2-2017

Interwar Price Level Targeting

James S. Fackler
University of Kentucky, jamesfackler@gmail.com

Randall E. Parker
East Carolina University

Interwar Price Level Targeting

James S. Fackler
Randall E. Parker

February 2017

Institute for the Study of Free Enterprise
Working Paper 5

University of Kentucky
244 Gatton College of Business and Economics
Lexington, KY 40506-0034
http://isfe.uky.edu/

Interwar Price Level Targeting

James S. Fackler
Randall E. Parker

February 2017

SCHNATTER INSTITUTE WORKING PAPER

John H. Schnatter Institute for the Study of Free Enterprise

University of Kentucky
334 Gatton College of Business and Economics
Lexington, KY 40506-0034
www.schnatterinstitute.org

Interwar Price Level Targeting

James S. Fackler and Randall E. Parker[1]

While the causes of the Great Depression have been hotly debated among economists for over three-quarters of a century, attention has turned recently to what was known about policy mistakes at the time. [2] For example, Tavlas (2011) presents evidence that contemporary economists predicted in advance that Federal Reserve policies had the potential to lead to the Depression. Here, we analyze the viewpoint, current in the period leading to the Depression and due in part to Knut Wicksell and Irving Fisher, that price level instability is the major cause of economic disruption and price level targeting is the cure. Specifically, we evaluate a policy proposal, due to Fisher, designed to reflate the Depression-era price level to the level that prevailed in the prior decade. To do so, we undertake a counterfactual econometric analysis of the monetary policy regime proposed by Fisher, a policy of price level targeting consistent with legislation introduced by Congressman T. Alan Goldsborough as early as 1922. Our results suggest that Fisher's proposed implementation of the key elements of the Goldsborough Bill would have likely prevented the Great Depression.

Counterfactual examinations of the evolution of the economy under alternative policies have been presented by McCallum (1990) and by Bordo, Choudhri, and Schwartz (1995). Using quarterly data, McCallum argues that a monetary base rule, and Bordo, Choudhri, and Schwartz that an M2 constant growth rate rule, would have produced GNP paths that would have largely

[1] Fackler's research was supported by a grant from the John H. Schnatter Institute for the Study of Free Enterprise at the University of Kentucky.

[2]Among the prominent ex post hypotheses are "inept" monetary policy conducted by the Federal Reserve (Friedman and Schwartz 1963), autonomous consumption shocks (Temin 1976), disruption of the credit intermediation process (Bernanke 1983), and the structure of the gold standard (Temin 1989; Eichengreen 1992).

or completely avoided the Depression. Fackler and Parker (1994) offer similar results using monthly data, including industrial production and M1.

The counterfactual analysis below contains several distinct differences from prior studies. First, our point of departure is the attention paid to price level targeting as a policy rule. Wicksell (1898) proposed such an approach, which was subsequently implemented in Sweden in the 1930s. In the United States, price level targets for monetary policy were also well known, as evidenced by literally dozens of bills introduced into Congress to charge the Federal Reserve with pursuing such targets. Second, as part of the Congressional Record, Fisher (US Government Printing Office 1932) described in detail how such a policy could be undertaken. We implement his methodology as closely as possible. Third, since national income accounting was in its infancy, the results of McCallum (1990) and Bordo, Choudhri, and Schwartz (1995) using GNP as the output variable, while suggestive in retrospect, could not have been used in the implementation of Fisher's scheme. However, since monthly data already existed for industrial production, we use this output metric rather than GNP. Our analysis, using our approximation to Fisher's explicit policy roadmap and data concepts available at the time, comes as close as we think possible to an examination of whether the alternative policy of targeting the price level would have produced an output path avoiding the Depression. Our results not only strengthen the Bordo, Choudhri, and Schwartz (1995) and McCallum (1990) conclusions, but also demonstrate that knowledge was available at the time that could have prevented the most cataclysmic period in US economic history.

The US economy experienced periods of substantial price instability during the interwar period, 1919–39. Deflations after World War I (WWI) and during 1929–33 were accompanied by substantial economic downturns. The deflation after WWI was a return to the antebellum

price level after the wartime inflation, and many observers at the time saw the deflation of 1920–21 as a necessity for the eventual restoration of the international gold standard. Thus, the recession of 1920–21 was but a short economic disruption after the tumult of WWI. In addition, many also considered the deflation of 1920–21 to be the first independent test (in the sense of not having to accommodate wartime finance concerns) of the Federal Reserve System, which the Federal Reserve was perceived to have passed convincingly (Friedman and Schwartz 1963; Eichengreen 1992). However, after approximate price stability throughout the remainder of the 1920s, the deflation of 1929–33 did not have such universal agreement regarding its origins or necessity and opinions on policy responses differed widely.[3]

The outline for the remainder of the paper is as follows. Section 2 contains a historical analysis of the Goldsborough Bill, including Fisher's strategy to implement the specifics of the bill. Section 3 contains our framework for a counterfactual analysis designed to investigate the impact of a price level target on the economy during the depths of the Depression. Section 4 discusses the data and provides a preliminary analysis of our macro model. Section 5 presents our basic results, and section 6 discusses the feasibility of our empirical analysis. Section 7 addresses the sensitivity of the results to key alternatives. Section 8 concludes.

[3] In addition to price level targeting, there were other distinct lines of contemporary thought about the deflation of the 1930s. First, a view attributed to so-called "liquidationists" was the idea that the deflation of 1929–33 was necessary to purge the economy of the excesses of the speculative 1920s. Second was the argument that operation of Say's Law would ultimately restore economic prosperity. Third, the real bills doctrine precluded the Federal Reserve from acting decisively and said that monetary policy was doing all that could and should be done. Fourth was the argument that the gold standard should be preserved no matter the cost in economic calamity and that deflation was the cost of that exchange regime's preservation. As these various potential policy (non) responses to deflation suggest, not everyone viewed the economic world and the events of this time through the same lens.

