Monetary Policy Alternatives at the Zero Bound:

Lessons from the 1930s U.S.

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Abstract: In recent years economists have debated two unconventional policy options for situations when overnight rates are at the zero bound: boosting expected inflation through announced changes in policy objectives such as adoption of price-level or nominal GDP targets; and LSAPs to lower long-term rates by pushing down term or risk premiums - "portfolio-balance" effects. American policies in the 1930s, when American overnight rates were at the zero bound, created experiments that tested the effectiveness of the expected-inflation option, and the existence of portfolio-balance effects. In data from the 1930s, I find strong evidence of portfolio-balance effects but no clear evidence of the expected-inflation channel.

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In recent years economists have considered two "unconventional" monetary policy options as last resorts for situations when real activity is too low, but the central bank has already pushed the overnight rate to the zero bound and done its best to convince the public the overnight rate will remain zero for a long time - "forward guidance." One is to announce a credible change in policy objectives that raises the inflation rate the public expects the central bank to aim for in the future, when the economy is out of the liquidity trap and conventional tools work again. An increase in the central bank's inflation target would do the trick. So would the replacement of an inflation target with a target for the path of the price level or nominal GDP: these imply inflation must be temporarily high at some point in the future to make up for current shortfalls. Another option is for the central bank to acquire long-term bonds in open-market operations, in exchange for newly-created reserve balances or short-term bonds from the central bank's portfolio. Such operations are often referred to loosely as "quantitative easing."[1] Federal Reserve policymakers call them "large-scale asset-purchase" programs or LSAPs.

A credible change in policy objectives could work partly as another form of forward guidance, through rational expectations of financial-market participants. If they become more convinced the central bank will choose low short-term interest rates in the post-trap future, current long-term rates may fall somewhat. However, in conventional New Keynesian models a bigger bang comes through rational expectations of agents participating in the wage- and price-setting process. In the "new Keynesian Phillips curve," current inflation is affected by levels of inflation and real activity expected to prevail at distant horizons. To the degree that a change in objectives implies higher inflation for the post-trap future, it raises inflation immediately, even while short-term rates remain stuck at the zero bound. That reduces real interest rates, boosts spending and can lift the economy out of the liquidity trap by its expectational bootstraps (Krugman, 1998; Woodford, 2012).

[1] "Quantitative easing" is sometimes used more specifically to mean operations that exchange long-term assets for reserve balances (not short-term assets).

Policymakers have not tried the expected-inflation mechanism in recent years, despite its theoretical appeal. Perhaps they doubt it would work in reality. Many empirical studies find the new Keynesian Phillips curve fits the data only if one assumes expectations are less rational than in standard models (Roberts, 1997; Ball, 2000; Rudd and Whelan, 2007; Fuhrer, 2012). Even if expectations are rational, it may be hard for policymakers to make the new objective credible.[2] To improve credibility, Lars Svensson recommends a policy package he calls the "Foolproof Way" out of a liquidity trap. A key element is a peg to a depreciated exchange rate, which "serves as a conspicuous commitment to a higher price level in the future" (2003, p. 155).

LSAPs, like a change in policy objectives, might lower long-term rates somewhat just by reinforcing the message that overnight rates will remain zero for a long time. During a financial crisis, LSAPs in disrupted markets can lower rates by reducing liquidity premiums (a form of "credit easing"). But most advocates of LSAPs hope they can lower long-term rates in well-functioning markets by pushing down on term or risk premiums - other "portfolio-balance" effects. As a matter of theory portfolio-balance effects are trickier than the expected-inflation mechanism. They do not exist at all in many economists' preferred models (Woodford, 2012).

Despite their theoretical shortcomings, LSAPs have been tried by the Federal Reserve and other central banks in the zero-bound era since 2008. The Fed's "Operation Twist" of 1961 was an LSAP: though the U.S. was not at the zero bound, the Fed bought long-term Treasuries (in an attempt to lower long-term rates and stimulate real activity) while selling short-term Treasuries (to raise short-term rates and improve the balance of payments). Some Bank of Japan (BOJ) "quantitative easing" operations in the early 2000s, when Japan was at the zero bound, were also LSAPs.[3]

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[2]It is not necessarily linked to any observable current action. It may be time-inconsistent: in a recovered economy, it would be better to return to the old inflation target, which presumably reflected underlying preferences (Eggertsson and Woodford, 2003; Adam and Billi, 2007).

[3]Not all. Some BOJ operations exchanged reserves for short-term assets with yields already practically zero (Gagnon, Raskin, Remache and Sack, 2011 p. 36; Ueda 2012). Everyone agrees that exchanging reserves for assets currently paying zero interest will have no effect on market yields even if there is a

Empirical studies have looked for effects of Operation Twist (Swanson, 2011), BOJ operations (Bernanke, Reinhart and Sack, 2004; Ueda, 2012) and post-2008 LSAPs by the Fed (Neely, 2012; D'Amico and King, 2012; Gagnon, Raskin, Remache and Sack, 2011; Krishnamurthy and Vissing-Jorgensen 2011) and the Bank of England (Joyce, Lasaosa, Stevens and Tong 2011). Most conclude these operations (with the possible exception of the BOJ's) did tend to lower long-term rates. But it is not generally agreed they did so through a portfolio-balance channel. A big problem is that the intent and timing of all these operations were well-publicized. Whether or not a portfolio channel actually exists, financial-market participants would presumably price in the *possibility* the LSAPs would work: there was practically no experience on which to base a reliable forecast they would fail (Reichlin, 2011, p. 192; Krishnamurthy and Vissing-Jorgensen discussion p. 280). That would create a temporary effect on term premiums. Indeed, some studies find that the apparent effects of the operations disappeared quickly (Wright, 2011; Neely, 2012, p. 27; Woodford, 2012 p. 71). Also, news about the operations may have changed market participants' expectations of future overnight rates by signalling something about policymakers' preferences or private information (Cochrane, 2011, p. 4; Woodford, 2012, p. 57, 72) - the "signalling channel." Some studies try to parse out the contributions of the signalling channel *versus* changes in term premiums with estimated dynamic term-structure models. Such models necessarily assume expectations of future overnight rates can be inferred from statistical relationships in data from periods when the overnight rate was positive. Unfortunately, it is not clear that key patterns remain the same when the overnight rate is zero (Bauer and Rudebusche, 2012, Woodford, 2012 p. 78). To generalize, within a model one can work out the correspondence between relationships observed to hold in ordinary times, and relationships that hold in the extraordinary conditions of the zero bound. In the absence of an agreed-upon model there may be special value to evidence drawn from periods when the economy was actually in a liquidity trap.

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portfolio-balance channel (Hamilton and Wu 2011, p. 7; Woodford 2012, p. 60).

The American economy has been in a liquidity trap once before, in the 1930s. Across the downturn of the Great Depression, from 1929 to early 1933, interest rates in America's formerly active overnight-lending markets fell to practically zero. According to Krugman (1998, p. 137), American interest rates were "hard up against the zero constraint." They remained there for the rest of the decade. Meanwhile, American policies tested the practical effectiveness of the expected-inflation option: over 1933 the incoming Roosevelt administration devalued the dollar as part of an announced policy to inflate the overall price level. Policy also created natural experiments testing the existence of portfolio effects. Over 1934-36, the interaction of Treasury and Federal Reserve practices created variations in asset supply relevant for some types of portfolio effects, specifically those due to investors' avoidance of duration (or interest-rate) risk. Importantly, these events were *accidental and unpublicized* (like the accidental reserve-supply shocks studied by Hamilton [1997] and Carpenter and Demiralp [2006]). Policymakers did not claim they would affect bond prices, and their exact timing was unknown to market participants. In this paper, I examine the results of both sets of experiments.

I begin by describing exchange-rate and monetary policies over the 1930s and interpreting them in terms of open-economy Keynesian models. Next, I look for evidence that devaluation and pro-inflation announcements over 1933-34 and monetary policy turns later in the 1930s affected inflation through long-term expectations. I find only very ambiguous evidence. Over 1933-34 there was a sharp pickup in inflation that cannot be accounted for by the usual Phillips-curve relation with real activity, or by direct effects of devaluation. But there is a good alternative explanation for these inflation anomalies: changes in labor markets that were, in the language of DSGE models, "markup shocks." Over 1933-34, the National Recovery Administration (NRA) fixed minimum wages by industry, banned wage cuts, encouraged union formation and strengthened union bargaining power. When the NRA was declared unconstitutional in 1935, many of its pro-union and wage-fixing policies were maintained in other forms. There is no way to honestly calibrate or estimate from another era the magnitude of these mark-up shocks. I cannot rule out that inflation was boosted by *both* markup shocks *and* an increase in expected future inflation. But the exact timing of the inflation anomalies is entirely consistent with the operation of the NRA and unionization.

Finally, I examine data from 1934-36 to see whether accidental fluctuations in asset supply affected bond yields as predicted by a duration-risk view of portfolio-balance effects. I find strong evidence they did.

1) Exchange-rate and monetary policies over the 1930s

The late 1920s

In the late 1920s the shortest maturity of lending in the United States was overnight. Overnight instruments included fed funds loans (loans between firms with accounts in the Federal Reserve system, usually without collateral); repurchase agreements (repos) on federal securities; "call money" or "brokers' loans" collateralized by stocks and bonds traded on New York exchanges; and interest-paying interbank deposits (Haney, Logan and Gavens 1932; United States Senate 1931 part 1, 1048; Turner 1931).

The U.S. and most of its international trading partners were in an international gold standard system. Monetary authorities exchanged currency and central bank reserve deposits for a fixed quantity of gold, effectively fixing international exchange rates. Authorities covered deficits in the balance of payments with outflows of monetary gold and/or sales of official foreign-asset reserves. Authorities facing a persistent balance-of-payments deficit would eventually have to raise local interest rates, depressing real activity. The resulting capital inflows and decrease in imports would improve the balance in the short run. In the long run, the disinflation or deflation associated with depressed real activity would decrease the country's relative wage and price level, devaluing its real exchange rate. A country with a balance-of-payments surplus was supposed to do the opposite, according to the gold standard's "rules of the game." In their classic form, the rules barred persistent accumulation of foreign reserves or sterilization of gold inflows so that a balance-of-payments surplus would automatically boost its high-powered money supply and hence reduce its short-term interest rates. Ultimately, a country's long-run price level would be determined by its currency's gold content and the gold price level of tradable goods. The gold price level depended in turn on the balance of world gold supply against gold standard countries' demand for gold reserves (as distinct from reserves of foreign assets). In the United States, most economists and writers in business publications thought about the price level in these terms. They assumed the dollar's gold value would remain fixed and forecast a stable or slightly decreasing price level based on the balance of world gold supply and demand (Nelson, 1991: 6-7).

In fact, many countries with persistent balance-of-payments surpluses accumulated reserves of foreign assets or increased gold reserves rather than allow domestic inflation to take place. One of these was the U.S. In the late 1920s the Federal Reserve system was in charge of America's gold reserves as well as domestic monetary policy. Fed staff monitored measures of domestic prices and economic activity. In decisions about discount rates and open-market operations, Fed policymakers aimed to keep inflation low, stabilize output and forestall financial-market bubbles. This usually required them to sterilize gold inflows and accumulate reserves (Meltzer, 2003: 169,209,230). Fed policymakers did not have a shared, coherent view of monetary policy, but one could argue they followed the Taylor rule rather than the gold-standard rules of the game (Orphanides, 2003). It is not clear what they would have done in the end if the Great Depression had not occurred. Presumably they would not have been willing to keep accumulating gold and foreign assets forever. That could mean they would have ultimately allowed inflation to take place in the U.S. But the imbalance could also have been resolved by forcing other countries, losing gold, to deflate.

The Great Depression and the onset of the liquidity trap

In response to the October 1929 stock market crash the Federal Reserve system cut discount rates, purchased Treasury bonds in open-market operations and refrained from sterilizing gold inflows. Fed funds and call money rates declined sharply, rose for a while in late

1931 as the Fed tightened in the wake of Britain's devaluation, then fell further. By late 1932 fed funds rates were as low as 13 basis points (Turner, 1931:47). As one would expect, the wave of bank panics that culminated in the national bank holiday of March 1933 shut down the fed funds market due to default fears. By early 1934 confidence in banks had been restored by steps such as the introduction of Federal deposit insurance: deposits flooded back into banks; bank stock and debt prices recovered. But the fed funds market did not revive: "there were practically no occasions when there were borrowers in need" (Willis 1957:11) The repo market was likewise moribund; the rate on interbank deposits at New York money center banks was cut to zero by early 1933, prior to the regulatory prohibition of interest on such deposits (Bradford, 1941: 445; Federal Reserve Board 1934: 629, 1936: 31; Homer, 1963: 376).The call money market had continued to function through the October 1929 stock crash (haircuts on collateral value were more than sufficient to protect lenders [Bradford 1941: 444]), but call money rates fell along with fed funds. Figure 1 plots the official call-money rate set by the New York stock exchange, with certain months marked for comparison with figures I present later. It was not actually cut to zero. After the bank holiday it was usually held fixed at one percent. But there appears to have been no demand for call money loans at this rate or at any lower, unofficial rate.[4]

From 1934 through summer 1936, the American economy was doubtless in a liquidity trap. There were simply no opportunities to lend overnight at a positive return, and almost no applications for discount loans from the Fed. The latter condition indicates a liquidity trap because, when the overnight rate is zero, banks hold enough excess reserves to cover any possible payments shortfalls and need not borrow to cover overdrafts or required-reserve deficiencies (Hanes, 2006). Treasury yields, also plotted in Figure 1, were extremely low but not as low as after 2008.[5] Three-month Treasuries were usually less than a quarter of a percent, but

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[4]It was not unheard of for stock-exchange authorities to deliberately set the official call-money rate above the market-clearing level: they had done this at times prior to 1932 (Beckhart 1932: 55).

[5]The maturity of newly-issued Treasury bills varied over the 1930s and discount rates on newly-issued bills were sometimes negative for well-understood reasons. The figure plots estimates of three-month

bond yields remained above 2 1/2 percent. Relative to the post-2008 period, financial-market participants may have placed a higher probability on a faster "lift-off" from the zero bound.

In the outside world, gold demand had increased sharply after 1929 due to widespread runs on banks and currencies. In any gold-standard country, output and employment could remain at the natural rate only if there was a massive deflation of wages and prices, or a devaluation of the currency relative to gold (Temin, 1989; Eichengreen, 1992; Bernanke, 1995; Bernanke and Mihov, 2000). Most countries eventually chose the latter, but only after suffering the former. Some, including France and the Netherlands, held to their 1929 gold values until autumn 1936 (Clarke, 1977; Eichengreen and Sachs, 1985). The resulting monetary regime was not like the recent era of floating exchange rates. It was more like the Bretton Woods system with a much smaller role for dollars. Major countries pegged against gold, or managed their currency's gold exchange rate within a tight band (e.g. Britain). Many countries (e.g. Germany) adopted exchange controls.

American policy 1933-39

Coming out of the Bank Holiday, in April 1933 the new Roosevelt administration ordered the Treasury and banks to cease paying out gold for currency and deposits, ordered Americans to sell privately held monetary gold to the government, and allowed the dollar to float against gold in foreign markets. In June 1933 Congress passed legislation abrogating financial contracts that required payment in gold at the old parity, and Roosevelt sent representatives to an international economic conference in London. The London conference was aimed at restoration of gold convertibility at the old exchange rates. But "while it was in process, the President apparently decided definitely to adopt the path of currency depreciation" (Friedman and Schwartz, 1963: 469). At the beginning of July, he sent a message to the conference disavowing its aims. In January 1934, the Gold Reserve Act fixed a new gold value for the dollar, depreciated about 40 percent from its pre-1933 value. Over January and February 1934 Treasury purchases of gold in

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yields that control for these factors, from Cecchetti (1988).

foreign markets drove the dollar down to the new rate. The dollar was not devalued again in the 1930s (and for a long time afterwards) but at times another devaluation was widely viewed as possible (Clarke, 1977: 11). The gold value fixed the dollar's exchange rate against countries that were holding to their 1929 gold values, such as France. Through early 1938 the dollar's exchange rate also remained within a tight range against sterling and the countries of the British Empire that pegged to sterling.

