French, and Belgian central banks to give notice the discount rate change was under consideration. Harrison similarly warned France, Germany, Italy, the Netherlands, Belgium, and Switzerland of the Board's impending refusal to approve discount rate rises.[21] Of course, these notices are more a courtesy than a coordinated action.

Central banks took cooperative action further than simple courtesy as they organized a cooperative loan to avoid European gold exports. Hungary applied for a collective loan for $10 million in gold bars from Belgium, Britain, France, the Netherlands, and New York. The banks participated equally in this loan which made the gold bars available in New York.[22] All participants agreed to make no public announcement, therefore this cooperative action was not simply a measure destined to manipulate opinions.[23] Harrison further agreed to buy sterling "if only as a temporary aid to your gold position".[24]

Norman and Harrison also coordinated their foreign exchange market interventions to support the dollar sterling rate "if and when sterling is about at your gold point and then preferably just before sailing dates"[25] in order to stop British gold losses. Both governors intervened to stop British gold losses on a boat by boat basis on multiple occasions, the following quotes are evidence of only a subset of these occasions: "Our purchase of sterling yesterday was designed chiefly to prevent gold moving on the Paris and

[20]Bank of England Archives, Series OV32/5 February 2, 1929, Norman to Lubbock.
[21]Ibid., March 13, 1929, Harrison to Norman.
[22]Ibid., June 20, 1929, Norman to Harrison.
[23]Ibid., July 2, 1929, Harvey to Harrison.
[24]Ibid., August 14, 1929, Harrison to Norman.
[25]Ibid., August 16, 1929, Harrison to Norman.

Olympic",[26] "If necessary I shall sell dollars to prevent the withdrawal of gold to-morrow for shipment by French boat sailing same night",[27] "Our present plan is to buy to-morrow having the Ile de France in mind and to go into the market again on Thursday to discourage operations for the Aquitania",[28] "We may buy again on Tuesday having the Bremen in view and possibly also on Thursday against the Berengaria",[29] or "if necessary we shall sell against Majestic to-morrow."[30]

[26]Ibid., August 22, 1929, Harrison to Norman.
[27]Ibid., August 23, 1929, Norman to Harrison.
[28]Ibid., August 26, 1929, McGarrah to Norman.
[29]Ibid., August 29, 1929, McGarrah to Norman.
[30]Ibid., September 2, 1929, Norman to Harrison.