II. Price Level Targets and the Goldsborough Bill

While our econometric focus is on the United States in the Great Depression, an important historical antecedent for the price targeting debate in the US interwar period is the work of Wicksell and the implementation of a price level target in Sweden, which we briefly review by drawing on the summary by Jonung (1979). As thoroughly discussed in Jonung, Wicksell (1898) proposed that monetary policy should aim at a stable price level. About three decades later, in 1931, the Riksbank formally adopted an explicit price level objective when it left the gold standard. Jonung details the ongoing debate regarding whether the price level objective should be the primary goal for policy or whether, instead, substantial weight should be placed on exchange rate stability. His description of Riksbank policy is that it allowed for what is now called "constrained discretion," with the price level being allowed to "vary within certain limits" (p. 479). However, if the price level violated this band, important pressure was brought to bear on policy makers to return the price level to target. The success of the policy is apparent in that, as reported by Jonung, from 1931 through 1936, the Swedish price level fluctuated by less than 3 percent. We note not only the precedent for price level targeting, but also the use of a tolerance band that provided for a degree of discretion when the price level was inside this band.

In the United States, the aim of this contemporary movement to target the price level was to amend the Federal Reserve Act to make price stability the key goal of monetary policy. In fact, the entire interwar era saw 78 different bills introduced before the House attempting to achieve this purpose (Joint Economic Committee 2004). Indeed, as the deflation intensified in the early 1930s, over the two-year period 1931–33, there were no fewer than 25 pieces of legislation introduced before the House of Representatives seeking to maintain the purchasing

power of the dollar and/or to restore the price level to its pre-Depression level. We know the history: not one was enacted into law.

Two bills aimed at altering the Federal Reserve Act received the most attention: the Strong Bill of 1928 (a major rewrite of the previously introduced Strong Bill of 1926) and the Goldsborough Bill of 1932. The Strong Bill (named after Representative James G. Strong of Kansas) was an attempt to amend the Federal Reserve Act so that, among other things, "the Federal reserve shall use all the powers and authority now or hereafter possessed by it to maintain a stable gold standard; to promote the stability of commerce, industry, agriculture, and employment; and a more stable purchasing power of the dollar, so far as such purposes may be accomplished by monetary and credit policy."

The Goldsborough Bill (introduced by Representative T. Alan Goldsborough of Maryland, who as early as 1922 had introduced legislation to stabilize the price level) was an attempt to amend the Federal Reserve Act so that it would be "hereby declared to be the policy of the United States that the average purchasing power of the dollar as ascertained by the Department of Labor in the wholesale commodity markets for the period covering the years 1921 to 1929, inclusive, shall be restored and maintained by the control of the volume of credit and currency."

The Goldsborough Bill passed the House of Representatives 289–60 on May 2, 1932 (Krooss 1969). Given that Senator Carter Glass of Virginia was the keeper of banking and monetary legislation in the Senate and one of the main authors of the Federal Reserve Act, the Goldsborough Bill had no chance in the Senate (see Butkiewicz 2007 and Meltzer 2007). Meltzer (2003) has called the failure to enact the Strong Bill a "missed opportunity" to avoid the Depression. Our econometric analysis will support this claim.

In the United States, Fisher heavily influenced academic opinion on price level targeting in the interwar era. During congressional testimony in hearings on the Goldsborough Bill in 1932, Fisher claimed that the stable price movement, and the accompanying policy to conduct monetary affairs to stabilize the price level, went back as far as 1824. Moreover, he firmly indicated that he thought the gold standard did not provide the stability and soundness to the dollar that its advocates claimed. While the gold standard would provide a fixed exchange value of the dollar with foreign currencies, it did so by sometimes introducing gyrations in the purchasing power of the dollar.

In testimony to Congress (US Government Printing Office 1932), Fisher presented a detailed and specific plan for reflation, which we will evaluate below. He proposed a rough draft of a bill referred to as "Suggestions for a bill for restoring to normal, and thereafter stabilizing, the price level by methods fitted to operate successfully under substantially all circumstances." Among his key points were the following:

1. "Raise the present deflated level of prices as speedily as possible to a level not above that existing before the present deflation." In large part, this policy path was intended to offset quickly the destructive effects of deflation on nominal debts. He provided two alternatives for determining the appropriate price index: an index determined by a proposed panel of experts or the then-existing wholesale price index. Fisher appeared to believe that targeting any appropriately constructed price index was more important than whether the index covered consumer or wholesale prices.
2. Once the target price level is attained, it would be maintained "as nearly as this is possible through monetary and credit policy. . . . In maintaining said

level so far as possible, the Federal reserve system is authorized to extend its open market operations by buying and selling commercial paper as well as all other types of drafts, bills of exchange, acceptances, municipal warrants, government bonds, and other securities." We interpret Fisher's reference to maintaining the price level "as nearly as this is possible" and again "as far as possible" as implying a tolerance band around the target path for the price level, as noted earlier for Sweden.

3. Fisher's proposal establishes procedures for both temporary and permanent adjustments to the gold standard, with the permanent adjustments focused on altering the official price of gold. In addition, he sets priorities in the event that the goals of a constant price of gold and a stable price level are incompatible: maintain the price level with what would be a likely one-time change in the price of gold. However, he emphatically notes that there would be no "need of America following the English example by abandoning the gold standard." Moreover, while he provides for the contingency of adjustment in the price of gold as the reflation and then stabilization of the price level proceeds, he appears to think that these parts of his plan are just that: contingencies. He notes: "Under these circumstances there seems no occasion for alarm, on the part of those who regard the Figure $20.67 as sacred, over the remote prospect of its being someday changed, especially as any change is authorized only

in furtherance of maintaining the gold standard and its chief purpose—stability."[4]

The discussion above establishes that targeting the price level was well within the scope of policy practice (in Sweden) and discussion (in the United States) during the Depression.[5] The remainder of the paper presents an econometric framework designed to conduct a counterfactual statistical experiment to see how much of the Great Depression could have been avoided if a price level target had been adopted and pursued with Fisher's policy strategy

III. A Framework for Evaluating Reflation Followed by Stabilization of the Price Level during the Depression

In this section, we outline a methodology that allows us to approximate Fisher's proposal on implementing price level targeting through monetary policy. Specifically, our approach allows for a quick return to the price level prevailing prior to the onset of the deflation, maintains this level of prices within a prespecified band, and monitors whether the cover ratio for the gold standard would be violated (and if not, how closely it would be approached).