Dollar devaluation was part of an announced policy to raise the overall price level, supported by Roosevelt and many congressmen. In May 1933 Roosevelt began to state clearly that his administration intended to "reflate" prices to their pre-Depression level, and Congress passed the Thomas amendment to the Agricultural Adjustment Act, which was "explicitly directed at achieving a price rise through expansion of the money stock" (Friedman and Schwartz, 1963, p. 465).[6] In a fireside chat of late October 1933, Roosevelt gave perhaps his most explicit and detailed statement of support for future inflation.[7] Roosevelt and other supporters of reflation believed (or at least hoped) it would promote economic recovery, but it is not clear what channel they had in mind.[8]

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[6]In his second "fireside chat" on May 7th, Roosevelt said "The Administration has the definite objective of raising commodity prices to such an extent that those who have borrowed money will, on average, be able to repay that money in the same kind of dollar which they borrowed."

[7]On October 22: "I repeat what I have said on many occasions, that the definite policy of the Government has been to restore commodity price levels. The object has been the attainment of such a level as will enable agriculture and industry once more to give work to the unemployed. It has been to make possible the payment of public and private debts more nearly at the price level at which they were incurred. It has been gradually to restore a balance in the price structure so that farmers may exchange their products for the products of industry on a fairer exchange basis. It has been and is also the purpose the prevent prices from rising beyond the point necessary to attain those ends...Obviously..we cannot reach the goal in only a few months. We may take one year or two years or three years...When we have restored the price level, we shall seek to establish and maintain a dollar which will not change its purchasing and debt paying power during the succeeding generation."

[8]Roosevelt took counsel from many economists and financiers. Some strenuously opposed devaluation and reflation. Roosevelt's actions were most consistent with the ideas of Cornell economist George F. Warren. Warren understood that under a gold standard each country's price level was determined by its currency's gold value, and that prices of internationally-traded agricultural commodities were set in world markets so their prices in any one country would respond immediately to a change in the

Figure 2 plots dollar exchange rates against sterling and the French franc from 1932 through 1937. The dollar had already deprciated substantially prior to FDR's disavowal of the London economic conference in July 1933. Figure 3 shows that the changing rate was immediately reflected in domestic prices of raw commodities traded on international competitive markets, such as cotton (a U.S. export) and rubber (an import). A price index from the era that covers a wide set of raw materials used by industry, weighted by values of domestic consumption, also shows a strong, immediate effect of devaluation.

Real activity, meanwhile, turned up from a trough in March 1933 according to the NBER's chronology. The upturn appears in the FRB's IP index, plotted in Figure 4 with a measure of unemployment I will explain later. The turnaround was perceived at the time. Businessmen expected it to continue.[9]

From 1934 through the end of the 1930s the U.S. usually ran a balance of payments surplus and accumulated monetary gold, as it had in the 1920s. Under new institutional arrangements gold was purchased from foreign sellers by the Treasury rather than the Fed. The Treasury also bought gold and silver from domestic mines. Through summer 1936, American

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currency's gold value (Warren and Pearson, 1933). He believed that the structure of relative prices had been disturbed after 1929, because prices of internationally traded agricultural commodities had plummeted but "sticky" prices of domestic manufactured goods had not. In the words of Warren's colleague and co-author, Frank Pearson (1957, p. 5671), "The problem..was to deflate the high, sticky prices down to the level of the low, flexible prices or to inflate the low, flexible prices up to the high, sticky prices. There was no other alternative..F.D.R. had plenty of advice on what should be done. One group proposed that the process of deflation should be completed; their remedy, completion of deflation, would have been politically unacceptable. Dr. Warren had the correct remedy: the equilibrium should be restored by inflating the flexible relative to the sticky prices by raising the [dollar currency] price of gold."

[9]In this era, railroad managers' associations surveyed freight customers on a quarterly basis to get their plans for rail shipments in the upcoming quarter. Customers reported their planned volumes of shipment for the next quarter as percent increases over the same quarter in the previous year. Suitably aggregated reports from manufacturing firms, given by Hart (1960), indicate their production plans for the upcoming quarter. Since early 1929, manufacters' production plans for coming quarters had embodied decreases in planned output from the same quarter of the previous year (and realized output had always been even lower than planned). Starting in the first quarter of 1933, manufacturers began to plan increases in production over the previous year. See especially Chart 2, p. 210.

policymakers allowed these specie purchases to boost the high-powered money supply. A Treasury gold purchase added to the money supply when the Treasury created a gold certificate "backed" by the purchased gold, deposited the certificate in its account at the Fed, and made payments out of its Fed account or transferred funds from its Fed account to Treasury accounts in commercial banks. The Fed did not sterilize effects of Treasury specie purchases. In fact it did not engage in open-market operations at all except to replace maturing securities in its portfolio (Friedman and Schwartz 1963: 511). As the economy recovered, some high-powered money growth went to accommodate increasing demand for cash, but most went into banks' excess reserves. This is apparent in Figure 5, which plots the American monetary gold stock (held by the Treasury), the high-powered money supply (cash held by the public plus nonborrowed reserves) and nonborrowed reserves from April 1934 on. From January 1934 to December 1936 the high-powered money supply increased about 63 percent. Nonborrowed reserves increased more than 85 percent.

In 1936 Federal Reserve policymakers began to push for a hike in reserve requirements to soak up excess reserves. They feared that the buildup of excess reserves could allow a burst of uncontrollable inflation to take place in the future.[10] They did not believe a hike in reserve requirements would have any immediate effect on interest rates, bank lending or real activity (Goldenweiser 1951: 175-82). In July 1936 the Fed announced a hike to take effect in August. Though the move had been negotiated with the Treasury, Treasury officials were not expecting the announcement to take place on the day it did (Blum, 1959:356; Meltzer 2003: 503). In

[10]Reputable professional economists have expressed similar fears about the post-2008 buildup of excess reserves, e.g. Martin Feldstein in the *Wall Street Journal* (January 3, 2013): "Because of the Fed's purchases of bonds and mortgage-backed securities, commercial banks have $1.4 trillion more in reserves than is legally required by the size of their balance sheets. The banks can use these excess reserves to create loans and deposits, which will increase the money supply and fuel inflation...the day will come when aggregate demand is increasing, companies want to borrow, and the banks are willing to lend aggressively." In the 1930s such fears were perhaps not unreasonable as the Fed had no notion of paying interest on reserves, and given the lack of knowledge at the time about the monetary transmission mechanism and the Phillips curve.

January 1937 the Fed announced that more hikes in reserve requirements would occur in March and May 1937. Meanwhile, in December 1936 the Treasury announced it would sterilize gold inflows. It began to do so immediately, by refraining from the creation of gold certificates against purchased gold. In effect, the Treasury began to pay for gold with additional Treasury borrowing rather than high-powered money creation. “Inactive” gold was counted part of the U.S. gold stock but not the high-powered money supply. As a matter of government accouting it was an addition to “Treasury cash” - funds credited to the Treasury but held neither in the Fed nor commercial bank accounts. The cessation of money growth and buildup in Treasury cash is obvious in Figure 5, which plots the sum of Treasury cash and Treasury Federal Reserve accounts.

According to the NBER chronology, the economy entered a recession in May 1937. Fed and Treasury officials had observed signs of a slowdown in economic growth before that. In response, they began to reverse their earlier actions. In March 1937 the Treasury bought bonds; in April the Fed announced that, for the first time since 1933, it would buy bonds to boost reserve supply (Blum 1959: 269-375; Gordon and Westcott 1937: 107). In September 1937 the Fed announced more bond purchases “for the continuation of the System’s policy of monetary ease” (Blum, 1959: 378) and the Treasury announced it would boost the money supply by creating gold certificates against part of its stock of inactive gold (Johnson 1939: 137). In February 1938 the Treasury announced that a limited volume of current gold purchases would be allowed to boost the money supply (Crum, Gordon and Westcott 1938b: 93). In April 1938 FDR announced that all inactive gold and all future gold inflows would be released into the money supply, and reserve requirements would be reduced immediately (Crum, Gordon and Westcott 1938b:94; Blum 1959:425).

2) The expected-inflation channel and 1930s policies

2.1) Theory

Roosevelt’s policy package of 1933-34 bears obvious similarities to Svennson’s

Foolproof Way out of a liquidity trap. Krugman (1998, p. 161), and Svensson (2004, p. 90) speculate that the Roosevelt administration's policies constituted an example of the expected-inflation option. Temin and Wigmore (1990, p. 485) argue that "The devaluation of the dollar was the single biggest signal" of a change in regime; "Devaluation...sent a general message to all industries because it marked a change in direction for government policies and for prices in general" (p. 485). Romer (1992, p. 176) argues that subsequent high-powered money growth from gold inflows depressed real interest rates as "consumers and investors realized that prices would have to rise eventually and therefore expected inflation over the not-too-distant horizon." Eggertsson (2008) shows that, in a new Keynesian model, a regime change representing the transition from Hoover to Roosevelt can account for the 1933 upturn and for a large part of the subsequent recovery through the expected-inflation channel. Using a similar model, Eggertsson and Pugsley (2006) argue that the policy reversal of 1936 caused the recession of 1937 by creating expectations of a possible switch to a less inflationary regime. But the models of Eggertsson and Eggertsson and Pugsley are closed economies. They depict the international gold standard as a sort of direct constraint on money growth, removed in 1933.

Here, I use a few equations to depict devaluation and sterilization explicitly, and to illustrate two key points. First, devaluation and unsterilized gold inflows could in principle stimulate demand through the same expected-inflation channel exploited by policies such as price-level targeting. Second, if the policy shifts of the 1930s *did* affect demand through the expected-inflation channel, they should have been associated with anomalous movements in wage inflation, or equivalently inflation in a price index for nonagricultural value-added. The equations are consistent with standard New Keynesian open-economy models (e.g. Svennson, 2000; McCallum and Nelson, 2000; Clarida, Gali and Gertler 2001) with one exception. In standard models, perfect international capital mobility - uncovered interest-rate parity (UIP) - holds. I cannot make sense of the 1920s or 1930s that way. I allow for imperfect international capital mobility (following Kouri and Porter, 1974), that is, a differential between expected returns on foreign *versus* American assets that increases with the share of world assets held by Americans.[11] For simplicity, I fix potential labor supply and production functions, as there is no evidence exogenous shocks to technology or fundamental preferences contributed to the Great Depression.[12] Also for simplicity, I do not allow for time lags in the effects of disturbances in interest rates or expectations on output and inflation. I will return to this point later on.

The expressions are loglinear approximations and omit constants. $E_t X_{t+\tau}$ is a rational expectation as of time *t* for the value a variable *X* will take at time $t+\tau$. Variables of the form ε_t^X tend to equal zero in the long run: at a long horizon $E_t \varepsilon_{t+\tau}^X = 0$.

Finished goods, which are differentiated, can be produced domestically or imported from foreign producers. Foreign and American-made goods are imperfect substitutes. *y* is an index of American real purchases of finished goods from American or foreign sources. *p* is the corresponding price index (often referred to as the "CPI" in the literature). Domestic demand for consumption goods and services is:

$$y_t = E_t y_{t+1} - \psi\left(i_t - E_t \Delta p_{t+1} - \bar{r} - \varepsilon_t^r\right) \quad \textbf{(1)}$$

ε^r reflects temporary disturbances to preferences, government spending and, in more complicated models, the efficiency of financial markets (Woodford, 2010). *i* is the expected one-period nominal yield on assets. There is no term premium in long-term rates, so the yield on a long-term bond paying off in T periods is:

$$i_t^T = \frac{1}{T} E_t \sum_{\tau=0}^{T} i_{t+\tau} \quad \textbf{(2)}$$

Domestic demand for real high-powered money is:

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[11] Some standard models (e.g. McCallum and Nelson, 2001) add a time-varying differential "risk premium" between expected returns to foreign *versus* domestic assets, but take it to be exogenous.

[12] Field (2011) presents good evidence that the rate of technological progress remained high or even increased in the Great Depression.

$$(m-p)_t^D \;=\; \omega y_t - \nu i_t + rr_t \;+\; \varepsilon_t^{md} \quad for \;\; i_t > 0 \qquad \textbf{(3)}$$

Money demand is not defined if $i = 0$. *rr* describes the effect of regulatory reserve requirements. ε^{md} accounts for, among other things, temporary disturbances to money demand from the agricultural sector.[13]

p^d is an index of domestic prices of American-produced goods (the "domestic price index"). $p*$ is the price level in foreign currency of finished goods produced abroad. *e* is the exchange rate (domestic currency price of foreign currency).

$$p_t \;=\; \alpha p_t^d \;+\; (1-\alpha)(p_t^* + e_t) \qquad \textbf{(4)}$$

Production of a finished good requires labor and a fixed quantity of an aggregate of raw materials. The agricultural labor force that produces raw materials is separate from the nonagricultural labor force that produces finished goods. *l* is an index of nonagricultural labor input. $y_t^d = \lambda l_t$ is American nonagricultural production of finished goods, including exports.

w is an index of nonagricultural wage rates, which are subject to Calvo (1983)-type nominal rigidity. w_j is the wage paid to one group within the labor force, e.g. workers in a particular establishment or firm. When it is possible to adjust a wage, the wagesetting process minimizes the expected value of a loss function that increases with the expected value of future gaps between w_j and a "desired" wage w_j^{des}, which is the wage that would be set for the group in the absence of nominal rigidity. The opportunity cost of a group's labor increases with *w* and with the level of nonagricultural employment *l* relative to *n* (the nonagricultural employment level that would be reached in the long run if labor markets were competitive). Due to factors such as workers' bargaining power and/or efficiency-wage mechanisms, w_j^{des} can exceed the

[13]These could be extremely complicated (Davis, Hanes and Rhode, 2009), so I do not depict them explicitly.

opportunity cost of labor by a markup μ_j.[14]

$$w_{jt}^{des} = w_t - \gamma(n-l)_t + \mu_{jt} \qquad \textbf{(5)}$$

where *(n-l)* is "unemployment." Wage inflation follows a new Keynesian Phillips curve:

$$\Delta w_t = -\beta(n - l - \mu/\gamma)_t + E_t\Delta w_{t+1} = \frac{\beta}{\lambda}(y^d - y^n)_t + E_t\Delta w_{t+1} \qquad where \quad y_t^n = \lambda(n - \mu_t/\gamma) \qquad \textbf{(6)}$$

y^n is the natural rate of nonagricultural output. μ/γ is the natural rate of unemployment. μ is an index of desired wage markups. μ can change from period to period but not predictably: $E_t\mu_{t+\tau} = \mu_t$. Because production technology is fixed, wage inflation is equivalent to growth in a price index for domestic nonagricultural value-added.

Some raw materials are produced abroad, some in America. All are traded on perfectly competitive world markets which are large relative to American production and use. $p^f(p^{f*})$ is an index of raw materials' prices in America (abroad).

$$p_t^f = p_t^{f*} + e_t = w^* + \varepsilon_t^f + e_t \qquad \textbf{(7)}$$

where w^* is the foreign wage level. ε_t^f represents temporary variations in the world relative price of raw materials (recall the equations omit constants). Approximating around long-run average cost shares,

$$p_t^d = \delta w_t + (1-\delta)p_t^f \qquad p_t^* = \delta w_t^* + (1-\delta)p_t^f* \qquad \textbf{(8)}$$

The share of expenditure devoted to American-made finished goods depends on the

[14](5) is consistent with many new-Keynesian models featuring nominal wage rigidity (e.g. Erceg, Henderson and Levin, 2000; Gali 2011), and also with many other types of models of efficiency wages and union bargaining (Summers, 1988). In some models the desired wage is affected by temporary fluctuations in the price of consumption goods (here p) relative to wages, because the loss of leisure's real value is part of the opportunity cost of type *j* labor and/or unemployed workers receive a dole with fixed real value. I have not accounted for that here. To get (5), one would assume the real value of leisure is not part of the opportunity cost of providing labor to a particular employer and any dole to the unemployed is indexed to the nonagricultural wage level rather than the CPI.

relative price of foreign output, which reflects the exchange rate and the difference between American and foreign wages:

$$y_t^d = y_t - \varphi(p^d - p^* - e)_t + \chi\varepsilon_t^{y*} = y_t - \varphi\delta(w - w^* - e)_t + \chi\varepsilon_t^{y*} \quad \textbf{(9)}$$

ε_t^{y*} represents temporary fluctuations in foreign expenditure on finished goods. φ can be small, even if import and export demand is very elastic, if foreign trade in finished goods is small relative to American finished-goods output. That was true in the the 1930s.

