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BETA/CNRS & Association Française de Cliométrie

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"*Did the financial collapse of the early 1930's have real effects on the macroeconomy, other than through monetary channel?*" (Bernanke, 1983, p. 275.)

A much debated hypothesis about the Great Depression of the thirties is Friedman and Schwartz's (1963) contention that a severe but non unusual recession turned into the greatest contraction of all times because the Federal Reserve (Fed) failed to undertake expansionary open-market operations. They would have offset a drastic decline in the stock of money attributable to a series of banking panics.

Bordo, Choudhri and Schwartz (2002) implemented a counterfactual analysis in order to test Friedman and Schwartz's proposition. They give evidence, in a monetarist framework, that the US, the largest country in the world who had massive gold reserves, was not constrained from using expansionary policy to offset banking panics, deflation and declining economic activity. Simulations, based on a monetarist model of a large open economy,

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indicate that expansionary open market operations by the Fed at two critical junctures —Oct. 1930 to Feb. 1931 and Sept. 1931 to Jan. 1932— would have been successful in averting the banking panics that occurred. Had expansionary open market purchases been conducted in the 1930s, the contraction would not have led to the international crises that followed.

The outcomes of this counterfactual analysis seem to have been well understood and applied today. Indeed, current American and European monetary authorities implemented expansionary monetary policies to prevent recession in 2008 and 2009, unlike in 1929. Nonetheless, Bordo *et al.* (2002) outcomes are tributary from the monetarist framework used. One could argue that their picture omits that the Great Depression may have been characterized by a situation of liquidity trap[2] (Keynes, 1936) which would have annihilated the positive impact of expansionary monetary policy on economic growth at that time. In a recent paper, Romer (2009) reintroduced the liquidity trap hypothesis to characterize the thirties but she defends the idea that even in such a context expansionary monetary policy would still be efficient to foster economic growth.

The purpose of our paper is to try to clarify the presumed lessons from the Great Depression for today. Indeed, today central banks act as lenders-of-last-resort to provide liquidity to their banking systems to foster economic growth, whereas in the thirties they refrained from it. Is it the appropriate strategy to get out of the financial crisis and does it prove a correct understanding of the past? This issue - the absolute relevancy of expansionary monetary policy even in a context of liquidity trap - ought to be considered and tested in order to appreciate possible mistakes in the lessons drawn from the past as well as in monetary policies' responses today.

Many attempts exist in the literature in order to deal with the current crisis in an historical perspective. The comparison between the two episodes of crises has lead to a growing interest and the amount of literature is increasing although still in progress. In section 1, we shall review the state of the art of this comparative literature. We shall distinguish some "chartist contributions", "the consensus view", notably developed by international institutions, Bordo *et al.* (2002) counterfactual analysis and finally "Christina Romer's monetary lesson" which directly drives to our own issue, testing the efficiency of expansionary monetary policy in a context of liquidity trap. Section 2 presents data. In section

[2] "*A liquidity trap is defined as a situation in which the short-term nominal interest rate is zero. In this case, many argue, increasing money in circulation has no effect on either output or prices. The liquidity trap is originally a Keynesian idea and was contrasted with the quantity theory of money, which maintains that prices and output are, roughly speaking, proportional to the money supply.*" (Eggertsson, 2008).

3, we address the following question: can we identify episodes of liquidity trap over the pre and post 1929 crisis period and did the Fed modified its monetary policy rule in consequence? We give empirical evidence that immediately after few and short episodes of liquidity trap in 1928 and 1929, that we characterize as a period when the interest rate remains insensitive to a variation in the money supply, the Fed adopted a new policy rule that we call “averting the trap” as soon as 1930 which lasted until 1933:12. This point contrasts the existing literature. Then in section 4, using a SVAR approach, we simulate how US economic activity would have reacted following an expansionary monetary policy after the 1929 crisis. We give empirical evidence that expansionary monetary policy would not have been the channel driving to US economic recovery. In conclusion, we suggest a renewed monetary lesson from the past for current monetary policies.

1. 2007-2009 in light of 1929, lessons from the past: a state of the art

1.1 Some “chartist” contributions

The renewed interest about a comparison of the Great Depression and the current crisis is striking: see for example Krugman (2009), Eichengreen and O’Rourke (2009), Helbling (2009) and Romer (2009). The literature on the Great Depression is considerable: for the US case, one can refer to Bernanke (2000), Bordo, Goldin and White (1998) and chapter 7 in Friedman and Schwartz (1963). A global outlook is delivered in Eichengreen (1992), James (2001) etc.

We shall only recall here the main outcomes of the recent comparative literature. Krugman (2009) has compared the fall in US industrial production from its mid-1929 and late-2007 peaks, showing it has been milder this time. Referring to the current situation he qualifies it as only “half a great depression”.

Eichengreen and O’Rourke (2009) consider that it is a misleading picture since as the Great Depression was a global phenomenon the comparison ought to be done for the world and not just for the US. Comparing the world industrial output, now and then, these authors obtain a more disturbing perspective than the single US case considered by Krugman (2009) with a similar decline in manufacturing production. Considering world stock markets, now and then, Eichengreen and O’Rourke (2009) note that they are falling even faster now than during the Great Depression.

Another area, where the results are worse than during the thirties, concerns international trade which shrinks: this is alarming if we refer to the prominence attached in the literature to trade destruction and protectionism as a factor compounding the Great Depression. Obviously, these observations are done only one year into the current crisis whereas after 1929 the world economy continued to decline for more than three years. Well-aware of this, these authors conclude that, after one year, the world economy is doing worse than during the great recession, whether in terms of industrial production, exports, or stock market. They suggest that "the great recession label may turn out to be too optimistic. This is a Depression-sized event".

What about monetary and fiscal policies' responses then and now? Eichengreen and O'Rourke (2009) use an indicator calculated as a GDP-weighted average of central bank rates for seven countries. This indicator shows that in the present crisis monetary rates are lower than in the thirties and have been cut more rapidly, although with a similar lag of five month[3]. A clear cut difference appears between the two episodes of crisis concerning the money supplies: in 2008 the global money supply continued to grow rapidly, unlike in 1929 when it declined dramatically.

An analogous picture can be drawn for fiscal policy (for 24 countries), using as indicator the fiscal surplus as a percentage of GDP. Fiscal deficits expanded only slightly after 1929 whereas they augmented in 2008-2009, illustrating the will of governments to use counter-cyclical fiscal policies on a world scale. Thus, contrarily to Krugman (2009), Eichengreen and O'Rourke (2009) conclude that "the world is currently undergoing an economic shock as big as the Great Depression shock of 1929-1930", but with opposite policy responses. They ultimately raise a crucial issue: "The question now is whether that policy response will work?"