In our base counterfactual experiment, we plan a path for the M2 money supply from 1931:1 through the end of 1938 aimed at asymptotically returning a measure of the consumer price level to its value in 1929:12. This plan is implemented in a model estimated with monthly

[4] Fisher also noted in his draft legislation that a change in the price of gold, however "remote," would not be an abandonment of the gold standard. He included a discussion of how to manage such a price change, including a bid-ask spread that could be employed in the presence of speculative pressures on the price of gold.

[5] Friedman and Schwartz (1963) seem to concur, at least broadly, indicating that "at all times, alternative policies were available and were being seriously proposed for adoption by leading Figures in the System. At all times, the System was technically in a position to adopt the alternative policies" (p. 391). Furthermore, in reference to most of 1930, they argue: "Expansionary measures offered no threat to the gold standard. On the contrary, the gold reserve was high and gold inflows persisted" (p. 392). Finally, had alternative policies been adopted in 1931, they express the opinion that "the drain of currency into circulation would have been smaller than it was" (p. 394). Interestingly, aside from a brief mention in a footnote on page 386, none of the alternative policies they assess was the price level rule proposed by Goldsborough in conjunction with the implementation plan proposed by Fisher. Appendix 1 contains additional discussion of congressional debate during the period on the topic of price level targeting.

data over the period 1920:2–1930:12 using data that either would have been contemporaneously available or is a reasonable proxy for available data. The path is implemented beginning in 1931:1, *after* the deflation has taken hold. Specifically, the price index we use had fallen from 119.5 in 1929:12 to 110.5 in 1930:12, a deflation of about 7.5 percent annually. Although there had been some variability over the 1920s, in 1924:1 the price level had been at 120.5, so that the level of prices was roughly unchanged over the last half of the decade prior to the onset of sustained deflation. Our rationale for the starting date of the experiment has two components. First, price level targets had been discussed long before this date, and hence could be used to justify initiating our experiment before what turned out to be the beginning of the Depression. Our intuition is that implementing such a policy after the price level had declined for a year is a more stringent test of price level targeting than if such a counterfactual policy had been implemented earlier. Second, a period of deteriorating economic conditions may have been a precondition for the realization of an urgent need for action.[6]

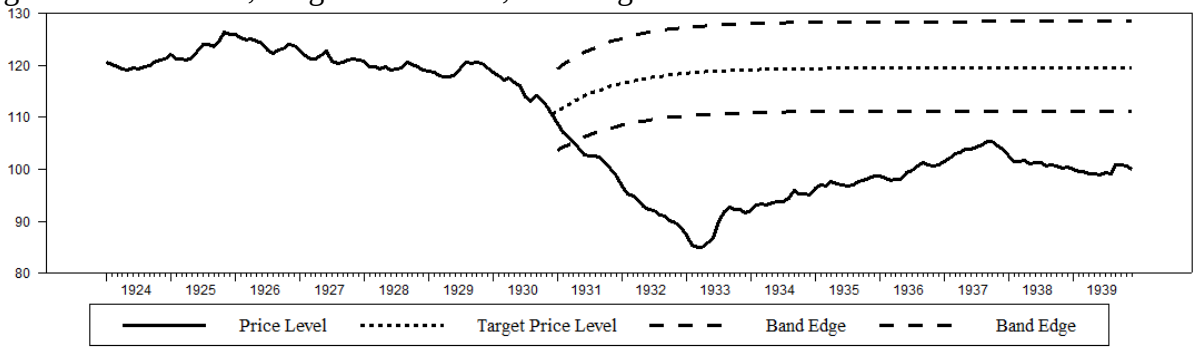
Figure 1 shows the actual price level and the target price level we adopt for our counterfactual experiment.[7] Since we do not propose that the price level target be attained precisely each period, also shown is a band within which the price level is allowed to fluctuate without policy intervention. Our price level target starts with the price level in 1930:12 and then over the 1930s asymptotically approaches the value of the log price level in 1929:12. The bands

[6] Some might argue that our counterfactual experiment should not begin until 1932, when the best-known of the Goldsborough proposals was given a formal hearing. However, there were 12 congressional bills on price stability introduced in 1919–29, including one by Goldsborough in 1922 and two by Strong in 1926 and 1928. Along with the experience in Sweden, beginning our experiment in 1931 after a year of falling prices accompanied by declining industrial production is plausible following a decade of such policy proposals in Congress.

[7] Note that our price level objective rises rapidly toward the long-run target level, consistent with Fisher's suggestion to raise prices "as speedily as possible." Specifically, while our target only asymptotically approaches the price level of 1929:12, about two-thirds of the objective is attained in the first year.

are ±1.5 percent around the log target.[8] That is, our approach is to maintain the price level within these bands, giving the policy maker some amount of discretion in reacting to ongoing economic shocks.[9] Should prices fall below or rise above this band, the policy maker will institute policy actions aimed at returning the price level to the band.

Figure 1: Price Level, Target Price Level, and Target Band



Our perspective is that of a policy maker who wishes to assess the implications of a price level rule in advance of implementing the policy. For our particular application, we have a model estimated through 1930:12 and want to determine the expected paths for all system variables associated with the target price level depicted in Figure 1. We assume that the policy maker will use M2 as the policy tool and only focus on attaining the price level within the specified band.

We begin with a structural model:

$$y_t = A_0 y_t + A_1 y_{t-1} + \ldots + A_p y_{t-p} + \varepsilon_t \qquad (1)$$

In equation (1), y_t is an (*Nx1*) vector of variables, the elements of the A_i matrices represent the structural coefficients, and the elements of ε_t are zero-mean structural shocks. We assume that

[8] With an initial value of the log price level of about 4.7, the ±1.5 percent band around this target implies, in levels, a band about 8 percent above and below the initial price level of 110. This allows a decline in the price level to about 102 prior to calling for a policy response, which may avoid large initial policy interventions that would otherwise potentially raise Lucas critique issues (more about that to come).

[9] Recall that Jonung's interpretation of the Riksbank policy was that the price level would be allowed to "vary within certain limits" and that Fisher's plan would maintain the price level target "as closely as possible."