The change in the real money supply from one period to the next is:

$$\Delta(m-p)_t = \kappa\Delta(i_t - i_t^* - E_t\Delta e_{t+1}^e) - \zeta\delta(w - w^* - e)_t - \iota y_t + \xi\varepsilon_t^{y*} + \varepsilon_t^{bop} - \Delta forres - \Delta tres + \Delta fed + \Delta\varepsilon_t^{ms} - \Delta p_t \quad \textbf{(10)}$$

The first term on the right-hand side of (10) describes the effect of international capital flows on the balance of payments. i^* is the expected return in foreign currency to holding foreign assets for a period. The next terms describe the effect of the trade balance. An increase in American wages relative to foreign wages or a decrease in the exchange rate reduces net exports of finished goods. Temporary fluctuations in foreign spending boost American exports of finished goods and raw materials; increases in American spending boost imports. ε_t^{bop} represents other factors affecting American net exports or international demand for American assets. ε^f, which affects the relative price of raw materials, does not appear in (10) because in the 1930s, unlike earlier eras, the value of American raw material exports was about the same as the value of raw material imports.[15] Thus the balance of trade was (approximately) unaffected by changes in the relative price of raw materials in general. *forres* is the effect of increases in Fed or Treasury holdings of foreign assets, which reduce gold inflow given the balance of payments.

The remaining terms in (10) represent the effects of domestic money-supply factors: *tres*

[15]Over 1932-1938, the value of imports of crude materials and foods rose and fell with real activity (rose over the 1933-36 recovery, fell over the 1936-38 downturn) but on average was about equal to the value of exports of crude materials and foods (Historical Statistics of the United States, Millenium Edition, series Ee 446-457).

for Treasury balances, which reduce the money supply given gold inflow; *fed* for open-market operations; ε^{ms} for remaining transient money-supply factors (e.g. "float").

Equating money supply to money demand gives a relation between changes in *i,* balance-of-payments determinants and the actions of the Treasury and Fed, which holds only outside a liquidity trap:

$$\Delta i_t = \Delta(i_t^* + E_t \Delta e_{t+1}) + \frac{1}{\kappa+\nu}\Big[-\zeta\delta(w - w^* - e)_t + (\iota+\omega) y_t - \omega y_{t-1} + \xi\varepsilon_t^{y*} \mp \varepsilon_t^{bop} + \Delta tres + \Delta for - \Delta fed + \Delta rr + \Delta\varepsilon_t^{md} - \Delta\varepsilon^{ms} + \Delta p_t\Big] \tag{11}$$

Whatever current conditions may be, the public believes that at some sufficiently distant horizon T the domestic and foreign economies will be in the long-run state of new Keynesian models: both domestic and foreign inflation will fluctuate around stable trend rates; net foreign assets will fluctuate around stable fractions of domestic income. This means:

$$E_t l_{t+T} = l_t^n \qquad E_t y_{t+T} = y_t^n \tag{12}$$

$$E_t \Delta p_{t+T} = E_t \Delta w_{t+T} = E_t \Delta p_{t+T}^d = E_t \Delta w_{t+T}^* + E_t \Delta e_{t+T}$$

$$E_t p_{t+T} = E_t w_{t+T} = E_t p_{t+T}^* + E_t e_{t+T} = w_t^* + e_t + \sum_{\tau=1}^{T} \left(\Delta w_{t+\tau}^* + \Delta e_{t+\tau}\right)$$

Nonagricultural output is thus:

$$y_t^d = y_t^n - \psi\left(i_t^T - \bar{r} - \frac{1}{T} E_t \sum_{\tau=1}^{T} \left[\Delta p_{t+\tau} - \varepsilon_{t+\tau}^r\right]\right) - \varphi\delta(w - w^* - e)_t + \chi\varepsilon_t^{y*} \tag{13}$$

where:

$$E_t \sum_{\tau=1}^{T} \Delta p_{t+\tau} = E_t \sum_{\tau=1}^{T} \left[\alpha\delta\Delta w_{t+\tau} + (1-\alpha\delta)(\Delta w_{t+\tau}^* + \Delta e_{t+\tau})\right] - \varepsilon_t^f \tag{14}$$

Expected wage inflation in the upcoming period for (6) is:

$$E_t \Delta w_{t+1} = E_t \left[\Delta w^*_{t+T} + \Delta e_{t+T} + \frac{\beta}{\lambda} \sum_{\tau=1}^{T} (y^d - y^n)_{t+\tau} \right] \quad \textbf{(15)}$$

Monetary authorities' behavior must support the assumed long-run state. One workable policy is a floating exchange rate combined with inflation targeting or a Taylor rule with an inflation target $\Delta\bar{p}$. That constrains long-run wage and price inflation: $E_t \Delta p_T = E_t \Delta w_T = \Delta\bar{p}$. Taking foreign wage inflation as given the exchange rate adjusts so that $E_t \Delta e_T = \Delta\bar{p} - E_t w^*_{t+t}$

Another workable policy is an international gold standard and the strict rules of the game. That means a permanently fixed exchange rate $\bar{e}$ and, in (10), $tres = fed = forres = 0$. This policy constrains long-run inflation to equal foreign inflation $E_t \Delta p_T = E_t \Delta w_T = E_t \Delta w^*_T$. The future wage and price levels must also be in line with the exchange rate:

$$E_t w_{t+T} = E_t\, p_{t+T} = \bar{e} + w^*_t + E_t \sum_{\tau=1}^{T} \Delta w^*_{t+\tau} \quad \textbf{(16)}$$

Taking foreign wage inflation as given, the fixed exchange rate amounts to a price-level target. The rules of the game amount to an interest-rate rule that pushes the domestic wage and price level to the target. If domestic wages are below the effective target level $\bar{e} + w^*$, the economy cannot remain in an equilibrium with expected and realized inflation equal to foreign inflation. Net exports will be too high, tending to put the balance of payments into surplus. In (11), the nominal interest rate keeps falling until the real interest rate is below the natural rate, temporarily raising wage inflation above $E_t \Delta p^*_T$ until the domestic wage level rises to the target.

U.S. policy in the 1920s - a permanently fixed exchange rate combined with something like inflation targeting or a Taylor rule - was tenable in the short run because the domestic wage level was less than $\bar{e} + w^*$, so the balance of payments was in surplus. In the long run, one possible outcome was for American authorities to stop accumulating gold and foreign assets, allow the money supply to grow faster, interest rates to fall, output to rise above the natural rate and inflation to occur. But another possible outcome was a decline in foreign wage inflation to lower $\bar{e} + w^*$.

Now consider a situation corresponding to early 1933: output far is below the natural rate; the exchange rate is fixed by the dollar's gold parity; the overnight rate is zero. Under the conventional view of the liquidity trap, a zero overnight rate means i is zero, so that demand for high-powered money is indeterminate. (I will return to this later.) The public expects the economy will lift off from the zero bound by some future point in time. The horizon T is, by definition, well past this point. What is the effect of a policy package like Roosevelt's? For simplicity, I describe the policy as an unexpected one-time devaluation, with no expectations of further devaluation. The latter would only reenforce the effects I describe here.

With the exchange rate expected to remain fixed current output is:

$$y_t^d = y_t^n - \psi\left(i_t^T - \frac{1}{T}(E_t w_{t+T} - w_t) - \bar{r} + \varepsilon_t^f - \frac{1}{T} E_t \sum_{\tau=1}^{T} \left[(1-\alpha\delta)\Delta w_{t+\tau}^* - \varepsilon_{t+\tau}^r \right] \right) - \varphi\delta(w - w^* - \bar{e})_t + \chi\varepsilon_t^{y*} \quad \textbf{(17)}$$

where:

$$E_t w_{t+T} - w_t = T E_t \Delta w_{t+T}^* + \frac{\beta}{\lambda} E_t \sum_{\tau=1}^{T} (y^d - y^n)_{t+\tau} \quad \textbf{(18)}$$

Current wage inflation is:

$$\Delta w_t = \frac{\beta}{\lambda}(y^d - y^n)_t + E_t\left[\Delta w_{t+T}^* + \frac{\beta}{\lambda} \sum_{\tau=1}^{T} (y^d - y^n)_{t+\tau} \right] \quad \textbf{(19)}$$

Price inflation is:

$$\Delta p_t = \alpha\delta\Delta w_t + (1-\alpha\delta)(\Delta w_t^* + \Delta e_t) + (1-\delta)\Delta\varepsilon_t^f \quad \textbf{(20)}$$

$$\Delta p_t^d = \delta\Delta w_t + (1-\delta)(\Delta w_t^* + \Delta\varepsilon_t^f + \Delta e_t)$$

Devaluation causes an immediate increase in domestic price inflation simply by raising raw materials' prices. By reducing the relative price of domestic goods devaluation also tends to boost net exports, with a small effect on domestic output and a potentially large effect on high-powered money growth through unsterilized gold inflows. But with the short-term rate at the zero bound, current money growth has no direct effect on interest rates.

The expected-inflation channel runs through the public's expectations of the future path of the output gap in (18). If the public believes monetary authorities will follow the rules of the game in one way or another, devaluation means that, for some periods in the span between liftoff and *T*, real activity must be higher than it would absent devaluation: otherwise wages cannot rise to match the new exchange rate. For any given long-term yield i^T in (17), that tends to decrease the long-term real rate, boosting current output. (There may also be a decrease in i^T due to expectations of lower nominal short-term rates in the post-trap future.) In (19), the increase in current output tends to raise wage inflation in the ordinary way. But the key point is this: due to expected-inflation mechanism there will be a further *extraordinary* increase in wage inflation through the second term on the right-hand side, that is through expected future wage inflation.

Given the experience of the 1920s the public could have doubted that authorities would actually allow future inflation to take place. Roosevelt's pro-inflation statements, the presence of inflation supporters in Congress and the absence of sterilization over 1934-36 could have made a difference in this respect. By the same token, the public could have taken reserve-requirement increases and gold sterilization over 1936-37 to indicate the Fed was likely to revert to its 1920s policies after all. Thus, the expected-inflation channel might have tended to decrease output in 1936-37. If it did, it should also have caused an extraordinary decrease in wage inflation.

2.2) Evidence of the expected-inflation mechanism in the 1930s

Did devaluation and pro-inflation rhetoric over 1933-34, and monetary policy turns later in the 1930s, really affect output through the expected-inflation channel? The cyclical upturn in April 1933 and downturn in 1937 are consistent with an expected-inflation mechanism, but there are other obvious explanations of both events: in 1933, the resurrection of the banking system from total breakdown; in 1937 a fiscal tightening among other things.[16] I know of no surveys from the 1930s that could be taken to indicate long-term inflation expectations directly.[17] I have examined newspapers and magazines from the era, following Nelson (1991) who attempts to discern inflation expectations over 1929-30 from an examination of the era's business publications. Clearly, the policies were of great public interest. While the Roosevelt administration was actively manipulating the dollar's gold price in late 1933, its daily value was front page news (Pearson, 1957, p. 5644). But I cannot find a dominant view of the policies' effects. They were variously described as impotent and as a cause of inevitable hyperinflation. Discussions of monetary policy in the press were as contradictory as in our own post-2008 era.[18]

A distinctive sign of the expected-inflation channel is anomalous movements in inflation. That is what I look for here. I estimate Phillips-curve relationships in data from the post-World War II era. I apply the estimated postwar coefficients to the path of real activity after 1929 to project a path for inflation over 1929-1940. I ask whether the actual path of inflation deviates from the projected path in ways consistent with effects of the expected-inflation channel. Simple new Keynesian models like that outlined above imply that the channel's effects on inflation must be coincident with effects on output and the public's receipt of relevant news about policy, because inflation and spending respond at once to changes in real interest rates and expected inflation. As

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[16]A great variety of evidence from the 1930s and other eras shows that banking crises have enormous real effects (e.g. Bernanke, 1983; Richardson and Troost 2009; James, McAndrews and Weiman forthcoming). On 1937 see Meltzer (2003:521-22), Currie (1938).

[17] Two studies attempt to infer inflation expectations in the 1929-32 downturn of the Great Depression indirectly. Cechetti (1992) produces statistical forecasts based on information available at the time, specifically lagged inflation and nominal interest rates. Hamilton (1992) uses agricultural commodity futures prices from the period. Their methods are obviously inappropriate for my purpose here. Cechetti forecasts future inflation from past inflation, and from nominal interest rates on the assumption that the real interest rate is stationary. If the expected-inflation channel is effective, those conditions do not hold. Hamilton's procedure assumes both rational expectations and a stable (stochastic) relationship between commodities prices and the price level. The relationship between commodities prices and the price level would be affected by changes in exchange rates and by the Roosevelt administration's agricultural programs. (That was the point of the programs!)

[18]The only obvious difference between 2008-12 and 1933-34 is that, in the earlier era, the *Wall Street Journal's* analysis was relatively insightful.

Svennson (2000) points out, this feature of new Keynesian models cannot be taken seriously. More realistic models imply lags in the response of spending and inflation to shocks. Thus, I will look for any kind of loose, perhaps delayed relation between inflation and policy turns.

As for Akerlof, Dickens and Perry (1996), my baseline Phillips curve is a simple regression of inflation on current real activity and two past years of inflation. To avoid direct effects of devaluation on product prices through raw-materials prices, I look at inflation in nonagricultural wages. Price indexes for nonagricultural value-added from the National Income and Product Accounts would also be appropriate, but for the 1930s NIPAs are available only at an annual frequency. For my purposes, data must be higher frequency and comparable between the 1930s and the postwar era - constructed in the same way with the same biasses. Monthly data on average hourly earnings in manufacturing, the main nonagricultural sector, fit the bill. It would be useful to compare 1930s inflation with projections from pre-1914 Phillips curves. But no 1930s wage series are comparable with long runs of pre-1914 data.

A problem with applying postwar coefficients to project inflation in an earlier era is a well-known historical shift in the empirical Phillips curve. Data that span years from the late 1960s through the early 1990s fit the "accelerationist" Phillips curve: coefficients on lagged inflation are positive, statistically significant and of a magnitude that indicates a nearly one-to-one relation between recently-experienced inflation and current inflation. Data from the pre-1914 era and the 1920s fit the original Phillips curve: coefficients on lagged inflation are small and usually not significantly different from zero at conventional levels (Gordon, 1990; Alogoskoufis and Smith, 1991; Allen, 1992; Hanes, 1993). I create 1930s projections from postwar coefficients in two ways. In one I apply both the real-activity and lagged-inflation coefficients. In the other I apply the postwar real-activity coefficient but set the coefficients on lagged inflation to zero. As it turns out, there is little difference for my purposes between projections with lagged-inflation coefficients on *versus* off. From 1929 through 1932 they follow about the same paths and fit actual wage inflation very tightly. From 1933 on actual inflation deviates from both with about the same timing.

It is well known that data from 1933-1940 deviate from any formulation of the Phillips curve.[19] Akerlof, Dickens and Perry (1996) argue that these deviations were due to “downward nominal wage rigidity” (a special constraint on nominal wage cuts). Blanchard and Summers (1986) argue they may reflect “hysteresis” in the natural rate of unemployment as laid-off workers lose membership in insider bargaining groups. I will not run the expected-inflation channel in a horserace against these alternative theories. But there are other extraordinary influences on wages in the 1930s, matters of fact, that must be accounted for.

The NIRA and unionization

The National Industrial Recovery Act (NIRA), passed in June 1933, applied to nearly all nonagricultural employers. The NIRA affected wages directly through the employment provisions of industry “codes,” which included industry-specific minimum wage rates. According to all accounts adoption of minimum wages raised wages of all workers because employers generally attempted to maintain pre-existing differentials. As soon as June 1933 auto manufacturers began to give raises to "improve their bargaining power in code negotiations" (Fine 1963: 125).[20] The first industry code, in cotton textiles, came into effect in July 1933 and was estimated to raise industry average wage rates substantially (Sachs, 1934: 147). At the end of July 1933 Roosevelt “invited” nearly all nonagricultural employers in industries that had not yet adopted their own codes to sign the “President’s Re-Employment Agreement,” known as the “blanket code.” Its provisions required most employers to raise wages. It came into effect in August.[21] Between August and December

[19]In the first application of the Phillips curve to American data, Samuelson and Solow (1960:188) found that "the years from 1933 to 1941 appear to be *sui generis:* money wages rose or failed to fall in the face of massive unemployment" (p. 188). See also Friedman and Schwartz (1960: 498), Gordon (1983).

[20]The NIRA required employers to negotiate with employee representatives, but it was not clear that this meant independent unions. Auto industry employers wanted NRA administrators to allow the industry to remain nonunion. They gave raises in June and July to demonstrate that unions were not needed to raise industry wages (Fine, p. 48-49 and p. 444 note 12).