1.2 The consensus view

The European Commission delivered in 2009 a report with a full chapter devoted to a comparison between the current crisis and the Great Depression. Similarities and differences

[3]It would have been better to distinguish the Fed rate and the European Central Bank rate; using a weighted central bank rate introduces a bias: indeed, this can explain that the levels of interest rates found by these authors are surprisingly lower now than then; the absence of central bank cooperation over the interwar period and the Gold Standard constraint may explain the propensity of each central bank to increase its domestic discount rate in order to capture gold resources. The weighted indicator catches this effect whereas using single domestic discount rates and notably the Fed rate, the level of central bank interest rate is not so different now and then (see, for instance, Romer, 2009).

seem to be definitely identified, in terms of geographic origin, causes, duration, transmission mechanisms, and policy responses. This apparently broad agreement should obviously be considered with caution. The purpose of our article is precisely to call into question this very questionable consensus.

First, this report (2009) recalls that the current crisis is the deepest, most global and synchronous since the Great Depression of the thirties. The roots the two crises are identified as financial: in both cases, an insufficiently supervised financial sector, an uncontrolled expansion of the shadow banking system led to massive bank failures and liquidity scarcity at the peak of the panic. Each episode was either followed by a deep recession in the real economy.

Strong differences are nevertheless identified. First, we no longer live under the constraint of the Gold Standard whose attempt of restoration in the thirties is supposed to have had a contractionary impact on economic growth. The defence of the fixed rate to gold by protecting gold bullion domestic holdings deepened the depression across the world. Tightening monetary policies was the channel through which the crisis became the Great Depression. According to the European Commission report (2009) inadequate policy responses in the thirties contrast the appropriate monetary and fiscal policies implemented nowadays. The strong and persistent decrease in the overall price level leading to a sharp deflation in the thirties was due to the restrictive monetary policies pursued at that time. The mass unemployment which reached an unprecedented scale in the thirties would have been avoided today thanks to automatic stabilisers and the efficiency of counter-cyclical fiscal policies implemented on a world scale. From these “well-understood lessons from the past”, the European commission (2009) forecasts a quicker recovery than in the 1930s.

Despite larger use of financial leverage in the current crisis which may reveal the persistence and depth of financial risks today, a consensus seems to emerge among American and European institutions that monetary authorities today did not repeat the errors of the past. This presumed consensus can be summarized as follows (see, section entitled ‘policy response then and now’, European commission report, 2009):

- macroeconomic policy response was the major factor contributing to the gravity and duration of the Great Depression;
- the lack of expansionary monetary measures by the Fed accentuated the Great Depression;

- protectionism undertaken by major countries during the thirties amplified the phenomenon.

The European commission (2009) identifies five major lessons giving evidence that proper exit strategies from crisis are now implemented based on a correct understanding and learning from the past:

- Lesson 1: maintain the public confidence in the banking system and prevent from a credit allocation collapse;
- Lesson 2: maintain aggregate demand and avoid deflation, by means of expansionary monetary and fiscal policies;
- Lesson 3: maintain international trade and avoid protectionism;
- Lesson 4: maintain international finance and avoid capital account restrictions;
- Lesson 5: foster closer international cooperation and avoid nationalism.

Thus, comparing the salient features between the Great Depression and today leads this "mainstream literature" to identify similar financial and economic vulnerabilities in both episodes and opposite policies' responses to fight the crises. We consider this consensus view as highly questionable for several reasons: do these proposals rely on a correct reading of the past? Second, a consensus does not necessarily mean that the diagnosis is not wrong. Maybe some absent parallels to the Great Depression remain, not taken into account by this analysis. For instance, a possible context of liquidity trap common to the two episodes ought to be assessed in order to test the relevancy of expansionary monetary policy, a point absent in Bordo *et al.* (2002).

1.3. Previous use of counterfactual approach in a monetarist framework by Bordo et al.

Counterfactual analysis is one of the cornerstones of the cliometric methodology (Fogel, 1964, Williamson, 1974). It is used to measure the deviation between what actually happened and what could have happened under different circumstances. This methodological principle relies on the measurement of the influence of a factor on a development by using the difference between the development actually observed and the hypothetical development that would have been observed if the factor in question had not existed. Our purpose in this article is to confront Bordo *et al.* (2002) outcomes to the case of liquidity trap.

The initial monetarist model developed by Bordo, Choudhri and Schwartz (2002) is a two-country model to determine US gold flows and to simulate the US gold reserves under alternative monetary policies.

The authors assume that the US demand for money in period t is given by:

$$m_t - p_t = \alpha_0 + \alpha_1 y_t + \alpha_2 i_t + v_t,\ \alpha_1 > 0,\ \alpha_2 < 0 \quad (1)$$

where, m_t, p_t, y_t represent logs of money stock, the price level and real income, i_t, denotes the interest rate and v_t is the error term. The determinants of m_t are expressed by the two following identities:

$$m_t \equiv \mu_t + \log(H_t) \qquad (2)$$

$$H_t = G_t + D_t \qquad (3)$$

where μ_t is the log of the money multiplier while, H_t, G_t, D_t represent high-powered money, gold reserves and domestic credit.

Using (1) - (3) and considering,

$$\underline{H}_t = (H_t + H_{t-1}) / 2$$

It comes in first differences (Δ) that:

$$\Delta G_t/\underline{H}_t = - \Delta D_t/\underline{H}_t - \Delta\mu_t + \Delta p_t + \alpha_1\Delta y_t + \alpha_2\Delta i_t + \Delta v_t \quad (4)$$

Equation (4) can be utilized to examine the effect of an expansion in domestic credit on gold flows. Although the direct effect of ΔD_t on ΔG_t equals -1 in (4), ΔD_t could also exert an indirect effect through other variables on the right hand side of (4). Over a very short period, (1 month), the authors assume that $\Delta\mu_t$, Δp_t, Δy_t, Δv_t are exogenous to ΔD_t and Δi_t is the only potential channel for the indirect effect. The authors model the monetary relations in the rest of the world to explore this channel. Assuming that the money demand function in the rest of the world is of the same form as (1), representing the determinants of money stocks by identities similar to (2) et (3), one obtains:

$$\Delta G_t^*/\underline{H}_t^* \equiv - \Delta D_t^*/\underline{H}_t^* - \Delta\mu_t^* + \Delta p_t^* + \alpha_1^*\Delta y_t^* + \alpha_2^*\Delta i_t^* + \Delta v_t^* \quad (5)$$

where these variables are expressed in foreign-currency units. Assuming that the world stock of gold is fixed and the US price of gold is constant over time, this implies that gold flows in the US and the rest of the world are linked as follows:

$$\Delta G_t = - \Delta(e_t G_t^*) \qquad (6)$$

where e_t denotes the exchange rate in representing the price of foreign currency in US dollars. The relationship between interest rates in the US and abroad is expressed as follows:

$$i_t = i_t^* + x_t + \varepsilon_t \qquad (7)$$

where x_t denotes the expected rate of US dollar depreciation and ε_t represents departures from perfect capital mobility (or uncovered parity) caused by factors such as risk premia, transaction costs, information lags and capital controls. If the gold standard had operated smoothly, no changes in gold parities would have been expected and $x_t = 0$. In this case, the Fed would still have been able to affect the interest rate differential $i_t - i_t^*$, if departures from perfect capital mobility allowed it to systematically influence ε_t. However, even if the interest rate differential could not have been changed by the Fed, the large size of the US would have permitted it to affect the world interest rate and hence follow and independent monetary policy under the gold standard.