$E(\varepsilon\varepsilon') = \Omega$ is diagonal. The reduced form of (1) is $\Pi(L)y_t = e_t$, where $\Pi(L) = I - \Pi_1 L^1 - ... - \Pi_p L^p$. Reduced-form coefficient matrices are given by $\Pi_i = (I - A_0)^{-1} A_i$ and reduced-form shocks by $e_t = (I - A_0)^{-1}\varepsilon_t$. The moving average matrix is defined as $C(L) = [\Pi(L)]^{-1}$, with $C_0 = I$. Define $D_s = C_s(I - A_0)^{-1}$. The moving average representation of equation (1), expressed in terms of the structural shocks, is

$$y_t = \sum_{s=0}^{\infty} D_s \varepsilon_{t-s} \,. \tag{2}$$

Fundamental to our analysis is the historical decomposition, which in its basic form is found by advancing equation (2) by *n* periods and then decomposing the resulting expression into two terms:

$$y_{t+n} = \sum_{s=0}^{n-1} D_s \varepsilon_{t+n-s} + \sum_{s=n}^{\infty} D_s \varepsilon_{t+n-s} \tag{3}$$

The second term on the right-hand side of equation (3) is the dynamic forecast or base projection (BP) of y_{t+n} conditional on information at time *t*. The first term on the right-hand side shows the influence on y_{t+n} of the shocks to the variables in the system between periods $t + 1$ and $t + n$. As noted above, even though the expected values of these shocks are zero, policy makers know that the realizations of these shocks over any particular period are likely to be nonzero, which provides the motivation for the stochastic part of our simulation. These shocks, which will be drawn from the estimated residuals, represent the source of variability around the base projection. We use the estimated residuals, rather than specifying a particular probability distribution from which to draw, as they are representative of the shocks to the system variables in the historical era. Given a set of shocks to the system, we obtain the path of the price level, along with the paths of the other system variables, from the relevant equations in system (3).

Prior to a trial, we take a draw from the historical residuals of the system of a length equal to the number of periods for which the simulation will be conducted. For the first period after estimation, the policy maker simulates the price level for 1931:1 by combining the dynamic forecast or base projection (the second term on the right-hand side of equation [3]) with the first element coming from the random draw of the system's historical residuals for each equation; these residuals can be used in conjunction with the moving average coefficients to simulate values of the system variables for the first period in the policy horizon. Since the base projection is based on historical residuals, it does not change across the trials of a given experiment. However, as in equation (3) above, in the moving average form of the VAR, these drawn residuals complement the base projection and generate a specific path for all the system variables in period $t + 1$ in the absence of any policy intervention. If this draw implies that the price level will remain within the target band, then no policy intervention is needed. However, if the draw implies a price level outside the band, then a policy innovation is implemented that will return the price level to a value on or within the edges of the band.[10] Thus, policy makers are forward looking, planning policy settings to maintain the price level on or within the specified band consistent with historical disturbances. While the policy maker knows that that the drawn residuals are zero-mean in expected value, it is not necessarily the case that computed policy interventions needed to attain price level values consistent with the band, here in the form of a shock to the M2 equation, will be zero-mean. Of course, this type of intervention raises Lucas critique issues, which we address below.

[10] Since the policy innovation is at the discretion of the policy maker, the size of the innovation can be selected to return the price level to the midpoint of the band, the edge of the band, or any other value between the band's boundaries. For reasons delineated below, our experiments compute any needed policy innovations to return the price level to the nearest edge of the band.

For the next period in the simulation horizon, 1931:2, the values of the simulated variables for 1931:1 are employed, which are used in the policy planning for 1931:2. Any computed policy intervention in a prior period is carried through over the entire horizon of the trial. Continuing in this fashion through the simulation period, we obtain the paths for all system variables for this particular trial where the implemented policy maintains the price level within the specified band. This policy planning for the entire horizon occurs at time period 1930:12, since the moving average coefficients in the first term on the right-hand side of equation (3) are known once the system is estimated. Conducting similar trials allows computation of the average path along with its standard deviation. Technical detail is included in appendix 2.

As indicated above, if the price level deviates "too much" from the target (i.e., is outside the band), a policy action is called for. Noting p^* as the path for the target price level, our goal for policy is for the price level to remain within the range $p^* \pm \tau$, where τ is half the bandwidth, with policy aiming at $p^* - \tau$ when prices are below the band and aiming at $p^* + \tau$ when prices are above the band. Our policy experiments return the price level to the nearest edge of the band rather than the midpoint for four reasons. First, the policy environment may be such that the policy maker operates with more than one policy objective. Generally, there may be an implied loss function involving a weighted average of squared deviations of several goal variables from desired levels, in which case a more aggressive policy action needed to return the price level to the midpoint of the band rather than the edge may induce additional variability in another goal, raising the overall loss. For example, in the historical period under analysis, the policy maker may want to avoid a counterfactual policy setting that would violate the cover ratio needed to maintain the gold standard. Second, as argued by Brainard (1967), if there is multiplicative uncertainty about the economy, the policy authority may not necessarily aim at the midpoint of

the range. Third, our policy rule that returns the price level to the edge of the band if forces in the economy would push it outside the band requires a smaller policy innovation than returning to the midpoint. That is, our rule is designed so that we undertake the smallest policy action needed to attain the price level objective. The trade-off is that these smaller interventions may be more frequent than relatively aggressive actions aimed at returning to the midpoint of the band. Fourth, in practice, there may be a lack of consensus among policy makers on how quickly to approach the target.

Our experiment with the specified price level target and bandwidth consists of 1,000 trials. As we conduct our trials, we are capturing the expected paths of the system variables—and the variability of the system variables around these paths—as represented by the draws from the estimated shocks to the economic system combined with any needed policy interventions.

IV. Data and Preliminary Empirical Analysis

The variables in the VAR model we estimate are standard for macro model analysis: a measure of output, the price level, a monetary aggregate, and an interest rate. Three additional variables are included in our analysis: a commodity price index, currency in circulation, and the ratio of Fed holdings of gold certificates to the sum of member bank reserves and Federal Reserve notes in circulation. A commodity price index is often included in post-World War II analyses to correct for a "price puzzle." Precedent for including it in the interwar period is found in Sims (1998) and Christiano (1998). The currency variable, the Friedman-Schwartz series on currency held by the public, is included to account for the behavior of agents who were concerned with the stability of the banking system. The ratio of gold certificates to member bank reserves plus notes in circulation is included so that we can monitor whether our counterfactual experiments would

have violated or threatened to violate the operation of the gold standard. Specifically, in order to meet the cover ratio, the Fed was required to hold gold certificates in an amount equal to the sum of 35 percent of member bank reserves plus 40 percent of Federal Reserve notes in circulation; roughly speaking, the ratio we employ must be in excess of about this range of 0.35–0.40 to technically avoid violating the gold standard. The actual ratio, in practice, tended to be substantially higher, often in excess of 0.65.