[21]The blanket code fixed minimum hourly wage rates, maximum weekly hours and minimum weekly earnings, and required "equitable" maintenance of differentials above the minimums for higher-paid workers (Sachs 1934, 131).

1933 industries representing the bulk of employment adopted their own codes; by June 1934 all industries had been codified (United States 1935: Chart 36). Industry codes created pay hikes beyond those associated with the blanket code. They required more wage hikes and changes in compensation policies such as premium pay for overtime (Schoefeld, 1935; Weinstein, 1980, 9; 17; 47).

In addition to (but interacting with) establishing the code process, the NIRA stated that employees had a right to organize for collective bargaining. The enforcement agency established by the NIRA, the National Recovery Administration (NRA), took months to work out what this meant in specific regulations and create institutional structures to enforce them. But workers immediately understood the NIRA to bar employers from replacing strikers or firing employees attempting to organize a union. The number of workers involved in new strikes, plotted in Figure 6, increased enormously from May to June 1933. It remained much higher through the rest of the 1930s than it had been in the late 1920s.

The NIRA was declared unconstitutional in May 1935 but most of its pro-union elements were re-established and strengthened by the Wagner Act (National Labor Relations Act) passed in July 1935 (Mills and Brown 1950). In November 1936 "The overwhelming Roosevelt victory" in the presidential election "led employers to expect aggressive organizing drives by trade unions...wage rates were influenced by the large number of industrial disputes and by the efforts of employers to forestall unions by making concessions" (Slichter 1938: 98-99). In April 1937 the Supreme Court ruled the Wagner Act constitutional, and many companies that had refused to bargain with elected unions despite the Wagner Act gave in (Fine, 1963: 415; Schatz, 1983: 70). Estimates of union membership, which are annual (and imperfect), indicate enormous increases in union density in 1937 and 1938, as shown in Figure 6. But it is important to keep in mind that workers' bargaining power increased even in establishments that were not formally unionized. Many firms that remained nonunion through the late 1930s raised wages at times over 1934-1938 to forestall union threats.[22]

What my exercise means in terms of the new Keynesian Phillips curve

My exercise is easy to interpret in terms of the new Keynesian Phillips curve. From above,

$$\Delta w_{t+1} = E_t[\Delta w_{t+T} + \frac{\beta}{\lambda}\sum_{\tau=0}^{T}(y^d - y^n)_{t+\tau}] = E_t[\Delta w_{t+T} + \frac{\beta}{\lambda}\sum_{\tau=0}^{T}(y^d - \lambda n)_{t+\tau}] + \frac{\beta}{\lambda\gamma}\mu_t \quad \textbf{(21)}$$

Current wage inflation is determined by $E_t \Delta w_{t+T}$ - expected wage inflation at the long horizon - and the expected value of the cumulative output gap over the span from the current period to that horizon. Assuming as I did above that the average wage mark-up is variable but unpredictable, the cumulative output gap can be broken into two components: the expected deviation from trend in output and a factor reflecting variations in the average wage markup - a "supply shock."

Suppose that in the absence of changes in the monetary regime the relation between current output and wagesetters' expectation of future output can be approximated by an AR(1) with coefficient ρ. For real GDP in the postwar era, a simple autoregressive univariate forecast like this is hard to beat (Faust and Wright, 2007). Then:

$$\Delta w_{t+1} = E_t \Delta w_{t+T} + \frac{\beta}{\lambda}\frac{1}{1-\rho}(y^d - \lambda n)_t + \frac{\beta}{\lambda\gamma}\mu_t + z_t \quad \textbf{(22)}$$

z represents the difference between the univariate forecast and wagesetters' *actual* forecast for cumulative future output. When the expected-inflation channel is (decreasing) output, z is positive (negative).

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[22]In March 1934 auto manufacturers gave a general ten percent wage increase "with a view to strengthening their position with the administration, their workers, and the public at a time when the A.F. of L. federal labor unions in their plants, for whose existence the N.I.R.A. was largely responsible, were threateneing an industry-wide strike"; but at the time no union had signed up a majority of workers in any auto firm, and neither the automakers nor the NRA had recognized any union as a bargaining agent for workers (Fine, 1963:125,142). In March 1937 the nonunion Westinghouse Corporation raised wages in response to General Electric's recognition of a union (Schatz 1983: 67). The Allis-Chambers Corporation did not have an NLRB-certified union until 1938, but in April 1936 "The impact of increasing union pressure on the company was obvious" and it granted substantial bonuses (Peterson 1976:322). Most International Harvester plants were not unionized until 1941, but the company gave a number of company-wide wage hikes in 1935 and 1936 to discourage unionization (Ozanne, 1967: 148, 178, 179).

(22) is consistent with empirical Phillips curves from both the pre-1914 and postwar eras assuming that in both eras the expected-inflation mechanism and changes in average markups were unimportant. (22) generates the pre-1914 pattern if $E_t \Delta w_{t+T}$ is uncorrelated with recent inflation. (22) generates the postwar pattern if, within the sample examined, $E_t \Delta w_{t+T}$ is strongly correlated with recent inflation. Much evidence confirms this is a good description of the behavior of expected inflation in the two eras.[23] For the 1930s, one might guess expectations followed the pre-1914 pattern until U.S. adherence to its the gold exchange rate came into question. That was, at the earliest, September 1931 when Britain devalued: at that time some financial-market participants began to bet the U.S. would too (Friedman and Schwartz, 1963, p. 316). The long-term inflation expectation might have been similarly stable after 1934, if the public believed the 1934 devaluation was a one-time thing. That would mean the baseline empirical Phillips curve for the 1930s, absent extraordinary factors, should follow the pre-1914 pattern - no positive coefficients on lagged inflation.

At the same time, there are problems with simply turning off positive postwar lagged-inflation coefficients to generate a projection for periods when $E_t \Delta w_{t+T}$ was stable. A postwar

[23]In the postwar era, professional economic forecasters have reported long-run inflation expectations in surveys. From the late 1960s through the early 1990s reported long-run expected inflation varied from year to year and was positively correlated with recently experienced inflation. Estimates of long-term expected inflation extracted from long-term interest rates have been unstable and strongly affected by news about inflation and economic activity (Gurkaynak, Sack and Swanson, 2005). Erceg and Levin (2003) show that a New Keynesian DSGE model reproduces postwar price-inflation movements fairly well assuming long-term inflation expectations responded to experienced macroeconomic conditions with magnitudes calibrated to the survey data.They argue that expectations were rational but, especially over the 1980s, realized inflation did not reflected the *ex ante* distribution: wage- and price-setters accounted for a possible but unrealized future in which monetary policy would accommodate high, persistent inflation. That is, there was a "peso problem." I know of no survey data on inflation expectations from the pre-1914 era, but the behavior of long-term interest rates in the pre-1914 era indicates long-term price inflation expectations were stable, remarkably unresponsive to experienced macroeconomic events (Bordo and Dewald, 2001). Barsky and DeLong (1991) find evidence that the long-term inflation expectations indicated by pre-1914 interest rates were perhaps too stable to be rational expectations: they failed to respond to data on gold production, available at the time, which turned out to predict realized inflation. But they also point out, like Erceg and Levin (2003) for the postwar era, that one cannot judge the rationality of expectations on the basis of distributions of observed outcomes. From a late-nineteenth century point of view, there were many possible relations between gold discoveries and inflation; the "theory" that turned out to be correct *ex post* was just one of many *ex ante* possibilities. Again, a peso problem.

coefficient on real activity has positive bias as an estimate of $(\frac{\beta}{\lambda}\ \frac{1}{1-\rho})$ in (22) if real activity was positively correlated with changes in $E_t \Delta w_{t+T}$. That is likely: long-horizon inflation expectations reported in surveys declined in the recessions of 1973, 1981 and 1991. On the other hand, measurement error in indicators of real activity creates the opposite bias, toward zero. Both these worries are minor next to another shaky assumption for the exercise: that the baseline relation between current real activity and forecasts of future real activity, absent the expected-inflation channel, was the same in the earlier eras as in the postwar era. In the end, the proof of the projections is their fit to actual wage inflation over the span between 1929 and March 1933, prior to the possible operation of the expected-inflation channel. As it turns out, the fit is very good.

Deviations from projections may reflect z, the expected-inflation channel. The problem is that they may also reflect changes in μ . All of my real-activity measures, including the unemployment rate series, are essentially deviations of output or employment from fixed trends. They do not account for changes in μ in any way. Features of the NIRA and later New Deal legislation that protected union organizers and hindered replacement of strikers increased μ . Other features of the NIRA simply broke the relationship described by (22). The NIRA's minimum wages cannot be described as increases in μ because they were nominal. Employers negotiating with the NRA knew that NRA administrators wanted to prevent nominal wage cuts, above all.

Data

1930s data on average hourly earnings in manufacturing by industry are comparable with postwar data.[24] Hanes (1996) matched 1930s industries to industries in postwar data and applied fixed industry weights to construct a manufacturing AHE series that is consistent from the 1920s through 1990. Industry-level AHE reflect many things other than wage rates (the distribution of workers across a given firm's wage structure, the distribution of employment between high- and low-wage firms, the fraction of hours paid at premium rates). To make sure key movements in

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[24] They are from surveys carried out by the National Industrial Conference Board beginning in 1920, and by the Bureau of Labor Statistics beginning in 1934, as described by Dighe (1997).

AHE actually reflect changes in wage rates I will check them against a wage index from the 1930s (which is unfortunately not comparable with any postwar series).

To project 1930s wage inflation at a monthly frequency my real-activity indicator is the Federal Reserve Board Index of Industrial Production. For the 1930s estimates of real GDP and unemployment rates are available only at an annual frequency.[25] Mainly as a check on monthly projections I make 1930s projections of annual inflation using NIPA real gross output of nonfarm private business, and David Weir's (1992) series for the "private nonfarm unemployment rate." Weir constructs his series in the same way across the 1930s and the postwar era up to 1990. Unlike postwar BLS unemployment series, it does not account for short-term fluctuations in the labor force - it is essentially deviation from a long-term trend in employment.[26] Figure 4 plots Weir's series. For IP and real GDP, "real activity" is the deviation of the log from a long-term trend.[27]

Inflation projections

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[25]Estimates apparently at a higher frequency such as Balke and Gordon's (1986) are actually interpolations between annual estimates based mainly on IP.

[26]Postwar unemployment data are based on household surveys that allow people to classify themselves as in or out of the labor force (on BLS definitions). For years before 1940 no such surveys are available. Unemployment must be estimated as the difference between employment estimates and the long-term trend "usual labor force" (indicated by population censuses). In one sector, agriculture, there is no reliable way to estimate short-term variations in employment absent household survey data since so much farm labor is family labor. There is no consensus on whether the large numbers of Federal relief workers in the 1930s should be classified as employed or unemployed (see Darby, 1976 *versus* Lebergott, 1964). Weir's estimate of the private nonfarm unemployment rate sidesteps these problems. Its denominator is the "usual labor force," estimated the same way, for postwar years up to 1990 and earlier years. It excludes agriculture, government and relief workers from both the employment and labor force figures. Within the 1920-30s its underlying estimates for private nonagricultural employment are not significantly different from those underlying the alternative unemployment series of Lebergott (1964) and Romer (1986).

[27]It is tricky to define trends for the Great Depression era. It is clearly inappropriate to use a Hodrick-Prescott trend with conventional parameters or a loglinear trend estimated within the interwar era alone. Either would imply output was close to trend or even above trend in the mid-1930s, which is inconsistent with all unemployment estimates. I follow Romer (1989) and Balke and Gordon (1989) and define trends by loglinear interpolation between benchmark "normal" years. They use 1924, 1947, 1955, 1962, 1972, and 1981. I add two more benchmarks: 1941 and 1990. Using these benchmarks, output was far below "potential" throughout the 1930s. Cole and Ohanian (1999, footnote 5) define trends by estimating one loglinear trend spanning both 1919-1929 and postwar years, and assuming 1929 was on trend, so that the trend level for 1930 is the 1929 level *plus* the trend growth rate. I tried that too but it made little difference to my conclusions so I present only the results from the benchmark-year trends.

Hanes and James (2012) give details on the postwar Phillips curve regressions and the estimated coefficients. To avoid years affected by wage and price controls, the postwar samples run 1956-1971/ 1977-1990.[28] Within the postwar era the regression coefficients give more or less unbiassed projections of disinflations in cyclical downturns. For monthly-frequency regressions the dependent variable is the change in the log of the AHE series from the same month in the prior year. Month-to-month changes would be sensitive to precise definition of seasonals. There is good reason to believe NRA code adoption affected AHE seasonals strongly. (Many codes introduced worksharing, stabilization of hours and premium pay, among other things).

Going back to the 1930s I project wage inflation starting with January 1929. The projections using lagged inflation jump off from actual wage inflation in 1927 and 1928. From 1930 on the lagged inflation rates entering projections are lagged projections.

Figures 7A and 7B show the annual projections. Actual inflation is quite close to projections from 1929 through 1932. But in 1933 inflation is higher, and in 1934 much higher than projected. In 1935 and 1936 inflation falls back toward projected levels, but remains high. Inflation shoots up again in 1937. These patterns are consistent with the expected-inflation channel. They mean anomalous high inflation in 1933-34 (devaluation), decreased inflation in 1936 (monetary tightening), and a return to anomalous high inflation in 1937 (tightening abandoned). But recall there were also markup shocks and other factors boosting wage inflation in 1933 and 1934 (NIRA) and another round of markup shocks after November 1936 (unionization).

Figure 8 shows the monthly projections. Wage inflation was close to projections right up through July 1933. Wage inflation turned up in July, but so did projected wage inflation (due to the increase in industrial production that had begun in the spring). The anomalous pickup in AHE began in August.

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[28] Rockoff (1984) gives chronologies of the Korean War and Nixon controls. Korean War controls were lifted in February 1953, plausibly affecting the rate of wage inflation from 1953 to 1954. With two years' lagged inflation in my specifications, I begin with 1956. The Nixon controls held in one form or another from August 1971 through April 1974 (affecting inflation from 1974 to 1975). For monthly data the sample runs from March 1955 through July 1971 and from May 1976 through December 1990.

Figure 9 plots the level of the manufacturing AHE series along with another wage series from the 1930s. From the early 1920s through October 1935, the BLS asked respondents to its monthly survey of manufacturing establishments to report changes in wage *rates* (the number of employees affected by changes in wage rates and the percent changes). Creamer (1950) constructed a wage index from these data. Both the wage index and AHE show a small increase in the wage level in July and an enormous increase in August.

The anomalous pickup in wage inflation in 1933 is entirely consistent with effects of the NIRA, which affected some industries (e.g. autos, cotton textiles) as soon as July 1933 and all industries in August 1933 - the blanket code.[29] Recall from Figure 6 there was also an enormous increase in strike activity, arguably indicating an increase in μ, across June 1933. It is true that policy news for the expected-inflation channel came at about the same time. Roosevelt disavowed the London economic conference just a few weeks before the blanket code came into effect. But there were a number of events and announcements prior to August 1933 which one might expect to have some effect if the expected-inflation channel were operative. These include the cessation of gold payments in March 1933 and the Thomas inflation amendment to the AAA, introduced in April and passed in May.

Returning to Figure 8, the monthly data show that the increase in the 1937 annual inflation rate reflects an inflation pickup that was, in fact, *not* coincident with or subsequent to the monetary loosening. Inflation began to rise much faster than the projections in the interval *between* the first tightening step in July 1936 (when the Fed announced coming hikes in reserve requirements) and the first loosening step in March 1937 (Fed open-market bond puchases). This span also contains November 1936, Roosevelt's re-election.

While the NIRA's codes affected very nearly all nonagricultural establishments, the wave of unionization over the 1930s was largely confined to manufacturing, mining and transportation

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[29]The timing of NRA effects has been misunderstood by authors of some existing studies of 1930s inflation. McCloskey and Zecher (1984, 141) suppose that they were coincident with code adoption; that is certainly incorrect.

(Lewis, 1963). In terms of (22) and (5), unionization would increase μ by increasing μ_i in manufacturing establishments specifically. That should boost manufacturing wages relative to the general wage level and to wages in sectors that did not unionize. In 1935 the BLS began to collect data to construct average hourly earnings from establishments in a few mostly-nonunion sectors: wholesale and retail trade, hotels and laundries. Figure 9 plots the ratio of the manufacturing AHE series to a fixed-weight average of the available nonmanufacturing earnings series.[30] It increases after November 1936, Roosevelt's re-election. This is evidence that μ increased after November 1936.