Using (4), (5), (6) and the first-difference form of (7), one obtains:

$$\Delta G_t/\underline{H}_t = \theta_t[- \Delta D_t/\underline{H}_t - \Delta\mu_t + \Delta p_t + \alpha_1\Delta y_t + \alpha_2(\Delta x_t + \Delta\varepsilon_t) + \Delta v_t]$$
$$+ (\theta_t\, \alpha_2/\alpha_2^*)(\Delta D_t^*/\underline{H}_t^* + \Delta\mu_t^* - \Delta p_t^* - \alpha_1\Delta y_t^* - \Delta v_t^* + \gamma_t) \qquad (8)$$

where $\theta_t \equiv \alpha_2^* e_t\, \underline{H}_t/(\alpha_2\, \underline{H}_t + \alpha_2^* e_t\, \underline{H}_t^*)$,

and $\gamma_t \equiv - \Delta e_t G_{t-1}^*/e_t\underline{H}_t^*$, which represents an adjustment for changes in the foreign price of gold (in periods when this price is constant, it equals zero).

Equation (8) can be used to examine the offset coefficient that is the proportion of an increase in US domestic credit offset by gold outflows in the short run. In the special case in which no changes in gold parities are expected and thus $x_t = 0$, and there is either perfect capital mobility so that $\varepsilon_t = 0$ or near-perfect capital mobility in the sense that $\Delta\varepsilon_t$ is independent of ΔD_t, then (8) implies that the offset coefficient equals $- \theta_t$. As the US stock of high powered money represented a substantial portion of the world stock during the Great Depression, θ_t was significantly less than 1.

The conclusion of the authors is that even with perfect or near-perfect capital mobility, gold flows would not have severely constrained the Fed's ability to determine the high-powered stock of money in the short run. The Fed would have been even less constrained under imperfect mobility in which case the absolute value of the offset coefficient would be smaller than θ_t. American monetary authorities would have had more room for manoeuvre.

Is this outcome robust to the case of liquidity trap? Very amazingly, Romer (2009) seems to justify this idea in a recent paper.

1.4 Christina Romer's suggestion: an expansionary monetary policy should still be efficient in a liquidity trap context

Romer (2009) draws lessons from the Great Depression for economic recovery in 2009. She underlines that both downturns have their fundamental causes in the decline in asset prices and failure of financial institutions. This, in turn, led to a collapse of the money supply (Friedman and Schwartz, 1963) and a collapse in lending (Bernanke, 1983), with short term interest near zero. We shall focus here on the monetary policy response side of Romer's analysis.

Concerning the monetary response, Romer (2009) draws a key lesson from the thirties: "monetary expansion can help to heal an economy even when interest rates are near zero". In our perspective, this constitutes a core issue because this author clearly pinpoints a case of liquidity trap. If we refer to the historical context of the thirties, in April 1933, after Roosevelt temporarily suspended the convertibility to gold which implied a substantial depreciation of the dollar, the come back to gold convertibility at a new higher price led to massive gold inflows. Under the Gold Standard constraint, the US Treasury was allowed to issue gold certificates in proportion of its gold holdings. Following gold inflows, the Treasury issued more notes. Friedman and Schwartz (1963) calculated that the rate of growth of the money supply was 17% a year over the period 1933-1936. Thus, contrarily to conventional wisdom, expansionary monetary policy was not fully absent after the Great Depression. It began after the dollar's devaluation. Could it have an immediate impact on interest rates?

As judiciously mentioned by Romer (2009), "this monetary expansion could not lower nominal interest rates because they were already near zero". Very interestingly, this author suggests that "what it could do was break expectations of deflation". She argues that since expectations were a continuation of deflation, although the nominal rate was near zero, this rate was considered still exceedingly high by agents. Increasing money supply would facilitate a reverse in expectations and "break the deflationary spiral". A replacement of expectations of deflation by expectations of price stability should bring real interest rates down and enhance consumption and investment. Romer (2009) noted that "the first thing that turned around was interest-sensitive spending. Car sales surged in the summer of 1933. One sign that lower real interest rates were crucial is that real fixed investment and consumer spending on durables both rose dramatically between 1933 and 1934".

Thus, the experience of the 1930s suggests to this author that even in a situation of liquidity trap[4], "expansionary monetary policy can continue to have an important role to play even when interest rates are low by affecting expectations, and in particular, by preventing expectations of deflation". This point constitutes the heart of the debate, but unfortunately Romer (2009) does not give empirical evidence of the existence of liquidity trap over the period.

Our purpose is to evaluate Romer's proposition according to which expansionary monetary policy is still efficient in a liquidity trap context. But first of all, prior to investigate whether quicker reactivity of monetary policy (as for today) is an appropriate policy tool, we have to answer a preliminary question: can we identify episodes of liquidity trap over the period 1921-1933? This is a prerequisite before asserting that expansionary policy could have been the right answer to combat the Great Depression even in a context of liquidity trap.

2. Data

Our data are monthly and cover the 1922:1-1933:12 time periods for five variables: the real industrial production index, y (considered as a proxy of the real economic activity), the consumer price index, p, the M2 money supply, m, the short-term interest rate[5], r, and the real deposits in suspended bank[6], s (which is considered as a measure of the importance of bank failure).