The specific data employed for the base model are: industrial production; the interest rate on commercial paper; the Friedman-Schwartz (1963) measure of M2; the consumer price index as compiled in Sayre (1948); currency held by the public (Friedman and Schwartz 1963, table A1); an index of commodity prices (Mack 1959); and the Fed's holding of gold certificates relative to select liabilities, as indicated above (Board of Governors 1943).[11]

Our selection of data attempts to use, to the extent possible (subject to various trade-offs discussed below), information that was available during the period. Perhaps most important, we use industrial production as the output measure since our primary interest is in determining the impact of the price level target on whether the depths of the Depression would have been avoided with such a policy rule. While GNP (e.g., Balke and Gordon 1986; Romer 1988) or NNP (Friedman and Schwartz 1982) are available only in retrospect, an additional issue is that these are quarterly data, which would have required interpolation to a monthly frequency to have sufficient observations available for estimation.[12] The commercial paper rate, the gold ratio, and currency in circulation were available contemporaneously as well. While Goldsborough

[11] For both simplicity and due to a paucity of data, we do not explicitly consider expectational variables in our analysis. We do note, however, that under some conditions, models with expectations of variables can be solved for a VAR of the type estimated here; see Fernandez-Villaverde et al. (2007) and Ireland (2007) for examples.
[12] Results using interpolated data might then reasonably be questioned on the issues of the interpolation technique as well as any selection of related series used in some interpolation approaches.

proposed targeting a wholesale price index and one was available for much of the period, the Sayre CPI was selected as it had a longer period of availability, an important consideration given the relatively short estimation period. In addition, as detailed in section 2, Fisher appeared flexible on the index to be used in his proposed implementation of a price level target.[13] M2 is used as the available policy tool in part because it is the focus of Friedman and Schwartz (1963) as reflective of the "inept" monetary policy conducted by the Fed during the contraction.[14]

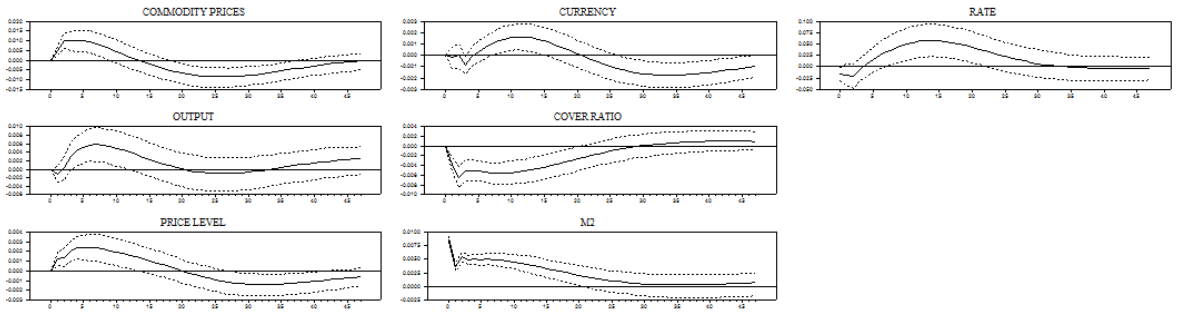
We estimate the VAR model using log levels of the data (other than the interest rate, which is included in levels) over 1921:2–1930:12 using three lags of each variable.[15] Furthermore, we largely allow the data to "speak," imposing minimal identifying restrictions. Specifically, we employ the Choleski decomposition with the policy variable, M2, next to last in the ordering in order to purge its residual of influences aside from the interest rate, which is below M2 in the ordering. We specify that the interest rate is last in the ordering on the assumption that the interest rate responds contemporaneously to a change in the quantity of money. Alternatively, we have also conducted the analysis with M2 last in the ordering in the spirit of a policy reaction function in which the money supply responds to all contemporaneous shocks, including movements in the interest rate.[16]

[13] We do, however, conduct an experiment for the available wholesale price index; results are briefly discussed in section 7 and additional detail is presented in the appendix.
[14] Bordo, Choudhri, and Schwartz (1995) also employ M2 in a counterfactual policy analysis in which Friedman's constant money growth rate rule (CGRR) is the counterfactual policy. They examine this rule under two alternative forms: (1) that the Fed could, in the background, manage the monetary base with sufficient skill that changes in the money multiplier could be offset within the quarter in order to maintain M2 on the CGRR path; or (2) under weaker conditions that the multiplier was only observed with a one-quarter lag and the Fed would set M2, conditional on the expectation of changes in the multiplier. Unlike our monthly analysis, their analysis uses quarterly data with the basic simulation estimated over 1921:1–1941:4. Like our analysis, they find that much of the fall in GNP would have been avoided with a well-defined counterfactual policy—CGRR in their analysis.
[15] The lag length is selected with the likelihood ratio test using the correction for the number of parameters estimated that was suggested by Sims (1980). The selected lag length appears to whiten the residuals of the equations.
[16] The results with M2 last in the ordering are very similar to those of the base case; basic results for this case (and others) are in section 7 and additional details are in the appendix.

Our estimation is in log levels due to evidence that imposing unit roots and cointegration may provide misleading information about the empirical links among the variables. Since an integral part of our exercise includes the dynamic forecast of the VAR, we note the recommendation of Lin and Tsay (1996) in the context of forecasting exercises. They argue that while the best forecasts are those that include the correct unit roots and cointegrating relationships, "when applied to real data, the results change. . . . Because the available cointegration tests have low power in rejecting the unit root hypothesis when the time series has characteristic roots close to 1, the danger of mis-imposing unit root constraints is real" (p. 537). More recently, Gospodinov, Herrera, and Pesavento (2013) argue that "the unrestricted VAR in levels appears to be the most robust specification when there is uncertainty about the magnitude of the largest roots and the co-movement between the variables."