I conclude that apparent wage inflation anomalies of the 1930s are well accounted-for as the result of the NIRA and unionization. There is nothing left for the expected-inflation channel to explain.

3) Portfolio effects and New Deal policies

So far I have taken for granted that monetary policy could affect the economy only through expectations. Because overnight rates were at the zero bound, demand for high-powered money was indeterminate. One current view on portfolio-balance effects of LSAPs, the duration risk view, implies something different.

3.1) The duration-risk view of portfolio effects

Gagnon, Raskin, Remache and Sack (2011: 7) argue that portfolio effects exist and their fulcrum is "the reluctance of investors to bear the interest rate risk associated with holding an asset that has a long duration." In an LSAP, a central bank removes long-term bonds from private-sector portfolios and replaces them with short-term bonds, or with reserves which are "zero-duration" assets free of interest rate risk. "With less duration risk to hold in the aggregate, the market should

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[30]The series are in United States BLS (1942, Table 6). I weight them by 1940 employment (in Table 4). The AHE series for trade and hotels included executive and supervisors' salaries prior to January 1938. That affects the recorded change from December 1937 to January 1938. Fortunately, the source (Table 6, p. 133) gives values for AHE excluding these salaries for one overlap month (December 1937). I adjusted the prior month's figures down by the percentage difference in this overlap month. The BLS did the same in later publications to construct continuous series for AHE in wholesale trade.

require a lower premium to hold that risk. This effect may arise because those investors most willing to bear the risk are the ones left holding it. Or, even if investors do not differ greatly in their attitudes toward duration risk, they may require lower compensation for holding duration risk when they have smaller amounts of it in their portfolios."

The duration-risk view of portfolio effects implies LSAPs are simple and effective. It does not matter which long-term bonds the Fed buys: Treasuries will do. Because LSAPs deflate term premiums, they "should not only reduce longer-term yields on the assets being purchased but should also spill over into the yields of other assets...Many private borrowers would find their longer-term borrowing costs lower than they otherwise would be, and the value of long-term assets held by households and firms, and thus aggregate wealth, would be higher" (2011: 8). It does not matter much whether the Fed pays for LSAPs by selling very short-term bonds or by creating reserves (as noted by Hamilton and Wu, 2012: 31) . An operation that did not change private-sector bondholdings at all but simply increased reserve supply - a "helicopter drop" of high-powered money - would also work, because it would decrease the private sector's *relative* holdings of assets subject to interest-rate risk. Term premiums would have to fall to make banks willing to hold more zero-duration assets.

The duration-risk view is not generally accepted, even among those who believe in portfolio-balance effects. Krishnamurthy and Vissing-Jorgensen (2011) argue that the spread between a bond's yield and expected overnight rates depends on the relative supply of bonds of that particular maturity and similar risk of default or prepayment (a possibility for mortgage-derived securities). D'Amico and King (2011) describe this as a "local-supply effect." Bauer and Rudebusche (2012: 6) call it the "*market segmentation* version of the portfolio balance channel." The local-supply or market-segmentation view of portfolio effects implies LSAPs may fail to spur aggregate demand even if they affect some long-term bond yields, because their effects are largely confined to the specific type of security being purchased. LSAPs in Treasuries reduce only Treasury yields, not private-sector borrowing costs (Krishnamurthy and Vissing-Jorgensen 2011: 285; Woodford, 2012: 65, 81).

3.2) Duration risk and money demand at the zero bound

Looked at from another angle, the duration-risk view implies demand for high-powered money is not indeterminate when the overnight rate is zero. It is instead a function of expected short-term returns to holding long-term liquid assets, as investors trade off expected return against duration risk. From the 1930s through the 1950s, Keynesian literature analysed money demand in these terms. Keynes (1936: 202) described the foregone interest earnings on money holdings as "a sort of insurance premium to offset the risk of loss on capital account," referring specifically to the risk that interest rates might rise above a current abnormally low level. Samuelson (1942: 594 footnote 3) observed "It is more and more being realized that reserves do not perform the function of till money. Rather they are felt to be necessary for the maximization of income over time in a world where uncertainty dictates a diversification of portfolios." Tobin (1958) showed that uncertainty about future bond prices together with "risk-avoiding behavior," implies "an inverse relationship between the demand for cash and the rate of interest" (:85). Viewing money demand as determined by interest rates in general, Keynes described the liquidity trap in terms of long-term rates and did not think it was binding in the mid-1930s. He admitted that open-market operations in bills were useless if bill rates had been driven to zero, for in that case bills were equivalent to money, but there was still a well-determined demand for money broadly defined as cash *plus* bills (Hicks 1982: 263). Thus, Keynes argued, a central bank could drive down long-term rates by purchasing longer-term bonds (Keynes 1930: 371; 1936: 207).

To see the peculiar relation between duration risk and money demand at the zero bound, suppose financial-market participants are certain the overnight rate will remain zero for an interval of time, but beyond that interval the overnight rate may rise. (Beyond a further horizon referred to as T above it is certain that the overnight rate will be above zero.) Bonds that pay off beyond the horizon of possible lift-off from the zero bound are subject to duration risk. Short-term safe bills that pay off within that horizon are equivalent to high-powered money (ignoring transactions costs, taxes and so on). Bills and high-powered money together constitute a homogenous asset class I refer to simply as "money." Following Vayanos and Vila (2009), suppose that risk-averse “arbitrageurs” interact with “preferred habitat” investors who have net demands for assets only at specific maturities. Money has a preferred-habitat clientele of its own (for example households without access to financial instruments whose money demand depends only on income and spending). Arbitrageurs hold money and an optimal portfolio of liquid bonds. (Relative yields and weights for bonds within the portfolio depend on interaction between arbitrageurs and preferred-habitat investors as in Vayanos and Vila.) P_t is the current unit price of this bond portfolio. Arbitrageurs have an expected value for *P* in the upcoming period $E_t P_{t+1}$ and a variance σ_P^2 for the possible surprise $(P_{t+1} - E_t P_{t+1})$ reflecting duration risk on safe bonds and default probabilities for riskier ones. The expected return to holding bonds one period is $\hat{i}_t = E_t P_{t+1} / P_t - 1$. Taking current assets A_t as given an arbitrageur chooses a money balance M_t and B_t units of the bond portfolio to carry into the upcoming period, acting to maximize:

$$E_t P_{t+1} B_t + M_t - \frac{q}{2} \frac{Var(A_{t+1})}{A_t} \qquad s.t. \quad A_t = M_t + P_t B_t \tag{23}$$

where *q* is a risk-aversion coefficient. An arbitrageur trades off the expected value of next period’s assets against variance scaled to assets. For realistic values of $\hat{i}$ the resulting demand for money is in logs approximately:

$$m_t^d \approx a_t - \frac{1}{q} \left(\frac{1}{\sigma_P / E_t P_{t+1}} \right)^2 \frac{\hat{i}_t}{(1 + \hat{i}_t)^2} \qquad \partial \hat{i}_t / \partial m_t^d \approx - q \left(\sigma_P / E_t P_{t+1} \right)^2 \tag{24}$$

Money demand is negatively related to the expected return to holding bonds one period. The slope of the money-demand curve increases with arbitrageurs’ risk aversion and with the degree of uncertainty about future bond prices.

In the 1930s, a prominent set of arbitrageurs holding money and liquid bonds was banks. Contemporary discussions of banking imply banks paid close attention to duration risk (Ayers 1937; Bradford 1941, p. 446-447; Meltzer 2003: 507) and actively managed the margin between cash and bonds, even though reserves were far in excess of regulatory requirements (for example

Federal Reserve Board 1938, p. 7; Bradford 1941, p. 447). (24) implies banks' demand for money broadly defined - reserve balances, vault cash and safe bills - was negatively related to the expected short-term return on liquid bonds, taking the volume of bank assets as given.[31] For nonbank arbitrageurs, the role of money in (24) might be played by demand deposits (which paid no interest in the 1930s). That might create a further relation between expected bond returns and banks' money demand through an effect of $\hat{i}$ on bank assets: an increase in $\hat{i}$ would drain deposits.[32]

Thus, the duration-risk view implies money demand was *not* indeterminate in the 1930s. Exogenous shocks to high-powered money supply should have affected expected bond returns, unless they were offset by changes in the supply of Treasury bills.

3.3) High-powered money supply shocks in the 1930s

Many studies have analyzed monetary and financial effects of gold purchases, sterilization and changes in reserve requirements over the 1930s. Some (e.g. Friedman and Schwartz, 1963: 534-545; Irwin, forthcoming) assume the "money multiplier" relationship between high-powered money and deposits held through the 1930s, even though the standard mechanics of the money multiplier are inoperative in a liquidity trap (Woodford 2012: 50). Other studies examine whether increases in reserve requirements (as distinct from gold sterilization) affected financial markets and contributed to the cyclical downturn of 1937 (e.g. Calomiris, Mason and Wheelock, 2011, who conclude that they did not). Bernanke, Reinhart and Sack (2004: 18) observe that the effect of unsterilized specie purchases from 1934 on "is reasonably characterized as a successful application of quantitative easing," but do not look into the issue. Hanes (2006) examines 1934-39 in terms of the liquidity trap and duration risk but without reference to post-2008 debates about LSAP's.

The Fed and Treasury engaged in some deliberate LSAPs in the 1930s. As tests of portfolio

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[31]Hanes (2006) derives an expression like (24) for a deposit-taking bank whose risk-aversion reflects a cost of falling below a capital requirement, and compares this peculiar type of reserve demand at the zero bound with reserve demand in ordinary circumstances.

[32]Conventional "money-demand" functions specifying negative relations between bill rates and aggregates of cash and deposits held by nonbanks appear to hold perfectly well in the 1930s (Meltzer 1963, p. 242; Gandolfi and Lothian 1976, p. 50).

effects these are, like post-2008 LSAPs or Operation Twist, complicated by the possibility of effects through the signalling channel. In 1937 the Fed and Treasury bought Treasury bonds on several occasions with the expressed intent of "monetary ease" or to counteract potential financial effects of reserve-requirement hikes (Blum, 1959: 369-75; 378; Gordon and Westcott 1937: 107; Crum, Gordon and Westcott 1938: 49). Over 1938-39, the Fed and Treasury attempted to "smooth" Treasury yields by selling (buying) bonds against increases (decreases) in prices (Meltzer 2003 pp. 506-33, 546-49). These operations were presumably responses to observed or predicted changes in yields due to other causes.

I focus on the period from late April 1934 through early July 1936. Within this period the Fed did not engage in open-market operations except to replace maturing securities in its portfolio. The Treasury did not engage in active foreign-exchange operations except for some days in January 1935 when the Treasury actively bought gold to fight an appreciation of the dollar (Blum 1959: 129). Growth in high-powered money was due to passive Treasury purchases of specie from foreign sellers or domestic mining. The Treasury purchased domestic specie at a fairly steady rate (judging from the available data, which are monthly [Federal Reserve Board 1943 table 156]) but purchases of foreign gold varied due at least partly to factors unrelated to American conditions. One important fluctuating factor was capital flight to the U.S. due to foreign political events such as the rise of Hitler (Federal Reserve Board, 1936a: 8-11; 1936b: 311-312; Friedman and Schwartz 1963:544; Romer 1992:773).

Short-lived but substantial effects on the high-powered money supply also occurred because of Treasury cash-flow management practices. Until a gold certificate was created, deposited at the Fed and spent a gold purchase could be covered out of the Treasury's accounts at commercial banks. Meanwhile the value of purchased specie appeared in the Treasury's books as an increment to its Federal Reserve accounts or Treasury cash (Federal Reserve Board 1943, p. 365). In effect, the gold purchase was temporarily sterilized. The balance of tax payments, spending, debt sales and repayments shifted funds between the Treasury's accounts in commercial banks and its accounts in the Federal Reserve system. The latter are not part of the high-powered money supply. In sum, the short-run effect of specie purchases and Treasury payments on high-powered money supply was equal to the change in the value of the Treasury's specie stock less the change in Treasury balances - the sum of Treasury cash and Treasury Fed accounts (Friedman and Schwartz 1963: 506-508). Nowadays, the Fed attempts to counteract the effects of these factors on reserve supply with open-market operations (Hamilton, 1997). It did not do so in the 1930s.

Importantly, there is no reason to believe that within this period week-to-week variations in gold purchases or Treasury balances had any effect through a signalling channel. Figures on the monetary gold stock and Treasury balances as of Wednesday were available to the public on Friday morning (in the Fed release then called the FR 283, now the H.4.1). But these figures had no implications for future monetary policy. They implied nothing about policymakers' preferences or private information. At the time no one claimed that they did (as far as I know).

Figure 5 shows short-term fluctuations in money supply due to interactions between gold purchases and Treasury balances. They were accommodated by fluctuations in banks' reserve accounts rather than outstanding currency. Scaled to the economy, these fluctuations in reserve supply were very large. Within April 1934-July 1936, week-to-week growth in nonborrowed reserves ranged between a minimum of less than zero to a maximum of half a percent of 1934 GDP. The total of *all* Operation Twist operations of 1961 was about 1.7 percent of GDP; the total of *all* the Fed's second post-2008 LSAP operations ("QE2") was about 4 percent of GDP (Swanson, 2011: 156).

Table 1 shows regression results that indicate the relation between gold purchases, Treasury balances and money within 1934-36. In the 1930s the reserve-requirement maintenance period was one week long, so Federal Reserve data are weekly. The first two columns show that gold purchases and Treasury balances largely determined week-to-week changes in the high-powered money supply, whether the latter is defined as cash *plus* nonborrowed reserves as for (1) or cash *plus* total reserves as for (2). Column (3) shows the relation between these factors and "money" broadly defined as the sum of high-powered money and outstanding Treasury bills (plus Treasury certificates, another form of short-term Treasury debt sold for some of this period). Fed data on outstanding Treasury bills in the 1930s are only for the final week in each month, but they give no sign Treasury bill issuance counteracted fluctuations in the high-powered money supply. Money broadly defined was positively correlated with gold inflow, negatively correlated with Treasury balances. (4) and (5) shows that the supply factors were strongly related to bank reserves. (6) shows they were not related to currency - the sum of banks' vault cash and cash held by the nonbank public.

What about holdings of money broadly defined by banks, the obvious arbitrageur? Unfortunately, data do not show banks' holdings of reserve balances *plus* vault cash *plus* safe bills. The Fed did not collect weekly data on banks' vault cash and other assets except from a sample of large banks, "weekly reporters." Even for weekly reporters, the data do not break out Treasury bills (or certificates). For weekly reporters, however, one can at least look at weekly changes in reserve balances *plus* vault cash, and changes in the ratio of that figure to total assets. (7) and (8) show that both were positively related to gold flows, negatively related to Treasury balances. Finally, (9) shows the relation between the change in the log of high-powered money and the two money-supply factors scaled as determinants of the change in the log, which I will use in the next table.

3.4) Money supply shocks and bond yields

The Treasury yields plotted in Figure 1 are available on a weekly frequency (as weekly averages through Saturday of daily closing bid-ask averages). The medium-term yield is an average for notes with maturities between three and five years. The long-term is an average for bonds with maturities of twelve years or more.[33] The duration-risk view implies these yields should be related in a particular way to weekly changes in money supply due to gold purchases and Treasury balances.