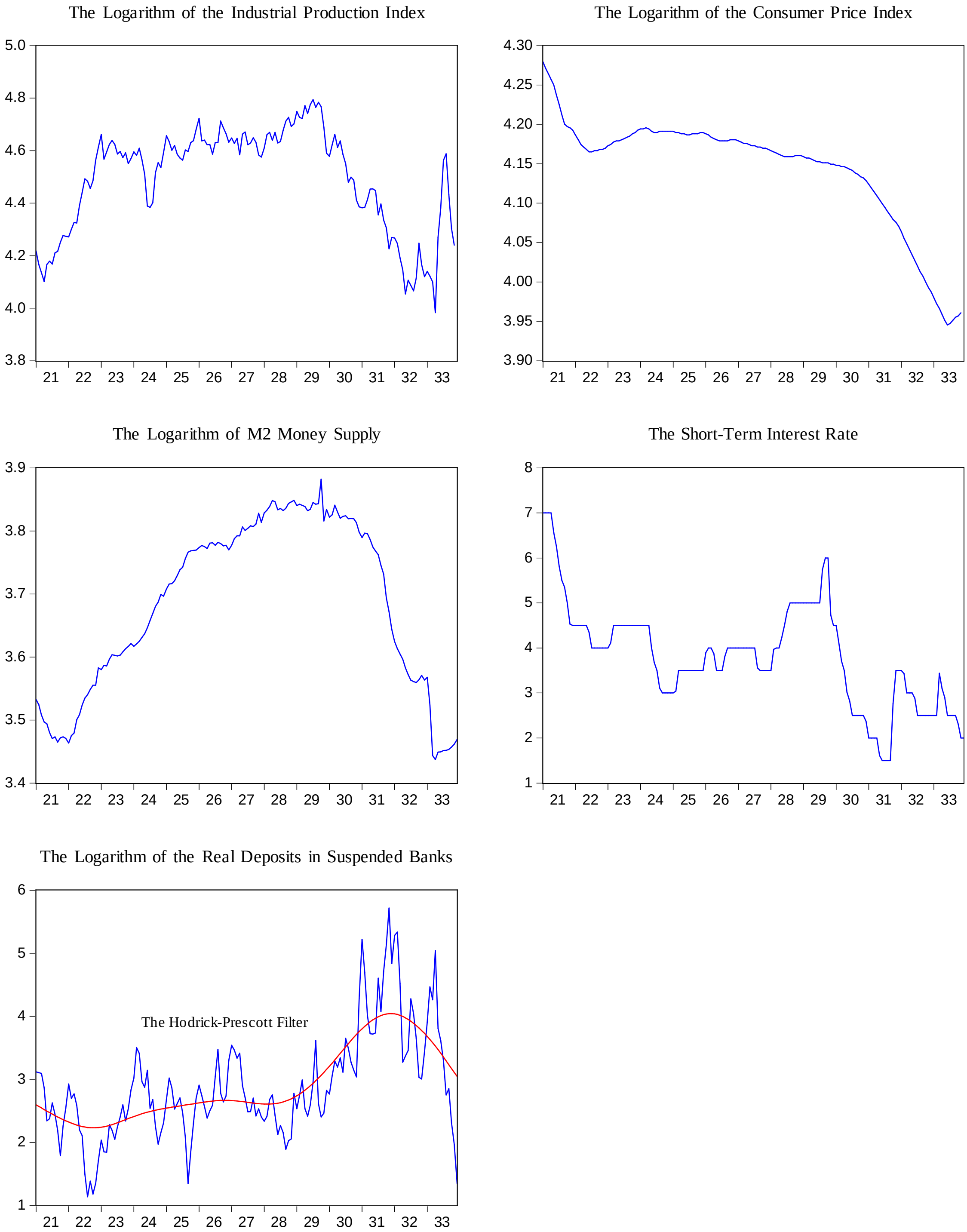
With exception of the interest rate, all variables are expressed in logarithms. The nominal M2 money supply is converted to a real variable by dividing it by the consumer price index. Finally, the inflation rates are computed as growth rates of the consumer price index.

[4]Romer (2009) never mentions this Keynesian term but she describes as follows this phenomenon when economic agents continue to expect deflation (over the period 1929-1933): "Consumers and businesses wanted to sit on any cash they had because they expected its real purchasing power to increase as prices fell". By that way, this author assimilates the period 1929-1933 to a context of liquidity trap.

[5]Balke and Gordon (1986), Friedman and Schwartz (1963).

[6]Federal Reserve Bulletin, Sept. 1937 (http://fraser.stlouisfed.org/publications/FRB/1937/); McCallum (1990). It is also used by Bernanke (1983) as a proxy for the nonmonetary influence of the banking failure on economic activity.

Figure 1


The Logarithm of the Industrial Production Index
The Logarithm of the Consumer Price Index
The Logarithm of M2 Money Supply
The Short-Term Interest Rate
The Logarithm of the Real Deposits in Suspended Banks
The Hodrick-Prescott Filter

As shown in Figure 1, the log of the real industrial production began to decline from April 1929 to the cyclical trough in 1933:1. This sharpest and prolonged decline was followed by a brief recovery at the beginning of 1933. The Consumer Price Index (CPI) plot illustrates the most severe deflation in the US history. Indeed, it declined by 23 percent from 1929 to 1933. Like the real industrial production, the log of the M2 money supply felt by more than 10% from October 1929 to March 1933. The short-term interest rate is clearly decreasing over the period. The sharp increase of the log of real deposits in suspended banks between 1930 and 1933 reflects in large proportion the fall in the money supply multiplier observed during this period. Friedman and Schwartz (1963) explained this decline of money supply by the series of banking panics which reduced the money supply and real activity through the money supply multiplier channel. The Hodrick-Prescott trend plot of the real deposits in suspended banks consolidates this finding since the banking panics outbreak precedes the decline in the money supply.

Table 1: Integration Tests

	y	*p*	*m*	*r*	*s*
ADF test	-2.06	-0.76	-1.02	-2.74	-2.82
KPSS test	0.32	1.12	0.44	0.74	0.89

The table shows the Augmented Dickey-Fuller and Kwiatkowski *et al.* tests for stationarity of each time series.

The unit root test results, given by Table 1, show that all the series appear to be integrated of order one I(1). Table 2 shows the results of tests for the orders of cointegration. Both Trace and Eigenvalue statistics indicate that the order of cointegration is 3.

Table 2: Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Max-Eigen Statistic	0.05 Critical Value
None*	0.4262	154.93	60.0614	83.3232	30.4396
At most 1*	0.2674	71.60	40.1749	46.6785	24.1592
At most 2*	0.1151	24.92	24.2759	18.3506	17.7973
At most 3	0.0281	6.57	12.3209	4.28050	11.2248
At most 4	0.0151	2.29	4.12990	2.29732	4.12990

*Denotes rejection of the hypothesis at the 0.05 level.

3. Can we identify episodes of liquidity trap over the period and did the Fed modified its monetary policy in consequence?

In this section we define the nature of the Fed reaction function. More precisely we test the liquidity trap hypothesis by considering the switching Markov and state space model. In the first case, we consider two states by which the interest rates are respectively different from zero and near-zero and we estimate the probability corresponding to the two states.

For the state space model, we estimate the Fed reaction function by assuming that all the regression coefficients are time-varying. By the estimation of this model we can detect the periods of near-zero interest rates which correspond to the near-null parameter of the money supply that is when the interest rate does not react to the variation of the money supply.

3.1 A regime-switching model for interest rates

We provide a description of the dynamics of short-term interest rates in the US using a Markov regime-switching framework. Let us consider a model with two modes given by:

$$r_t = \mu_{s_t} + \phi'_{s_t} x_t + \varepsilon_{s_t} \quad (9)$$

where $\theta = \left(\mu_1, \mu_2, \phi_1, \ldots \phi_4, p_{11}, p_{22}, \sigma^2\right)$ and $x_t = \left(r_{t-1}, y_t, p_t, m_t, s_t\right)'$. ε_{s_t} is $iidN(0, \sigma^2_{s_t})$,

and f_t is a binary variable following a Markov chain of order one:

$$p\{f_t = j / f_{t-1} = i, f_{t-2} = f, \ldots\} = p\{f_t = j / f_{t-1} = i\} = p_{ij}$$

where p_{ij} is the transition probability which gives the probability that state i will be followed by the state j.