To establish the usefulness of the model for monetary policy evaluation, the macroeconomic effects of monetary policy are estimated by computing impulse response functions (IRFs) for shocks to the policy instrument. The point estimates and confidence bands for IRFs for a shock to the money supply for the model are presented in Figure 2, which shows the impact on each system variable of a one standard deviation increase in M2.[17]

Figure 2: Impulse Response Functions, Monetary Policy Shock



[17] The confidence bands are generated using the Montevar.src code available at the Estima website for the RATS software.

Assuming that innovations to M2 represent a reasonable proxy for the monetary policy innovation, a one standard deviation increase in M2 leads to significant contemporaneous and sustained increases in the commodity price index and the price level. Output also rises significantly after a lag of three months, an increase that is also sustained. Currency in circulation rises, mostly significantly, over the first year and a quarter, consistent with a portion of the increase in the money stock being held in part as public holdings of the currency component of the medium of exchange. The Fed's gold reserve ratio falls significantly, perhaps reflecting the anticipated rise in the price level and any accompanying inflation. Finally, the interest rate falls immediately, but subsequently rises as the economy expands, a common pattern of rising rates as output grows. In general, the responses of the variables to a rise in the money supply seem broadly consistent with macroeconomic theory.

V. Basic Results

Figure 3 shows the average counterfactual price level (the dotted line) over 1,000 trials, which by construction remains well within the specified bands (the dashed lines). Also shown is the actual price level path. The price level rule would have avoided the dramatic deflation associated with the Depression, including the dynamics of debt-deflation presented by Fisher (1933) in which debts denominated in nominal terms became increasingly burdensome as deflation proceeded.

Before discussing the basic results, we present in Figure 4 examples of four specific trials (of our 1,000) to illustrate that the algorithm controlling the price level maintains the value of this variable within the specified bounds on a trial-by-trial basis. Given the deflationary pressures in the economy, we are not surprised to find several instances where the algorithm prevents the

price level from falling below the specified lower bound. The lower left panel shows one instance among the four trials where the upper bound was reached.

Figure 3: Price Level, Counterfactual Price Level, and Target Band

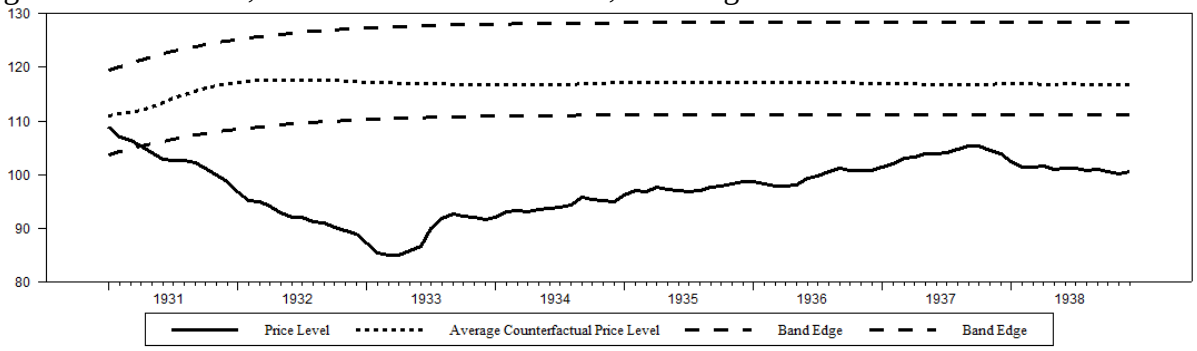
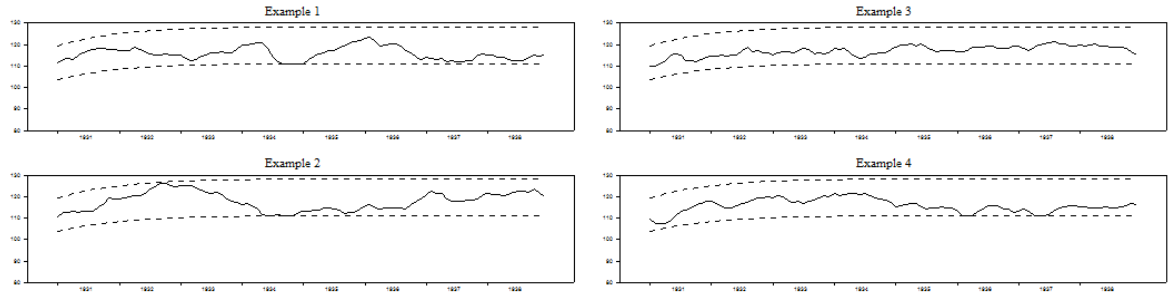


Figure 4: Example Counterfactual Trials: Price Level; Trial Path and Target Bands



Given that that the price level objective is met on average (Figure 3) and in each trial (as in the examples in Figure 4), the primary question is how the other system variables evolve in the environment of price level targeting and stability. We begin with the overall behavior of output.

Figure 5 includes the history of output as well as the average path and plus/minus one standard deviation confidence bands beginning in 1931:1. These results suggest that the price level target adopted here would have likely allowed the economy to have avoided the worst of the Great Depression.