If the duration-risk view is correct weekly money demand can be described as:

[33]In this period Treasury notes were entirely tax-exempt and were not callable before their redemption date. Treasury bond coupon payments were tax-exempt then as now. The note series is best described in Federal Reserve Bulletin (May 1936: 317-319). The bond series includes all issues not due or callable for twelve years or more. "The yields are figured to call date when the issue is selling above par and to maturity date when the issue is selling below par" (Federal Reserve Board, 1943: 429).

$$m_t^{\,d} = -\nu\hat{i}_t + \varepsilon_t^{md} \qquad \textbf{(25)}$$

where ε^{md} reflects factors such as arbitrageurs' assets and the supply of safe bills. The change in the money supply is the change in the monetary gold stock g (gold purchases) *less* the change in Treasury balances *plus* remaining money-supply factors. The gold stock and hence the money supply were affected by international capital flows through the balance of payments. Presumably, international capital flows responded to changes in the expected return to short-term assets. Thus, the change in the money supply can also be described by (11) above, replacing i with $\hat{i}$ and holding fixed spending, wage and price levels to describe a weekly frequency. Finally, redefine ε^{bop} to account for weekly changes in the expected short-term return to foreign bonds along with other balance-of-payments factors. Thus:

$$\Delta m_t = \Delta g - \Delta tres + \Delta\varepsilon_t^{ms} = \kappa\Delta\hat{i}_t - \Delta tres + \varepsilon_t^{bop} + \Delta\varepsilon_t^{ms} \qquad \textbf{(26)}$$

so:

$$\Delta\hat{i}_t = -\frac{1}{\nu}\Delta m_t + \frac{1}{\nu}\Delta\varepsilon_t^{md} = \frac{1}{\nu}\Delta tres_t - \frac{1}{\nu}\Delta g_t + \frac{1}{\nu}\Delta\varepsilon_t^{md} - \frac{1}{\nu}\Delta\varepsilon_t^{ms} \qquad \textbf{(27)}$$

$$\Delta m_t = \frac{\nu}{\nu+\kappa}(\varepsilon^{bop} + \Delta\varepsilon^{ms} - \Delta tres)_t + \frac{\kappa}{\nu+\kappa}\Delta\varepsilon_t^{md}$$

$$\Delta g_t = \frac{1}{\kappa+\nu}\left[\nu\varepsilon^{bop} + \kappa(\Delta tres - \Delta\varepsilon^{ms})\right]_t + \frac{\kappa}{\nu+\kappa}\Delta\varepsilon_t^{md}$$

Assuming changes in Treasury balances are exogenous to money demand, they are positively related to $\Delta\hat{i}$. The correlation between $\Delta\hat{i}$ and gold purchases depends on the relative importance of unobserved money-demand factors ε^{md}, because gold purchases are positively correlated with ε^{md}. Absent ε^{md}, gold purchases are negatively related to $\Delta\hat{i}$, but if variations in ε^{md} are important this negative relation may not appear. The negative correlation between $\Delta\hat{i}$ and changes in the money supply is likewise weakened by variations in ε^{md}, but it is strengthened by variations in remaining money-supply factors ε^{ms}. The quantitative effect of exogenous money-supply factors on $\Delta\hat{i}$ is the inverse of the elasticity of demand for money as a zero-duration asset. (24) suggests that elasticity reflects the degree of duration risk. The more uncertainty there is about future bond prices, the bigger is the effect of a given money-supply shock on expected bond returns.

What do these relationships imply for Treasury yields, assuming Treasury balances and gold purchases had no direct effect on expectations of future interest rates? Holding fixed expectations of future bond prices, a decrease in the expected return to holding bonds for a short period means an increase in today's bond price. The effect on today's *yield to maturity* is bigger for shorter-term bonds. Thus, effects of money-supply factors should be stronger for bonds of shorter maturity (but not so short that their yields are scraping the zero floor). Regressing changes in medium-term yields on changes in the high-powered money supply or on the portion of money-supply changes due to gold purchases and Treasury balances, the coefficient should be negative. With gold purchases and Treasury balances separately on the RHS, the coefficient on Treasury balances should be positive; the coefficient on gold purchases may or may not be negative depending on the importance of money-demand shocks. Longer-term yields should give coefficients of smaller magnitude.

Table 2 shows results of such regressions. I include quadratic time-trend terms on the right-hand side but excluding these made no difference. The patterns are as predicted. The first columns are for medium-term Treasuries. In (1) I use two-stage least squares with gold purchases and Treasury balances as instruments for the change in the money supply. For (2) the sample excludes the weeks in January 1935 when the Treasury was purchasing gold actively. For (3) the RHS variable was just the money-supply change in OLS. Always, the coefficient on the money-supply change is negative and significantly different from zero at the one percent level. For (4) I include gold purchases along with the change in the money supply. This has little effect on the money-supply coefficient, and the coefficient on gold purchases is not significantly different from zero: clearly, the variable related to bond yields was the money supply *not* foreign purchases of American assets as the latter variable would be more closely correlated with gold purchases. For (5) gold purchases and Treasury balances are entered separately on the RHS. The coefficient on Treasury balances is positive and significant at the one percent level; the coefficient on gold purchases is negative but significant only at the ten percent level. The next columns are for long-term Treasury bonds. Coefficients have the same sign as those for medium-term notes, but their magnitudes are smaller so they are not significantly different from zero.

4) Conclusion

Roosevelt really did try Svennson's Foolproof Way out of a liquidity trap. Especially when viewed in the context of gold-standard experience, his devaluation and pro-inflation jawboning over 1933-34 could have had the same effect as adoption of a price-level target. But if you want evidence that the expected-inflation option can work you must look elsewhere. Inflation anomalies in the 1930s U.S. are easily explained by the NIRA and unionization. Of course, one could argue these massive disturbances to wage inflation just obscured effects of the expected-inflation channel. And if the expected-inflation channel did fail, it could have failed for two very different reasons: because wagesetters' expectations were insufficiently forward-looking, or because it was rational to expect a future return to 1920s-style sterilization.

With respect to LSAPs, American experience from the 1930s gives much clearer evidence: when overnight rates are at the zero bound, central banks can still influence long-term rates through portfolio effects. Over 1934-36 weekly fluctuations in the high-powered money supply were correlated with changes in medium- and long-term Treasury yields as one would expect if portfolio effects exist and their fulcrum is duration risk. It is relatively clear these correlations were not due to signals of policymakers' intentions for future overnight rates, because the money-supply fluctuations were accidental.

Duration risk still matters for banks (e.g. English, Van den Heuvel and Zakrajsek, 2012). So if these effects were present in the 1930s, it should still be possible for a central bank to press down on term premiums by adding to the supply of high-powered money, provided it does not simultaneously decrease the supply of other zero-duration assets - it must buy bonds not bills, or it must exchange bills for bonds. At the same time, if the effects apparent in 1930s data were indeed due to avoidance of duration risk, their magnitude was greater than what one would observe today. Today's central banks provide more forward guidance about future policy than the Fed did in

1934-36. As forward guidance decreases uncertainty about future bond prices, it would increase the elasticity of high-powered money demand due to duration risk and hence decrease the effect of an increase in money supply on expected bond returns.

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Table 1
Week-to-week changes in money, gold purchases and Treasury balances, April 1934-July 1936*

G Value of U.S. gold stock (held by the Treasury)
Tres Treasury balances (accounts at Federal Reserve banks *plus* Treasury vault cash)
HPM1 Nonborrowed reserves + cash in circulation or bank vaults
HPM2 Total reserves + cash in circulation or bank vaults
Bills Treasury bills and certificates outstanding
NBR Nonborrowed reserves
R Total reserves
C Currency in circulation or bank vaults
Cwr Weekly reporters' nonborrowed reserves + vault cash
Awr Weekly reporters' assets
Δg $Ln(\Delta G + HPM1_{-1}) - Ln\ (HPM1_{-1})$
$\Delta tres$ $Ln(\Delta Tres + HPM1_{-1}) - Ln(HPM1_{-1})$

Estimated coefficient
[Robust SE]
p-value

LHS Variable	ΔHPM1 (1)	ΔHPM2 (2)	Δ(HPM1+ + Bills) (3)	ΔNBR (4)	ΔR (5)	ΔC (6)	ΔCwr (7)	Δ1000(Cwr/ Awr) (8)	Δhpm1 (9)
N. obs.	117	117	28**	117	117	117	96***	96***	117
ΔG	0.95	0.95	1.9	0.82	0.81	0.13	0.9	0.027	
	[0.10]	[0.11]	[0.30]	[0.16]	[0.16]	[0.13]	[0.23]	[0.008]	
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.27*	*0.00*	*0.00*	
ΔTres	-0.97	-0.97	-1.19	-1.00	-1.00	0.03	-0.88	-0.026	
	[0.02]	[0.02]	[0.15]	[0.02]	[0.02]	[0.04]	[0.03]	[0.002]	
	0.00	*0.00*	*0.00*	*0.00*	*0.00*	*0.50*	*0.00*	*0.00*	
Δg									0.93
									[0.11]
									0.00
Δtres									-1.00
									[0.02]
									0.00
R^2	0.96	0.96	0.76	0.92	0.92	0.02	0.84	0.68	0.96

Bills data last week in month, changes from previous month. All other data weekly Wednesday

* Week ending April 21, 1934 through week ending July 11, 1936 **End of April 1934 through end of July 1936
***Data begin September 1934

Source: Federal Reserve Board 1943, Tables 103 and 146. NBR is "Member bank reserve balances, Total" *minus* "Reserve Bank credit outstanding, Bills discounted." G is "Gold stock." TB is "Treasury cash holdings" *plus* "Treasury deposits with Federal Reserve Banks." C is "Money in circulation."

Table 2
Weekly changes in Treasury yields and money-supply factors April 1934-July 1936*

Estimated coefficient
[Robust SE]
p-value

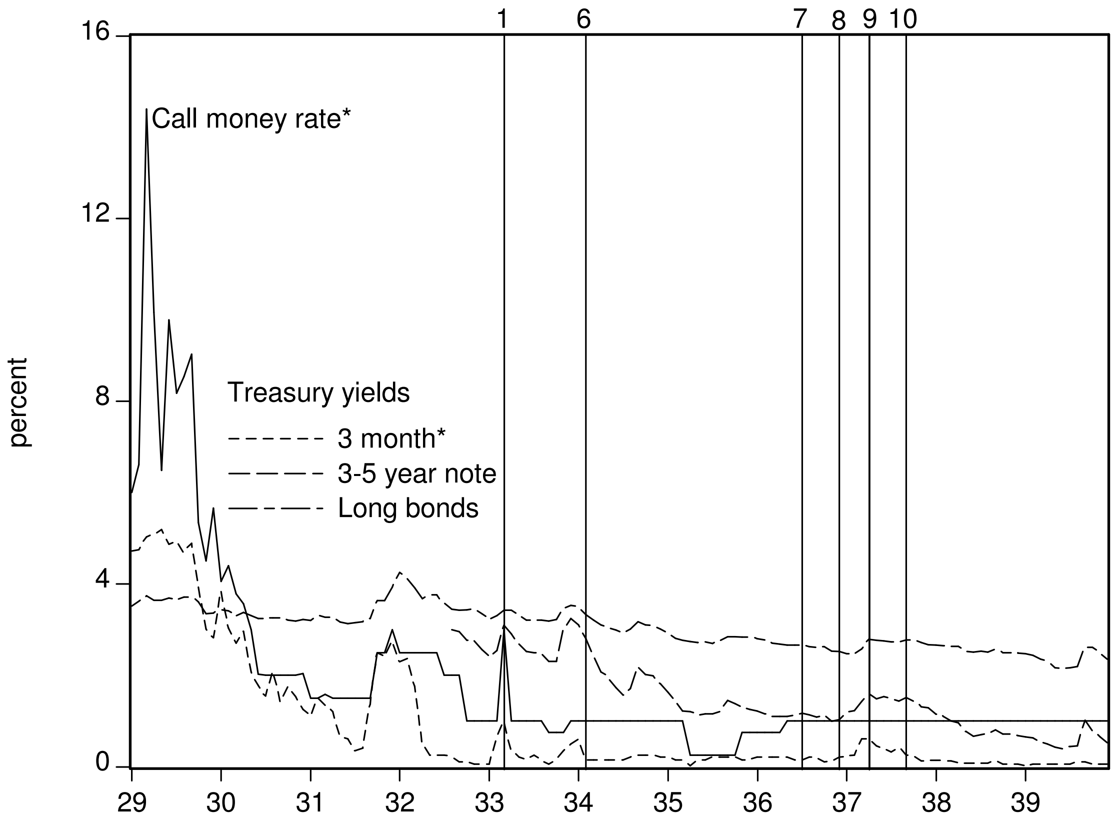
	Medium-term 3-5 year notes					Long-term bonds				
	2SLS	2SLS	OLS	OLS	OLS	2SLS	2SLS	OLS	OLS	OLS
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
N. obs	117	114**	117	117	117	117	114	117	117	117
Δ*Ln*(*HPM1*)	-1.050	-1.043	-1.016	-0.934		-0.182	-0.158	-0.190	-0.171	
	[0.322]	[0.321]	[0.332]	[0.315]		[0.144]	[0.140]	[0.146]	[0.140]	
	0.00	*0.00*	*0.00*	*0.00*		*0.21*	*0.26*	*0.20*	*0.23*	
Δ*g*				-2.638	-3.524				-0.610	-0.774
				[1.907]	[1.984]				[0.796]	[0.821]
				0.17	*0.08*				0.45	*0.35*
Δ*tres*					0.966					0.162
					[0.304]					[0.139]
					0.00					*0.25*
Time/1000	-0.168	-0.142	-0.166	0.042	0.071	0.000	0.146	0.087	0.135	0.142
	[0.660]	[0.659]	[0.658]	[0.668]	[0.659]	[0.002]	[0.241]	[0.244]	[0.253]	[0.252]
	0.80	*0.83*	*0.80*	*0.95*	*0.91*	*0.72*	*0.55*	0.72	0.59	*0.57*
Time squared /10,000	0.002	0.002	0.002	0.000	0.006	-0.000	-0.001	-0.001	-0.001	-0.001
	[0.004]	0.005]	[0.005]	[0.004]	[0.048]	[0.000]	[0.002]	[0.002]	[0.001]	[0.001]
	0.61	*0.65*	*0.61*	*0.85*	*0.89*	*0.76*	*0.51*	*0.76*	*0.64*	*0.62*
$\bar{R}^2$	0.03	0.03	0.03	0.03	0.03	-0.01	-0.01	-0.01	-0.02	-0.02

*Week of April 21, 1934 through week of July 11, 1936

**Excluding first three weeks of January 1935.

Source: Treasury yields from Federal Reserve Board 1943, Tables 123, 129 Other data and sources as in Table 1.

Figure 1 Interest Rates January 1929-December 1939, monthly



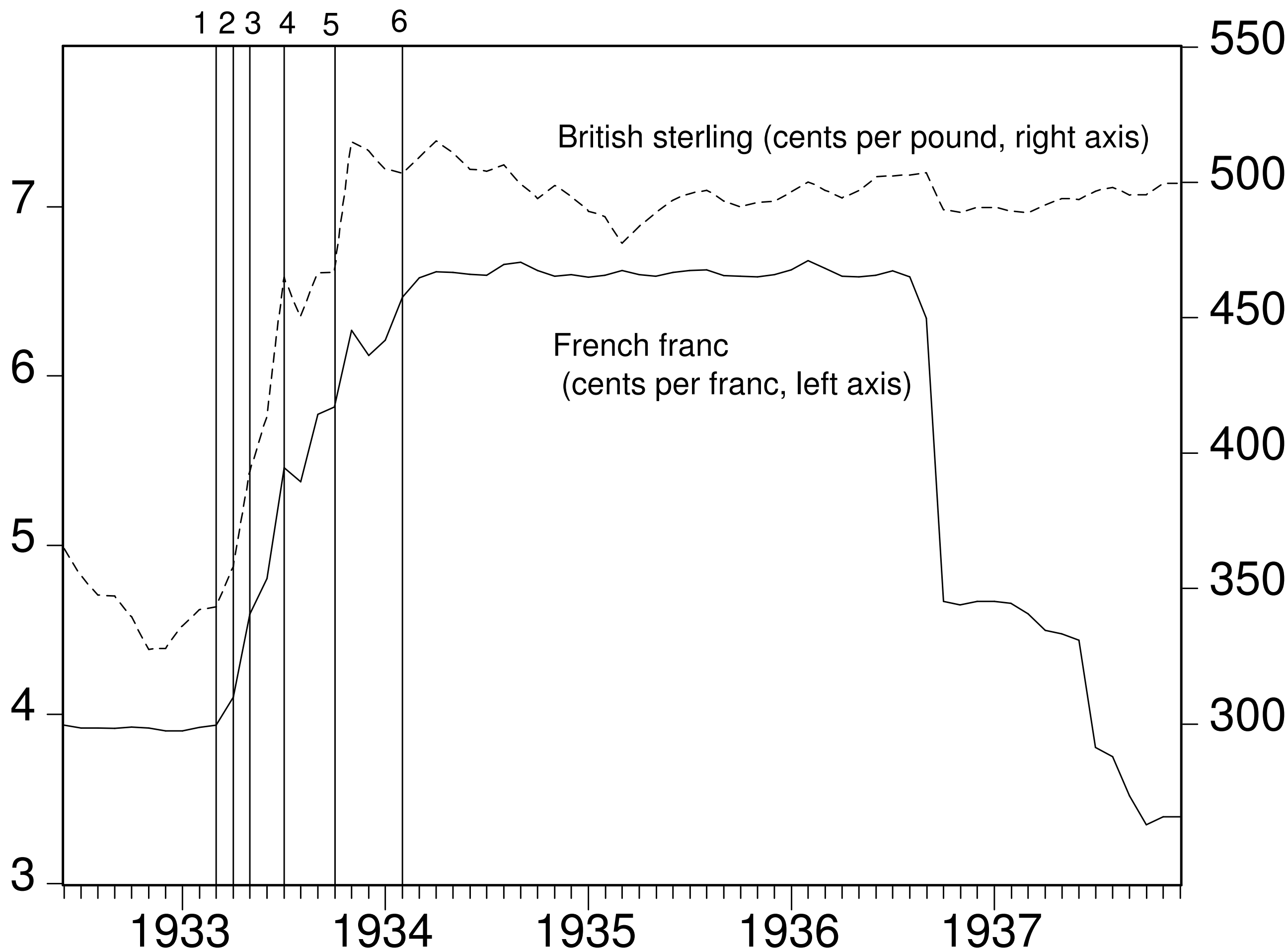
*Last week in month

Sources: Cecchetti (1988: table A1), Federal Reserve Board (1943: tables 120, 122, 128)