In our case, we will consider only two-state Markov chain: normal and liquidity trap cases by which the interest rate is respectively different from zero (state 0) and near-zero (state 1). The probability to remain in the same state during the following period is given by:

$$p\{f_t = 0 / f_{t-1} = 0\} = p_{00}$$

and

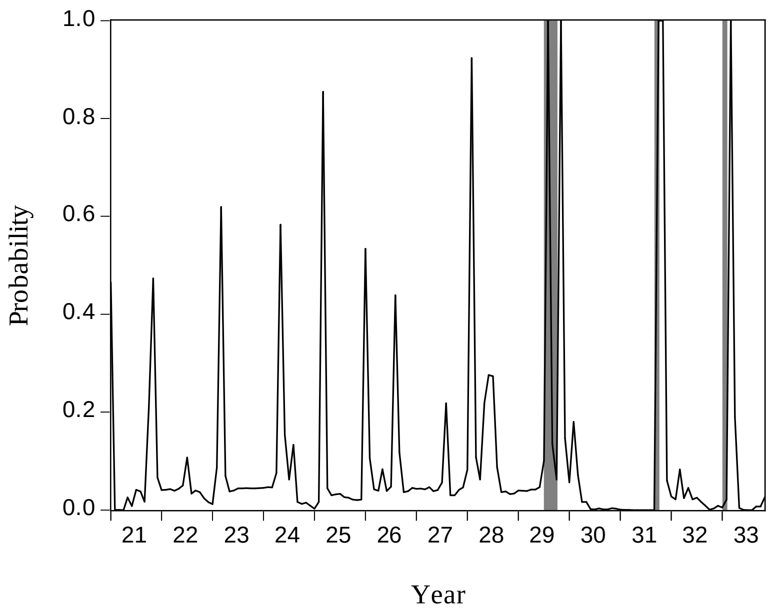
$$p\{f_t = 1 / f_{t-1} = 1\} = p_{11}$$

$p_{01} = 1 - p_{00}(p_{10} = 1 - p_{11})$ corresponds to the transition probability from state 0 (1) to state 1 (0) during the following period.

The estimation results from two-regime model with constant transition probabilities show that the transition probability of staying in state 0, p_{00} (0.91) is more persistent than the one of staying in state 1, p_{11} (0.21). This fact is confirmed by the value of the expected duration of regime zero and one which are respectively equal to 11 and 1 periods.

Figure 2 contains plots of the smoothed probability of being in the trap liquidity regime. It measures the probability that next month's interest rate innovation will be drawn from the trap liquidity regime, conditional on the entire information sample. The period between 1929 and 1933 exhibits few switches. Indeed, the only periods for which p_{11} is near one, which indicates the persistence of a situation of liquidity trap, is between 1928:1-1929:10, 1931:9-1931:10, 1933:1-1933:2, conforming the characterization of the interest rate process with short-lived episodes of liquidity trap. We underline that below in the aftermath of these episodes of liquidity trap, the Fed monetary policy rule may be assed as "repelling the trap".

Figure 2: Smoothed Probability



3.2 The Kalman Filter Estimation

We model the interest rate process as:

$$r_t = c_1 + \alpha_{1t} y_t + \alpha_{2t} p_t + \alpha_{3t} m_t + \alpha_{4t} s_t + \varepsilon_t \qquad \varepsilon_t \approx N(0, \sigma_\varepsilon^2) \quad (10)$$

$$\alpha_t = \alpha_{t-1} + c_2 + v_t \qquad v_t \approx N(0, \sigma_v^2) \quad (11)$$

where $\alpha_t = (\alpha_{1t}, \alpha_{2t}, \alpha_{3t}, \alpha_{4t})$.

We assume that the dynamic of the interest rate, *r* is given by a time-varying parameters model and the coefficients α_t are driven by an Auto-Regressif process (AR(1)). Equations (10) and (11) represent respectively the mesasurement and transition equations. The estimation of all the parameters by the Kalman filter allows us to determine the temporal receptivity of the interest rates to different variables. The Maximum Likelihood estimates of the parameters of the models are reported in Table 3. The results indicate that all parameters α_{it} for $i = 1,...4$ are statistically significant suggesting that, except for the real suspended bank deposits, the Fed was receptive to the variation of all variables.

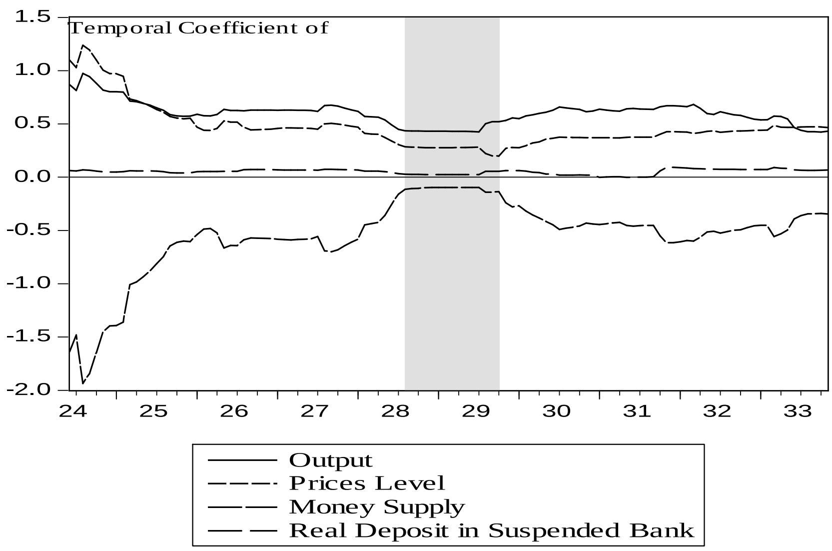
Figure 3 shows the dynamic degree of interest rate receptivity to the variations of output, prices level, money supply and suspended deposits. More particularly, we see that the money supply coefficient reached the zero value only for a short time, 1928 and 1929. This near zero money supply coefficient illustrates the case of liquidity trap since the interest rate is insensitive to a move in the money supply.

Table 3: Maximum Likelihood Estimation Results of the Model (Equations (10) and (11))

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	-2.6129	1.3239	-1.9736	0.0484
C(2)	0.9454	0.0231	40.8219	0.0000
	Final State	Root MSE	z-Statistic	Prob.
α_1	0.4311	0.1863	2.3138	0.0207
α_2	0.4657	0.1449	3.2135	0.0013
α_3	-0.3447	0.1526	-2.2580	0.0225
α_4	0.0664	0.0290	2.2834	0.0224
Log likelihood	-42.0924	Akaike info criterion	0.5856	
Parameters	3	Schwartz criterion	0.6447	
Diffuse priors	4	Hannan-Quinn criterion	0.6096	

At the end of 1929 the money supply coefficient α_{3t} reversed its upward trend for few months then it stabilized for the rest of the period. In light of this empirical evidence, we suggest that in the aftermath of the 1929 crisis the Fed reaction function moved to preventing the liquidity trap situation. This new strategy adopted by the Fed in December 1930 could explain the reason why the Fed did not implement any expansionary monetary policy from 1930 to 1933. Figure 3 illustrates that the sensitivity of the interest rate to the output and the money supply was quite similar, especially during the adoption of this new reaction function. This reaction function was also characterized, as revealed by Figure 3, by the Fed insensitivity to the real deposits in suspended bank fluctuations for the whole period of estimation, which means that the Fed never acted as a lender-of-last-resort.