Figure 5: Actual Output, Average Counterfactual Output, and Confidence Bands

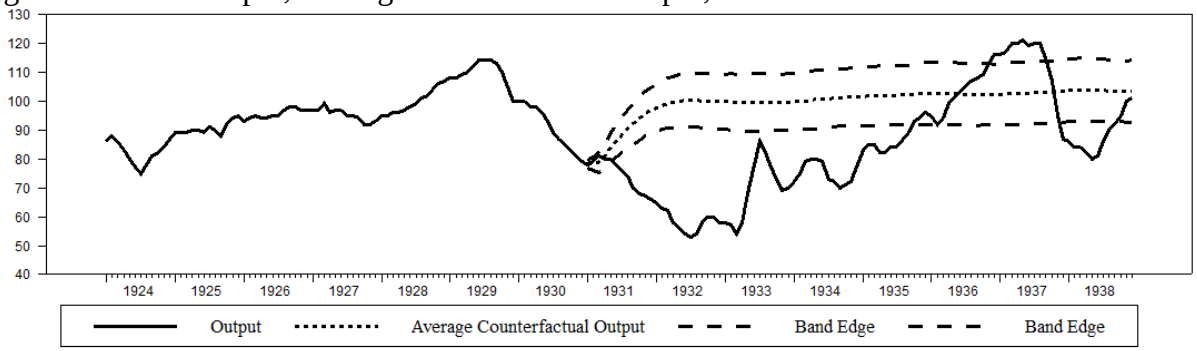
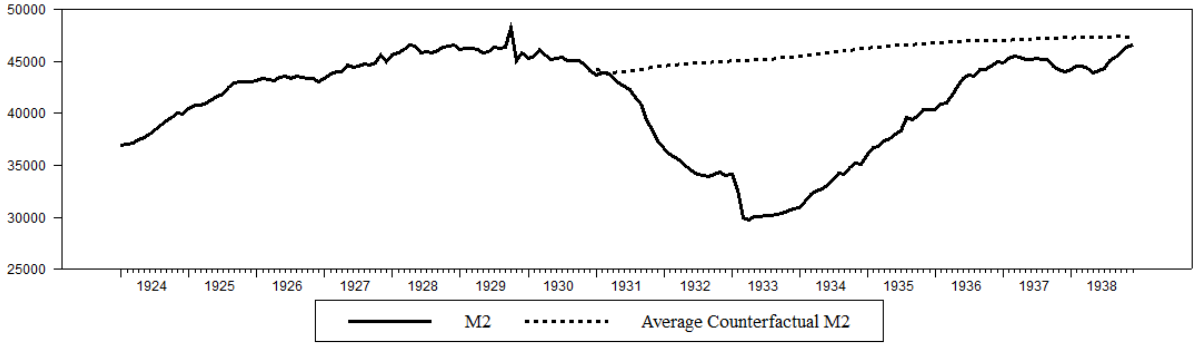


Figure 5 has several notable features. First, the simulation results are shown in the broader context of output over most of the interwar period. Second, actual output declined after the spring of 1929 through about the end of 1930, and then began a modest rise as the simulation period starts in 1931:1. In actuality, this rise was short lived, with output subsequently collapsing until early 1933. Third, the average simulation path rises along with the incipient expansion in early 1931, and the counterfactual monetary policy aimed at restoring the price level to its 1929 level allows the initial expansionary pressures to take hold. The behavior of other system variables, shown below, will help to clarify why it appears that the policy of targeting the price level seems to have aided the recovery in the counterfactual trials. Fourth, we note that the counterfactual path is significantly higher than output until late 1935. That is, the monetary policy aimed at the price level target would have allowed the economy to avoid the depths of the Great Depression. Fifth, our counterfactual policy seems to restrain the economy in the late 1930s, perhaps due to restraining the price level to the 1929:12 level rather than allowing some upward drift as the economy expanded. We address this possibility in the sensitivity analysis in section 7 and provide more detail on this case in appendix 3A.

Figures 6, 7, and 8 show the average counterfactual paths of the money supply, currency in circulation, and the interest rate. Figures 6 and 7 suggest that a price level target during the 1930s would have reversed two of the more remarkable aspects of the early years of the Depression: the drop in the money supply and a key contributing factor to that drop, the rise in currency holdings. The historical rise in currency holdings reflected the risk associated with holding bank deposits in the presence of widespread bank failures and in the absence of deposit insurance. Historically, this increase in currency holdings then led to a sharp drop in the money multiplier and the decline in the money supply.[18] Furthermore, during these early years of the Depression, the monetary base was growing rapidly, so a policy maker monitoring the base may have viewed policy as expansionary, though what was occurring was that the substitution of currency for bank deposits was associated with falling M2 despite the rise in the base. The results here suggest that a policy focused on the price level, in contrast, would have produced superior results by apparently exploiting the historical links between the money stock and the price level.

Figure 6: Actual M2 and Average Counterfactual M2



[18] Counterfactual experiments such as ours, along with those such as Bordo, Choudhri, and Schwartz (1995) and McCallum (1990), don't statistically address the issue of whether the alternative policy paths would have muted volatility or, in the extreme, structural shifts in system variables. Bordo, Choudhri, and Schwartz hypothesize that stable paths for key variables such as M2, the monetary base, or the price level "could have diminished the effect of all types of shocks to the economy" (p. 486).