Dates:

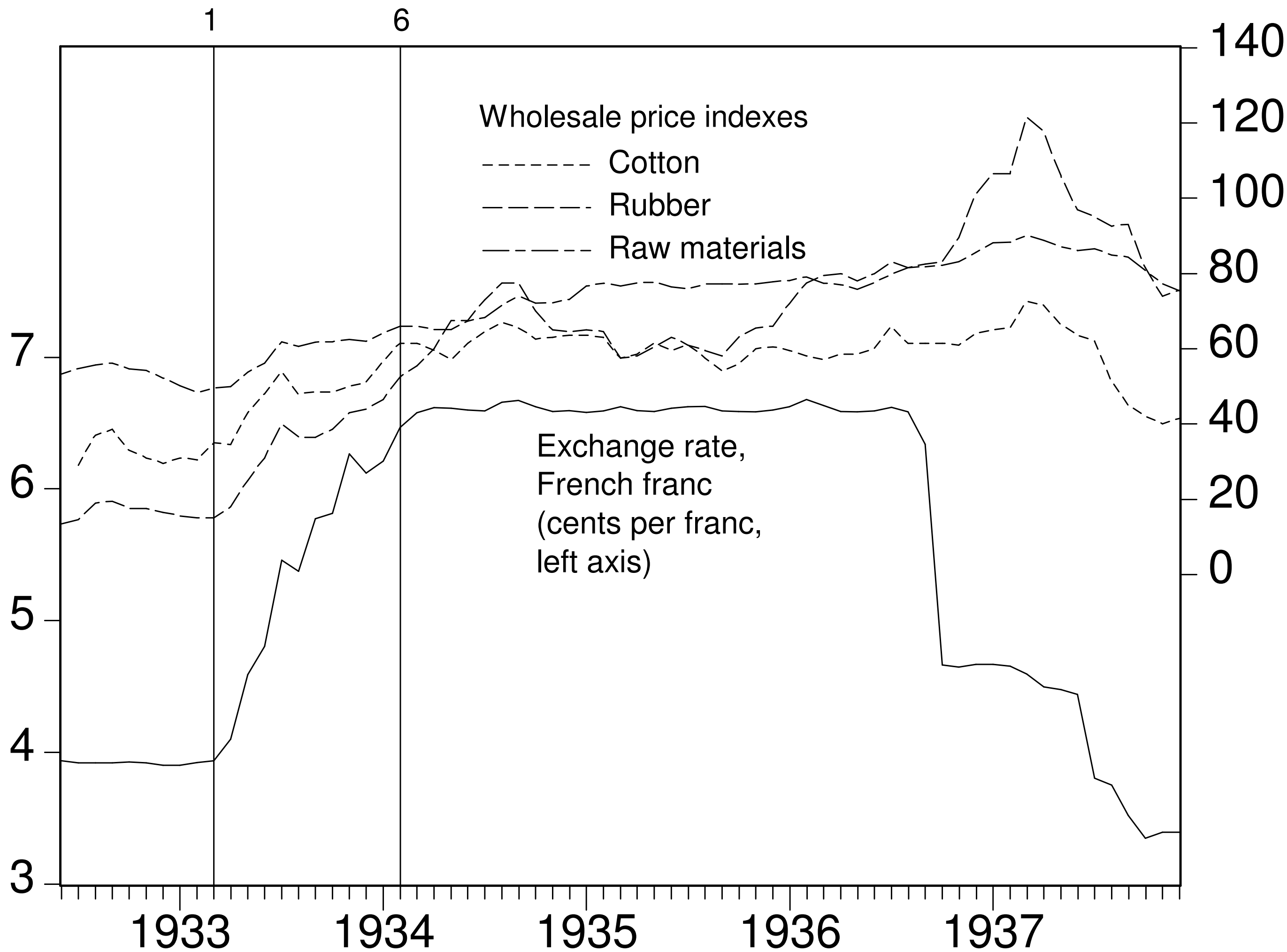
1. March 1933: Bank Holiday. Cessation of gold payments
6. End of January 1933: Gold Reserve Act fixes new gold price
7. July 1936: Fed announces coming hikes in reserve requirements
8. December 1936: Treasury announces gold sterilization
9. April 1937: Fed announces bond purchases
10. September 12 1937: Fed announces Treasury will release some sterilized gold

Figure 2 Exchange rates July 1932 - December 1937, Monthly



Dates:
1. March 1933: Bank Holiday. Cessation of gold payments
2. April 1933: Thomas “Inflation” amendment to AAA introduced
3. May 1933: Thomas amendment passes
4. July 1933: FDR disavows London economic conference
5. October 1933: FDR announces goal of reflating prices in fireside chat
6. End of January 1934: Gold Reserve Act fixes new gold price

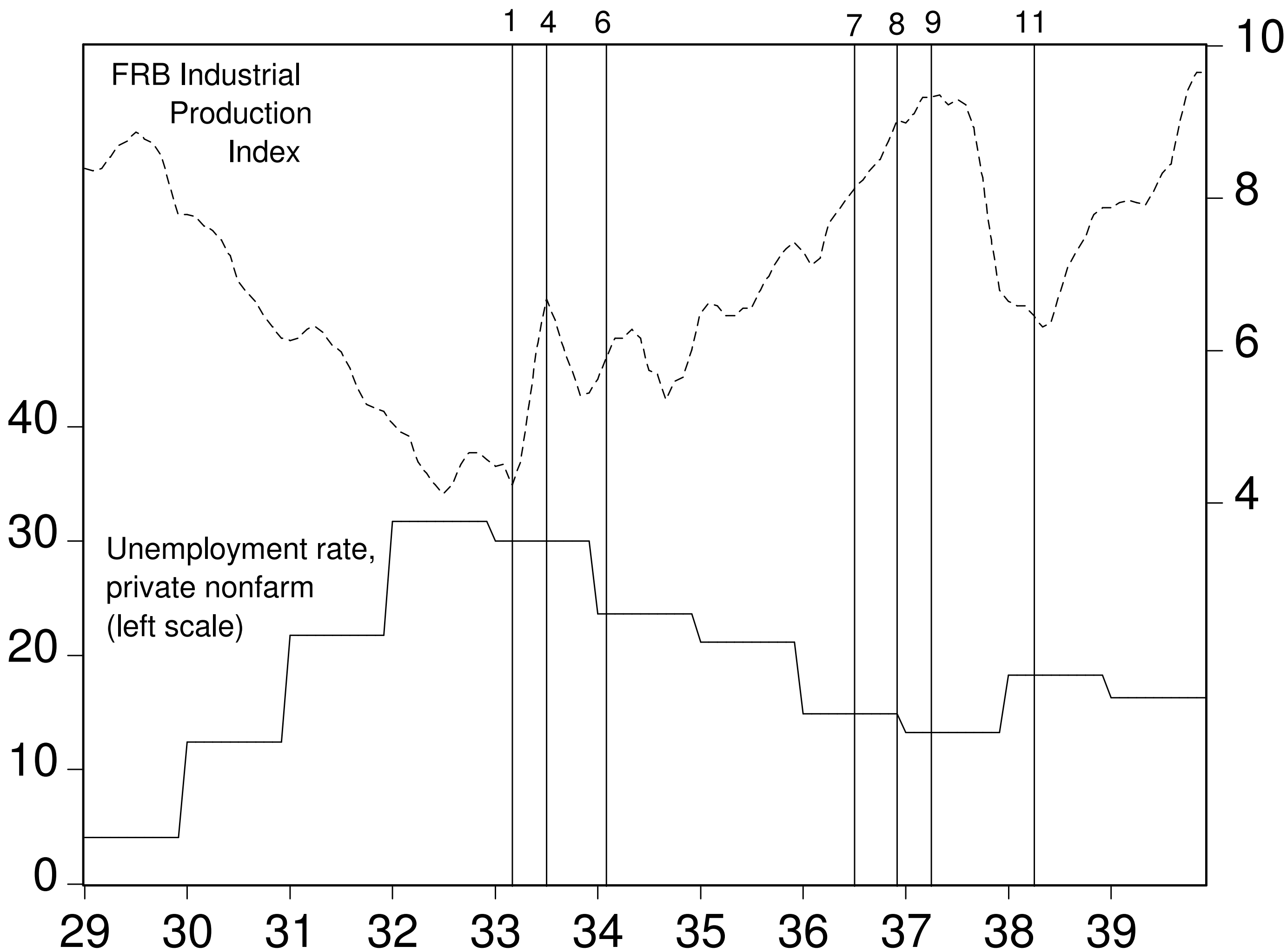
Figure 3 Exchange rate and commodity prices July 1932 - December 1937, Monthly



Dates:
1. March 1933: Bank Holiday. Cessation of gold payments
6. End of January 1934: Gold Reserve Act fixes new gold price

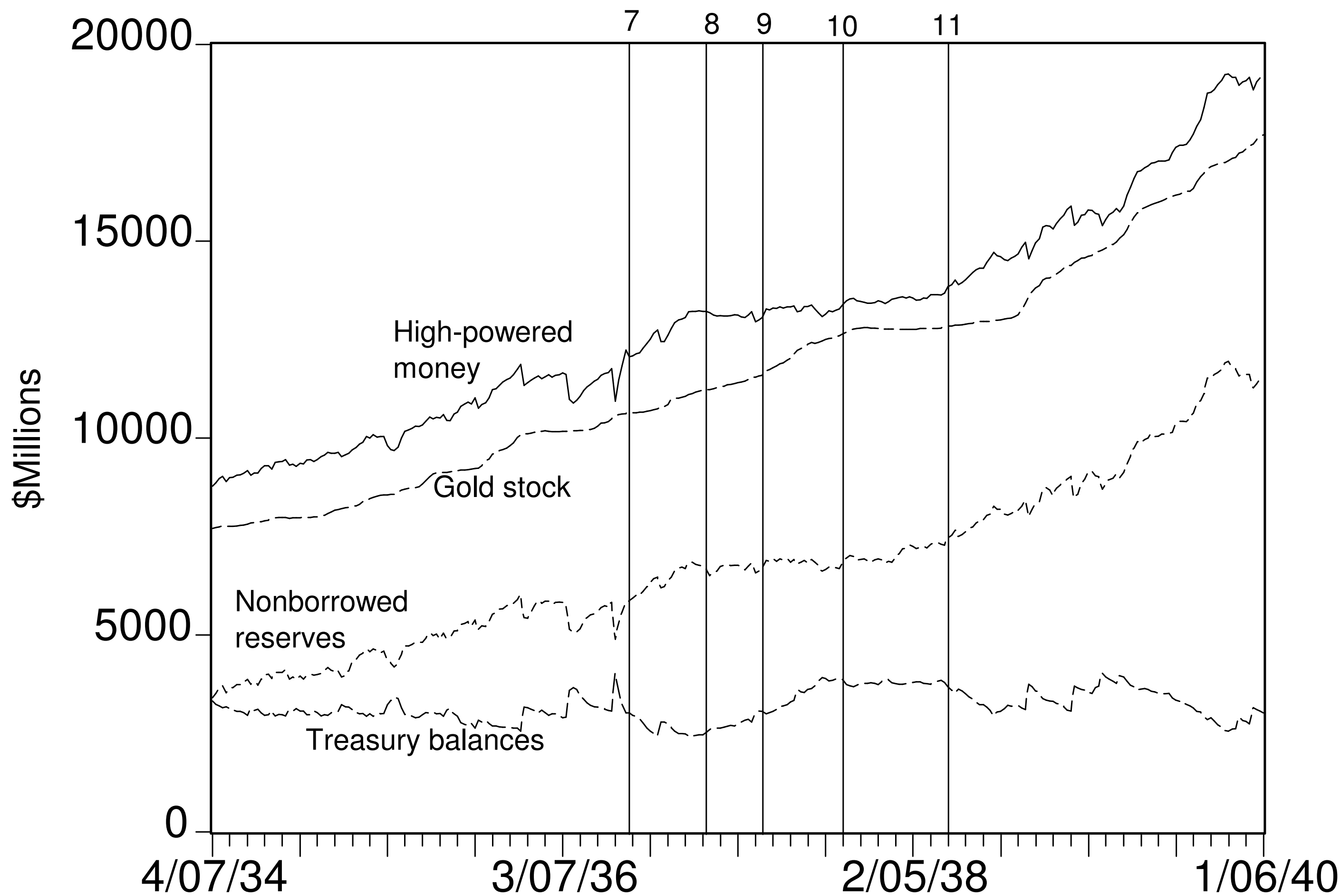
Price indexes rebased to fit graph. Cotton and rubber calculated from monthly averages of weekly observations. Source: NBER Macro History Database (cotton m04006a; rubber 04077b).

Figure 4 Industrial Production (monthly) and Unemployment Rate (annual)
January 1929 - December 1939



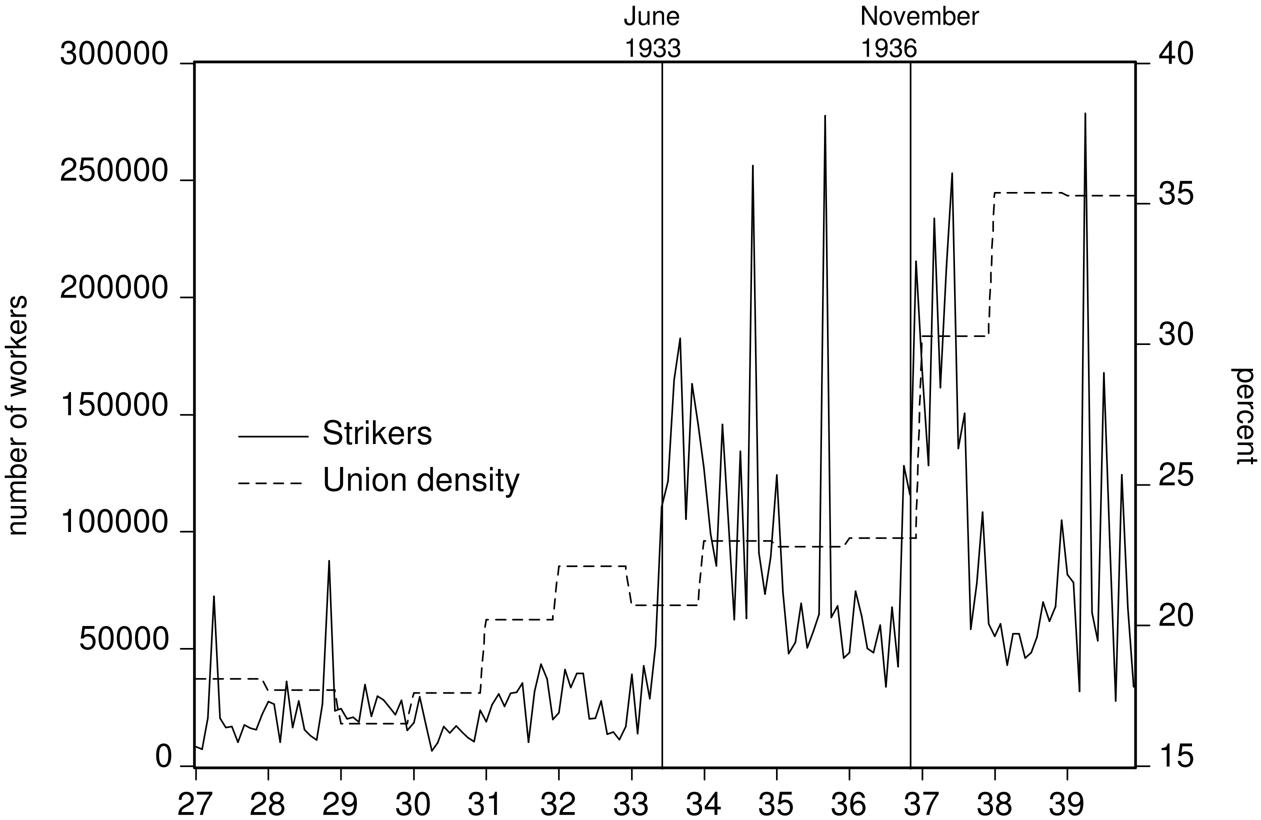
Dates:
1. March 1933: Bank Holiday. Cessation of gold payments
4. July 1933: FDR disavows London economic conference
6. End of January 1934: Gold Reserve Act fixes new gold price
7. July 1936: Fed announces coming hikes in reserve requirements
8. December 1936: Treasury announces gold sterilization
9. April 1937: Fed announces bond purchases
10. September 12 1937: Fed announces Treasury will release some sterilized gold
11. April 1938: Treasury releases all sterilized gold
: Fed announces decrease in reserve requirements
: Treasury announces end of sterilization