Figure 3: Time-Varying Fed Reaction Function



In light of this analysis of the Fed reaction function as "averting the liquidity trap" after 1929, we now turn to the issue of the macroeconomic incidences of such a move in the policy rule. Did it cause the deepening of the Great Depression or was it part of the solvency of the problem? Would expansionary monetary policy have been a better tool to combat the Great Depression? Did the absence of the Fed as a lender-of-last-resort inhibit the banking channel? To answer to these crucial issues we adopt a Structural Vectoriel Auto Regressive specification in order to explore, by means of the estimation of the impulse reaction functions (IRF) the effects of aggregate supply shock, aggregate demand shock, money supply shock, money demand shock and banking shocks on real activity during the Great Depression.

4. How would US economic activity have reacted following an expansionary monetary policy after the 1929 crisis: lessons from a SVAR approach

In the previous section, we highlighted that there was a change in monetary policy rule by the Fed as soon as 1930. Considering this feature, the current section is devoted to the following issue: how would the US economy react consequently to an expansionary monetary policy?

4.1. Methodology

We develop a SVAR model which should allow for a simultaneous examination of the real economic activity reaction to an expansionary monetary policy shock, had it been implemented after 1929:10. In order to build the dynamic structure of our SVAR approach, we use economic theory and econometric considerations through various kinds of restrictions on the structural parameters.

The basic approach derives from the studies of Blanchard and Quah (1989), Shapiro and Watson (1988), Blanchard (1989) and others, on structural modelling. Indeed, many SVAR model identification processes define either short run (Kim and Roubini, 2000) or long run (Blanchard and Quah, 1989) restrictions.

In light of the previous empirical results, especially the presence of cointegration relations among variables and since our primary focus is on the short-run dynamics of the system including all the variables we present and estimate our Structural VAR in levels (Faust and Leeper, 1997).

In this paper we adopt a short-term restrictions approach within an open economy framework to analyze the contribution of monetary shock for explaining the reaction of the real US economic activity. To determine the transmission mechanism shocks, we briefly summarize the SVAR modelling process[7].

In the first step we estimate the VAR reduced-form:

$$y_t = A_1 y_{t-1} + A_2 y_{t-2} + \ldots + A_p y_{t-p} + \varepsilon_t \quad E(\varepsilon_t \varepsilon_t^{'}) = \Omega \quad (12)$$

[7]For a complete mathematical presentation, see Hamilton, 1994.

Where A_i are *(nxn)* coefficients matrix and y is a covariance stationary vector process. The vector $\varepsilon_t = (\varepsilon_{1t}, \varepsilon_{2t}, \ldots, \varepsilon_{nt})'$ is a n-dimensional.

The structural form of (1) can be written as:

$$Ay_t = A_1^* y_{t-1} + A_2^* y_{t-2} + \ldots + A_p^* y_{t-p} + Bu_t \quad (13)$$

where $E(u_t) = 0$ and $E(u_t u_t') = I_n$

The relation between reduced and structural shocks is simply obtained by multiplying the relation (13) by A^{-1}:

$$\varepsilon_t = A^{-1} B u_t \quad (14)$$

Equation (14) illustrates the relation between the reduced-form (disturbances) and the structural-form (innovations).

The connection between these two forms is given by:

$$A_j = A_j^{-1} A_j^* \quad (15)$$

The matrix *A* allows the modelling of the instantaneous relations while *B* is a structural form parameter matrix. The identification of the structural vector autoregression requires the introduction of additional constraints since, following (14) the number of non-redundant element of Ω ($n(n+1)/2$) is less than the overall number of elements in the matrix *A* and *B* ($2n^2$). The identification structure is therefore achieved by imposing $2n^2 = n(n+1)/2$ restrictions, taken from economic theory and intended to represent some meaningful short term relationship between the variables and the structural shocks.

Our system (see equation 1) includes endogenous variables: *y* is the real industrial production index, *p* the consumer price index, *m* the M2 money supply, *r* the interest rate, and *s* the real value of deposits in suspended banks. With exception of the interest rate, all variables are expressed in logarithms. We take the log of the deposits in suspended banks, *s*, as proxy of the banking panics.

The architecture of our short term restrictions is characterized by the following structure:

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & 0 & a_{53} & 0 & 1 \end{bmatrix} \begin{bmatrix} y_t \\ p_t \\ m_t \\ r_t \\ s_t \end{bmatrix} = A_1^* y_{t-1} + \ldots + A_P^* y_{t-p} + \begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 \\ 0 & 0 & 0 & 0 & b_{55} \end{bmatrix} \begin{pmatrix} u_{yt} \\ u_{pt} \\ u_{mt} \\ u_{rt} \\ u_{st} \end{pmatrix} \quad (16)$$

$$\begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ a_{21} & 1 & 0 & 0 & 0 \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} \\ a_{41} & a_{42} & a_{43} & 1 & 0 \\ a_{51} & 0 & a_{53} & 0 & 1 \end{bmatrix} \begin{bmatrix} \varepsilon_{yt} \\ \varepsilon_{pt} \\ \varepsilon_{mt} \\ \varepsilon_{rt} \\ \varepsilon_{st} \end{bmatrix} = \begin{bmatrix} b_{11} & 0 & 0 & 0 & 0 \\ 0 & b_{22} & 0 & 0 & 0 \\ 0 & 0 & b_{33} & 0 & 0 \\ 0 & 0 & 0 & b_{44} & 0 \\ 0 & 0 & 0 & 0 & b_{55} \end{bmatrix} \begin{pmatrix} u_{yt} \\ u_{pt} \\ u_{mt} \\ u_{rt} \\ u_{st} \end{pmatrix} \quad (17)$$

$\varepsilon = [\varepsilon_y, \varepsilon_p, \varepsilon_m, \varepsilon_r, \varepsilon_s]$ correspond to the errors of the reduced VAR form, while the structural disturbances u_y, u_p, u_m, u_r, u_s are, by definition (IS/LM models originated by Hicks, 1937 and its extensions, see especially Gali, 1992), aggregate supply shocks, aggregate demand shocks, supply monetary shocks, demand monetary shocks, and banking shocks:

$$\begin{aligned} &\varepsilon_{yt} = b_{11} u_{yt} \\ &a_{21}\varepsilon_{yt} + \varepsilon_{pt} = b_{22} u_{pt} \\ &a_{31}\varepsilon_{yt} + a_{32}\varepsilon_{pt} + \varepsilon_{mt} + a_{34}\varepsilon_{rt} + a_{35}\varepsilon_{st} = b_{33} u_{mt} \\ &a_{41}\varepsilon_{yt} + a_{42}\varepsilon_{pt} + a_{43}\varepsilon_{mt} + \varepsilon_{rt} = b_{44} u_{rt} \\ &a_{51}\varepsilon_{yt} + a_{53}\varepsilon_{mt} + \varepsilon_{st} = b_{55} u_{st} \end{aligned} \quad (18)$$

This model is exactly-identified because we impose 35 restrictions which correspond to the case of five endogenous variables.

The first row of the system (16):

$$y_t = A_1^{*(1,1)} y_{t-1} + \ldots + A_P^{*(1,1)} y_{t-p} + b_{11} u_{yt} \quad (19)$$

specifies that, except aggregate supply shock, all the others affect real activity with a lag (Sims and Zha, 2006). Such a restriction can be justified by the inter-temporal IS equation, by which the interest-sensitive expenditure is predetermined (Rotemberg and Woodford, 1999).

The relation given by the second row:

$$p_t = -a_{22} y_t + A_1^{*(2,.)} y_{t-1} + \ldots + A_P^{*(2,.)} y_{t-p} + b_{22} u_{pt} \quad (20)$$

is consistent with the specification by which the inflation rate reacts contemporaneously to output shocks (Woodford, 2003). Indeed, based on Calvo (1983), Rotemberg (2003), Rotemberg and Woodford (1999), we assume that effects on price changes on the remaining variables occur with a delay (except for the real economic activity).

The third row:

$$m_t = -a_{31} y_t - a_{32} p_t - a_{34} r_t - a_{35} s_t + A_1^{*(3,.)} y_{t-1} + \ldots + A_P^{*(3,.)} y_{t-p} + b_{33} u_{mt} \quad (21)$$

corresponds to the global liquidity aggregate dynamics, which is assumed to react contemporaneously to real income, demand aggregate, the short-term interest rate shock, and bank failure shocks.

The fourth equation:

$$r_t = -a_{41} y_t - a_{42} p_t - a_{43} m_t + A_1^{*(4,.)} y_{t-1} + \ldots + A_P^{*(4,.)} y_{t-p} + b_{44} u_{rt} \quad (22)$$

represents the central bank reaction function by which the Fed reacts contemporaneously to movements in output, prices level and money supply.

The last equation:

$$s_t = -a_{51} y_t - a_{53} m_t + A_1^{*(5,.)} y_{t-1} + \ldots + A_P^{*(5,.)} y_{t-p} + b_{55} u_{st} \quad (23)$$

represents the banking shocks dynamics relevant to bank suspensions and failures.

The introduction of such shock mechanism in our specification is motivated by the contribution of a series of banking panics from 1930 to 1933 to explain through the money supply multiplier the severe decline of the money supply.

Indeed, as explained by Friedman and Schwartz (1963), the banking failure generated by the absence of Fed lender-of-last-resort action, altered the public's confidence, leading to a massive decline in the deposit-currency ratio. This naturally forced the banks to reduce in turn their loans what has caused a sharp fall in the deposit reserve ratio. Bernanke (1983) also highlights the important role played by the bank failures in affecting the financial intermediation process and hence reducing the level of real output.

4.2. Empirical results

4.2.1 Impulse response functions analysis

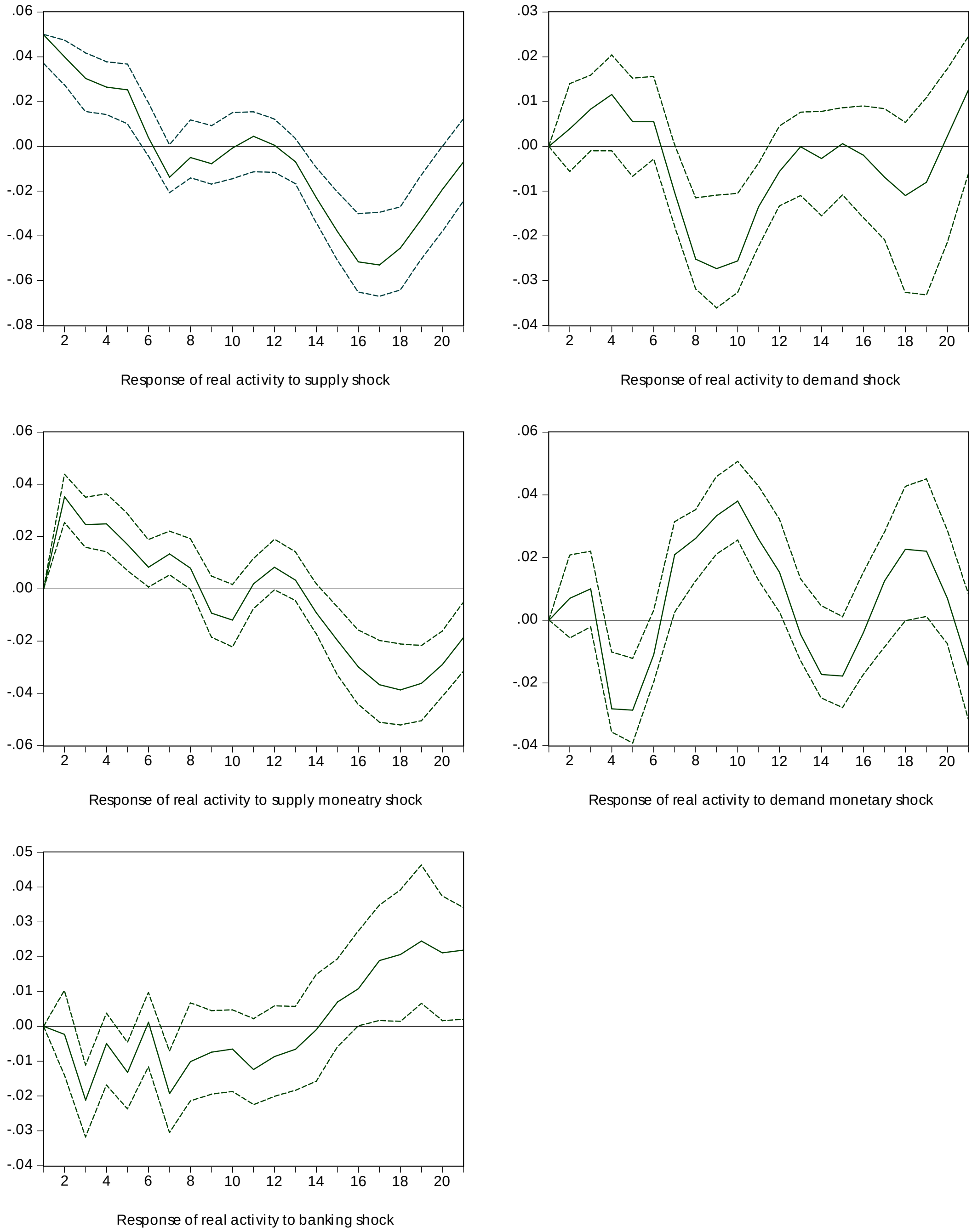


Figure 4: IRF

We develop now our impulse response function (IRF) analysis about the reaction of real economic activity to different shocks. We follow the calculation procedure presented in Hamilton (1994).

In the figure above, we display the real economic activity estimated by impulse response functions with 95% confidence intervals. The response of real economic activity to an unexpected aggregate supply shock is in line, but only at short term, with the literature. Indeed, after only 6 months the real activity becomes significantly negative and remains so for the rest of the period. This result may illustrate the difficulty to undertake structural or cyclical policies in an unstable economic environment.