Figure 5 Money supply and components April 1934 - December 1939, Weekly



7. July 15 1936: Fed announces coming hikes in reserve requirements
8. December 21 1936: Treasury announces gold sterilization
9. April 5 1937: Fed announces bond purchases
10. September 12 1937: Fed announces Treasury will release some sterilized gold
11. April 14 1938: Treasury releases all sterilized gold
    April 16 1938: Fed announces decrease in reserve requirements
    April 18 1938: Treasury announces end of sterilization

Figure 6 Strikes (monthly) and Union Density (annual) 1929-1939



Sources: Workers involved in strikes beginning in month from Peterson (1938 Table 21), U.S. BLS (1942, Table 2), seasonally adjusted by X-11.
Percent union membership among wage and salary workers in manufacturing, mining, forestry, fisheries, construction, transportation, communication and utilities, from Lewis (1963, Table 51, column (1)

Figure 7A Actual and projected AHE inflation, Annual Data

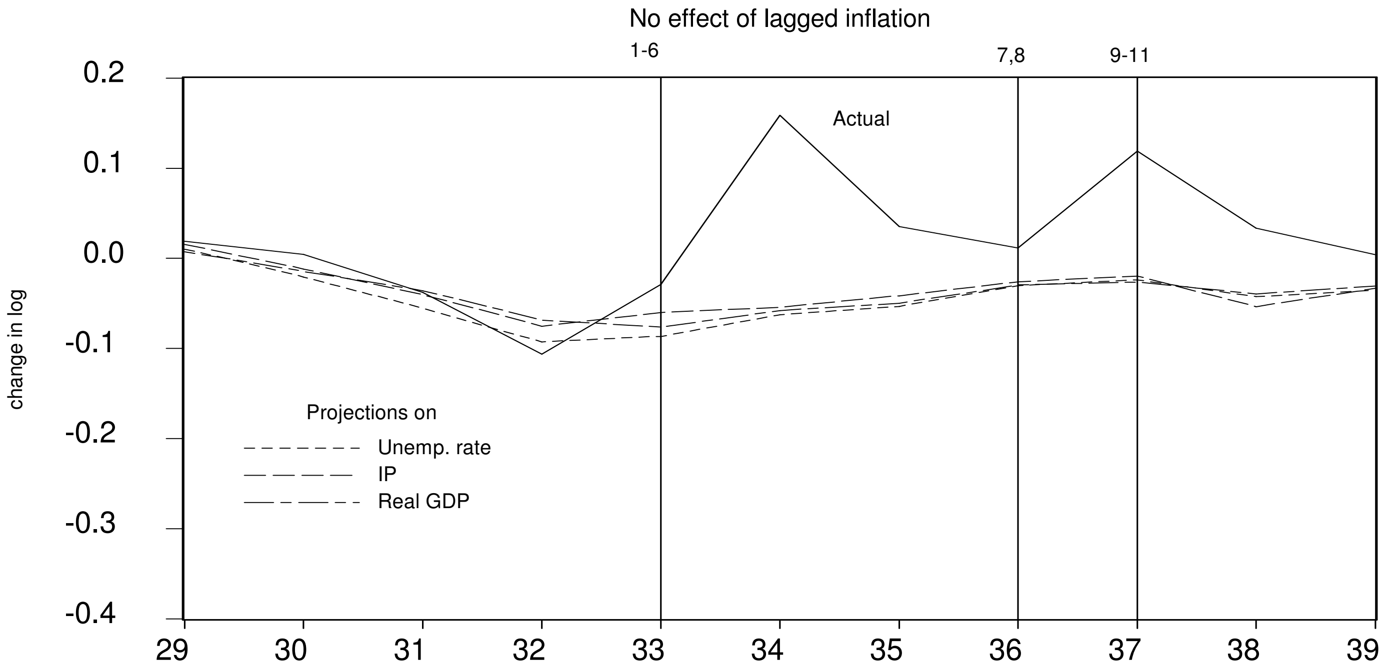
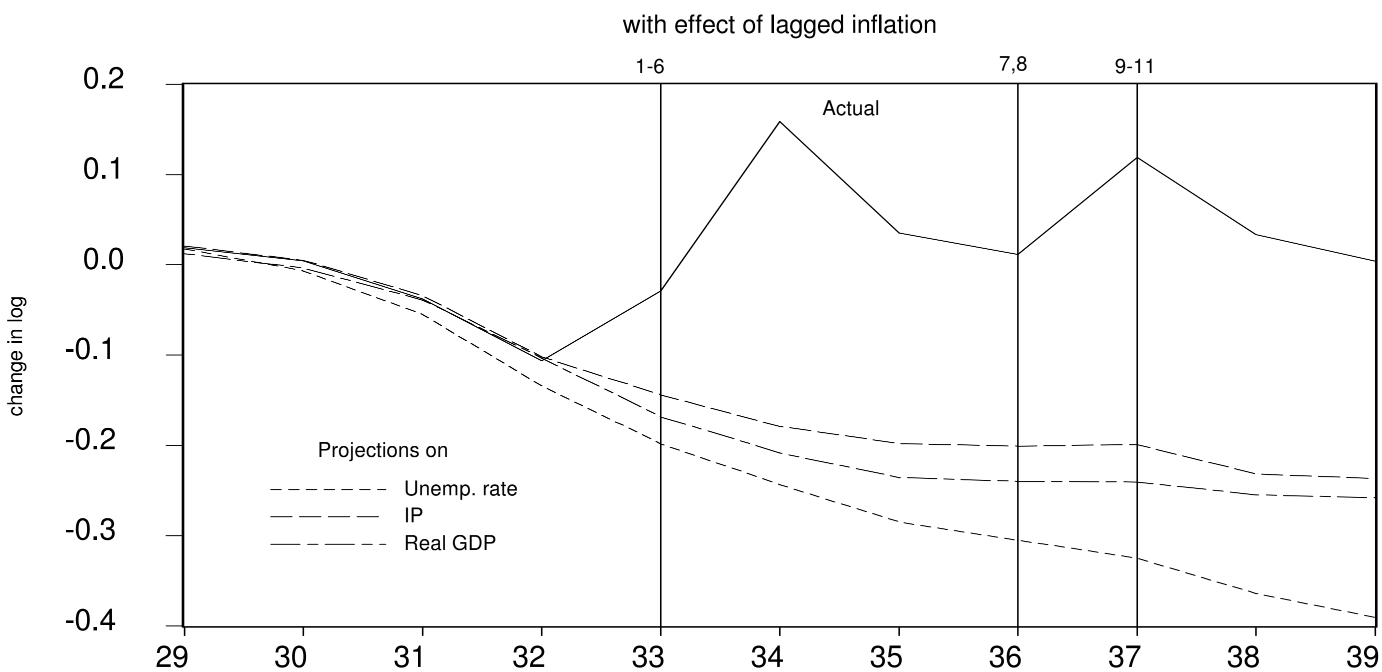
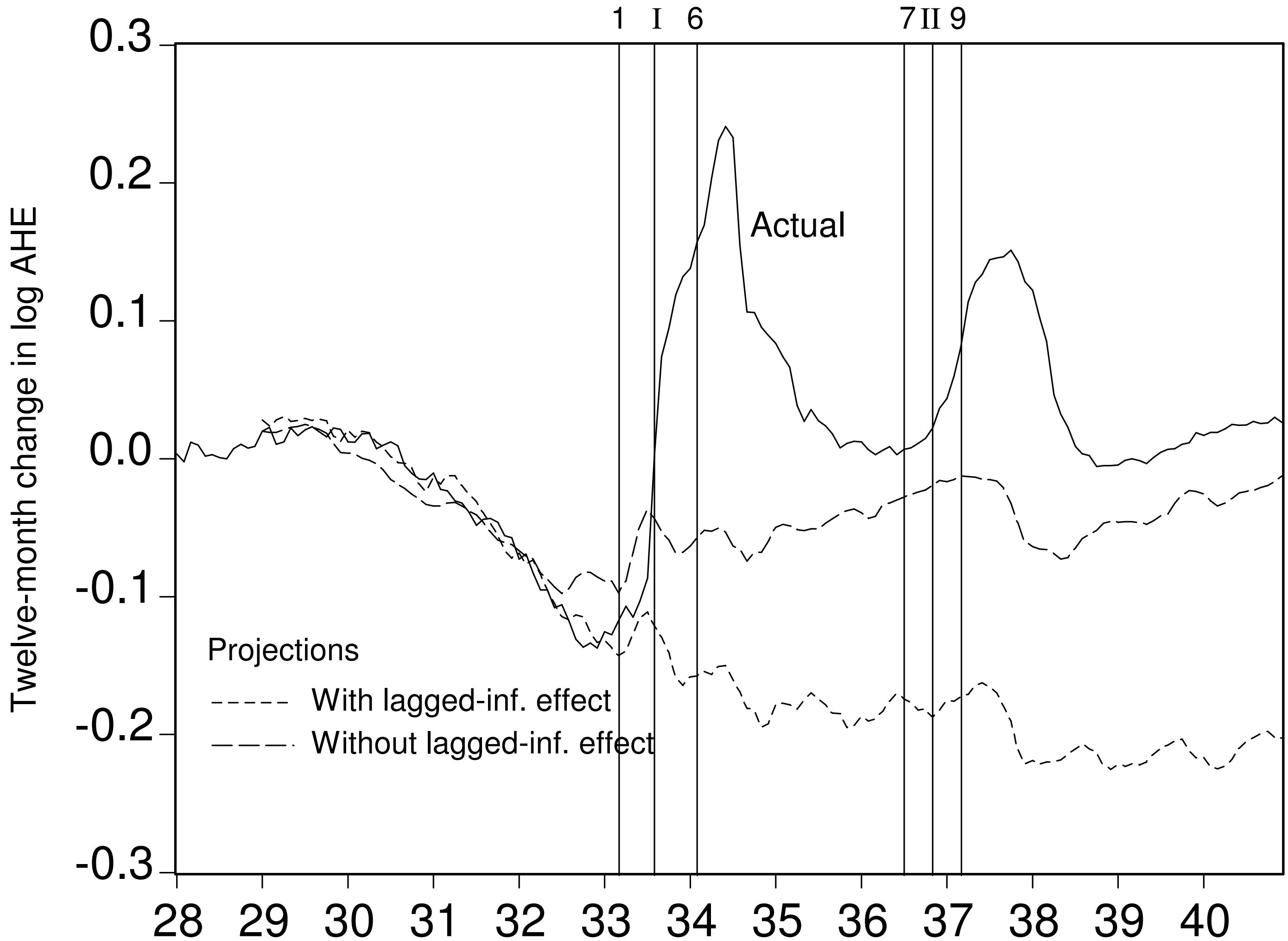


Figure 7B
1-6 Devaluation



7,8 Monetary tightening
9-11 Monetary loosening

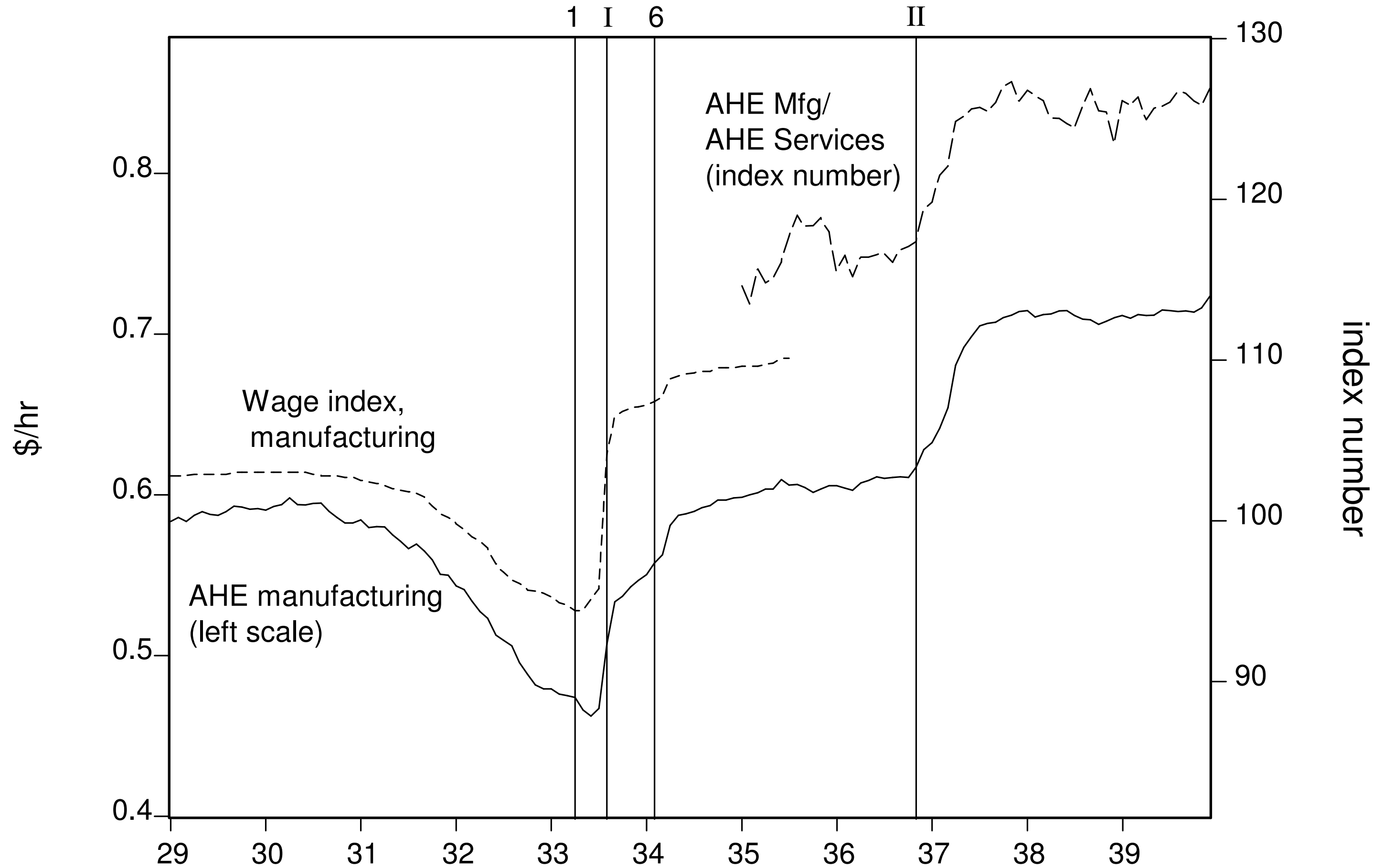
Figure 8 Actual and projected 12-month AHE inflation, monthly



1. March 1933: Bank Holiday. Banks and U.S. Treasury cease gold payments
6. End of January 1934: Gold Reserve Act sets new gold price

I August 1933: NRA Blanket code
II November 1936: Roosevelt wins re-election

Figure 9 Manufacturing average hourly earnings, wage index, and ratio to nonmanufacturing, monthly



Sources: Wage index from Creamer (1950: Table A, all manufacturing)
Rent index from Sayre (1948: Table 1, "Housing")
AHE manufacturing from Hanes (1996: Appendix Table 1)
AHE nonmanufacturing: see text

1. March 1933: Bank Holiday. Banks and U.S. Treasury cease gold payments
6. End of January 1933: Gold Reserve Act sets new gold price

I August 1933: NRA Blanket code
II November 1936: Roosevelt wins re-election