The response of real activity to demand shock reflects the incidence of increasing prices on the output. We recall that it enables precisely to evaluate "Romer's channel": as Romer (2009) suggested, expansionary monetary policy affects expectations of deflation and replaces them by expectations of inflation which lowers real interest rates and triggers economic growth. As we can see, the "Romer's channel" does not imply permanent effects. Indeed, after 6 months, a shock on price affects negatively the output for the rest of the period. The positive effect of expansionary monetary policy does not seem to transit by a "break of expectations of deflation". An increase in prices has no permanent effect on economic activity. "Romer's channel" is not effective.

The real output increases at short term in response to an unexpected supply monetary shock, but it begins dying off after 8 months and remains so for the rest of the period. So, expansionary monetary policy exerts positive effects on economic growth in the very short run but negative effects after that (as a matter of fact, the level of real economic activity decreases by -4% after 18 months). Thus, Friedman and Schwartz (1963), Bordo *et al.* (2002), Romer (2009) are not (completely) wrong! The 1929's great contraction would certainly have been attenuated but not offset by expansionary monetary policy. Our results tend to minor the role of the monetary channel as a solution to the financial crisis.

The lack of efficiency of expansionary monetary policy after the 1929 crisis could be explained by the existence of banking panics. Indeed, the real activity decreases for 14 months after a banking shock. Runs deposits have immediate adverse effects on economic growth which conform theoretical predictions. Bernanke (1983) is right! The banking variable plays as a crucial transmission channel of the financial crisis. But interestingly, among all variables, it is the only one (with the interest rate, see below) to exert positive effects on economic activity in the mid term (after 14 months). We suggest that this positive effect transits through expansionary monetary policy used to fight bank failures. A renewed intermediation is a condition to enhancing economic growth. The effects we observe are in line with the stylized facts: indeed, banking panics significantly contributed to the emergence of the 1929's great contraction and would have been attenuated, had the Fed adopted an expansionary monetary policy. In other words, the positive mid term effect of banking shocks on real activity could be explained by the Fed intervention as lender-of-last-resort.

Lastly, we focus on the response of the real activity to a monetary demand shock. How does economic activity react following an increase in interest rate? Our findings in section 3 that the Fed adopted a new monetary policy rule "averting the trap" are corroborated by the IRF analysis. Despite leads and lags, we observe that after 6 months, the impact of raising interest rate on economic growth is nearly continuously positive (except an episode of 2 months around the 15th month): this corroborates the underlying situation of liquidity trap over the period. We note that a raise in interest rate may help breaking the speculative money demand and restore confidence in economic recovery. This finding echoes Dell'Ariccia-Blanchard-Mauro's suggestion (2010) to increase the interest rate in the current crisis situation: "to prick asset bubbles before they grow dangerously large relies on raising interest rate"… "it would have been good to start (the current crisis) with a higher nominal rate".

Thus, evaluating the incidence of increasing the interest rate in the thirties leads us to meet the old Keynesian lesson about liquidity trap… and a more disconcerting comprehension of the Fed policy rule as trying to avert the trap as soon as the thirties...

4.2.2. Variance decomposition analysis

Table 4: Variance decomposition

Months	Aggregate supply shocks (u_y)	Aggregate demand shocks (u_p)	Supply monetary shocks (u_m)	Demand monetary shocks (u_r)	Banking shocks (u_s)
2	0.75	0.02	0.13	0.08	0.02
6	0.49	0.07	0.09	0.31	0.04
12	0.38	0.12	0.07	0.24	0.19
20	0.39	0.11	0.05	0.33	0.12

Table 4 displays the historical decompositions of the real economic activity, i.e. the real US output from 1929:10 to 1933:12. Columns 1 to 5 contain the portion of the real activity that can be respectively explained by aggregate supply shocks (u_y), aggregate demand shocks (u_p), supply monetary shocks (u_m), demand monetary shocks (u_r) and banking shocks (u_s).

Two main features appear: after 20 months, a significant fraction (39%) of the real output variance is due to aggregate supply shocks and another important contribution can be attributed to demand monetary shocks (33%). These results confirm those given by the IRF figures that, in addition to aggregate supply shocks, demand monetary shocks constitute the most important propagation channel affecting the real sector, in the mid-term. By contrast, the contribution of the supply monetary shock is the weakest (only 5% after 20 months). This result calls into question the monetarist claim for increasing the money supply in times of financial crisis. For the period 1929-1933, we suggest that the impact of the liquidity trap constraint limited the efficiency of expansionary monetary policy. We also verify the contribution of the banking shocks (12%) as another transmission channel for explaining the real US output variations. But this contribution, smaller than expected, corroborates the idea that, in a liquidity trap context, the banking system cannot fully play its role of intermediation.

5. Conclusion

In this paper, we gave empirical evidence that a situation of liquidity trap prevailed in the US in 1929 which in turn pushed the Fed to adopt a new policy rule over the period 1930-1933. We called this new policy rule “averting or repelling the trap”. This innovative result which contrasts the existing literature on the 1929 crisis is corroborated by the simulations driven in a SVAR framework. The liquidity trap context explains why expansionary monetary policy would have had small effects on real economic activity and only in the very short run. The monetarist lessons from the 1929 crisis (Friedman and Schwartz, 1963; Bordo *et al.*, 2002)) should then be balanced. Moreover, in a situation of liquidity trap the “Romer’s effect” appears to be limited in time.

Another key finding is that the channel of run deposits (“Bernanke effect”) exerted strong adverse effects on real economic activity in the short run. We suggest an indirect link between expansionary monetary policy and banking failures by which monetary injection dedicated to avoid bank failure succeeds in the mid-turn. Expansionary monetary policy may help to compensate in the mid term the adverse effect of banking shocks on real economic activity but in no way should we expect a miracle in terms of economic growth by the only means of expansionary monetary policy.

For the Great Depression as for today, it seems that the role played by the banking sector was an important channel, a decisive intermediary between the lender-of-last-resort and the public or private investor and consumer. This lesson from the past seems to have been well understood by current monetary authorities and financial institutions. Nevertheless, the other crucial outcome of our analysis remains ignored: the banking channel was obviously combined with a liquidity trap context. Our simulations indicate that the Great Depression would have been better contained and less persistent with an increase in interest rate that breaks the speculative money demand and restores confidence in economic recovery than with increasing the money supply. Interestingly, this echoes Ariccia-Blanchard-Mauro's (2010) recent suggestion to increase the interest rate in the current crisis situation.

As a matter of fact, we consider that the lessons from the Great Depression have been partially misunderstood which in turn led to mistakes in monetary policies' responses today. We suggest that today's certainties may rely on an erroneous diagnosis of yesterday. Our diagnosis of the 1929 crisis is that the banking channel was obviously combined with a liquidity trap context. We highlighted from a historical perspective that facing this double constraint two policy tools were required:

- the quantitative side of monetary policy ought to be devoted to combat banking panics and failures, not to restore economic growth: expansionary monetary policy in that purpose proved to be inefficient;
- an adequate interest rate policy means an interest rate helping to escape the liquidity trap, i.e. not a near zero interest rate as today.

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