Figure 7: Actual Currency Holdings and Average Counterfactual Holdings

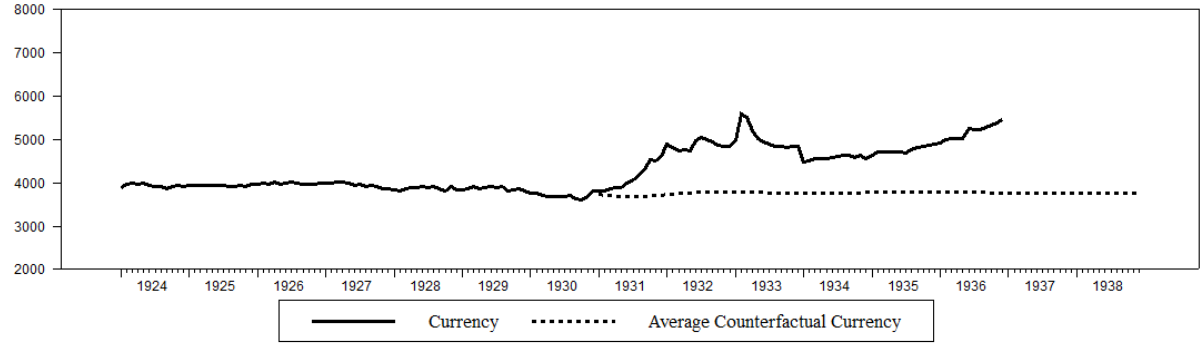


Figure 8: Actual Interest Rate and Average Counterfactual Interest Rate

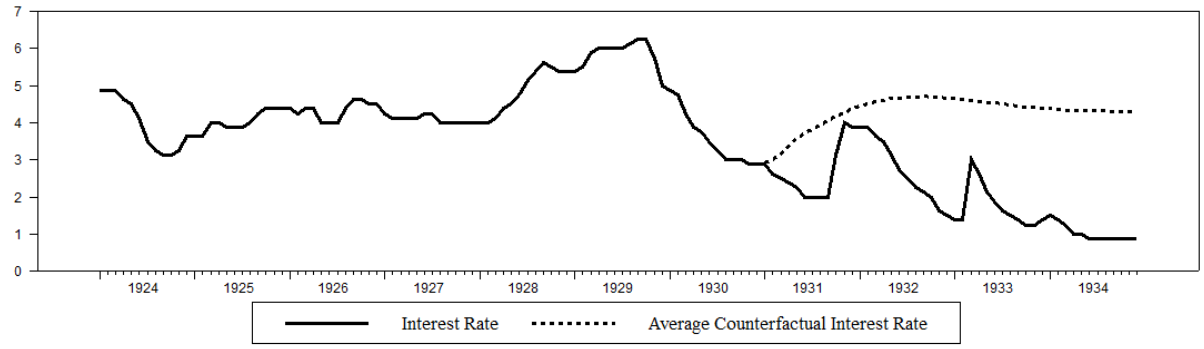


Figure 8 shows that our counterfactual policy of using the money supply to target the price level would not have led to unusual behavior of the interest rate. The average counterfactual rate drifts up to about 4.75 percent over the first half of the 1930s and then settles at about 4.5 percent. While we did not constrain the interest rate away from zero, we note that it did not fall to that level in our simulations.

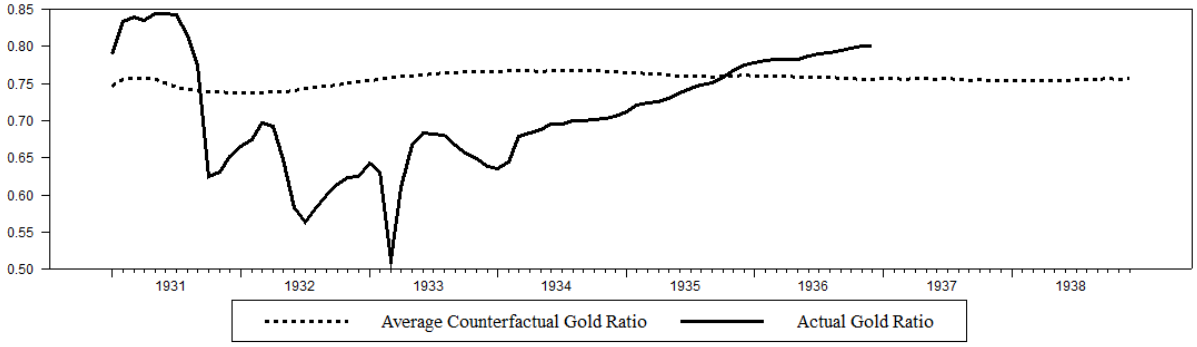
VI. Further Results: Was the Price Level Target Feasible?

Three issues could potentially challenge our results. First, would adherence to the gold standard have prohibited implementation of the price level targeting strategy simulated above? Second, was there a shift in the structure of the economy between the start of the deflation and our

proposed starting date for targeting the price level, 1931:1? Third, even if the answers to the previous questions are no, would the targeting strategy have required sufficiently large policy interventions to signal to agents that a new policy regime was in place—that is, does the Lucas critique overshadow the results and conclusions?

We address the first question by examining the behavior of the Fed's holding of actual reserves relative to those required under the gold standard as depicted by the cover ratio. Recall that the cover ratio for the gold standard was a weighted average of bank deposits at the Fed and the quantity of Federal Reserve notes in circulation, with the weights being 35 percent and 40 percent, respectively. Thus, violation of the gold standard would be an actual ratio roughly within or below that range. To that end, Figure 9 presents the actual reserve ratio held by the Fed, along with the average of the counterfactual trials, during the simulation period. Clearly, under the price level targeting regime, there is no evident concern about violation of the gold standard during the early 1930s, at least on average. However, there may have been gold standard violations that are masked by the presentation of just the average cover ratio over a large number of trials. To check this possibility, we monitored the counterfactual cover ratio in each month of each trial and found that the minimum value was 0.55. These results are consistent with the prediction of Fisher in his 1932 testimony that there would be no "need of America following the English example by abandoning the gold standard." The results are also consistent with the retrospective opinion of Friedman and Schwartz (1963, p. 392) quoted above that "expansionary measures offered no threat to the gold standard."

Figure 9: Actual Gold Ratio and Average Counterfactual Gold Ratio



The second potential issue is that of structural shifts that may obviate the results. There are two problems regarding structural shifts that arise, only one of which we deal with directly. The first structural shift problem, the collapse of the financial system, is strongly suggestive that the economy's structure changed substantially during this period. Our simulations presented above suggest that, with price level targeting apparently stabilizing the economy, the financial collapse would not have occurred, which in turn makes the introduction of the various types of legislation problematic. We are unable to test the presumption that implementation of a price level target would have avoided a structural shift in the economy, including shifts in the financial markets. Our results only suggest that the absence of the collapse in output and the continued historical trend behavior of the money supply and currency holdings during the 1930s could have avoided the subsequent structural shifts that occurred, as argued by Bordo, Choudhri, and Schwartz (1995) and McCallum (1990). The second structural shift problem, whether a structural break occurred between the onset of the deflation and the initiation of our targeting scheme, can be examined. To that end, we employed a stability test proposed by Chow (1960) and summarized by Johnston (1972) that tests whether adding observations to an initial regression signals a structural break in the relationship. Since the simple reduced form VAR can be

estimated with OLS equation by equation, we examined each equation in our model individually. Specifically, the test statistic is:

$$F = \frac{(e'e - e_1'e_1)/m}{e_1'e_1/(n-k)}$$

where e_1 is the set of residuals from the initial regression $y_1 = Xb + e_1$ with k regressors and n observations and where e is the set of residuals from a new regression with m ($< k$) additional observations from the regression $y = Xb + e$, pooling the $n + m$ observations. Beginning with initial regressions estimated through 1929:12 and then adding one additional observation at a time through 1930:12, none of the model regressions showed evidence of a break up to the point at which the counterfactual simulations begin, 1931:1. Thus, even though we cannot directly address the issue of whether adoption of the Goldsborough price level targeting rule would have muted or eliminated structural shifts later in the decade, we can argue that no structural break had begun prior to the proposed adoption of our price level target, reinforcing our suggestion that a steady policy as proposed by Fisher and implemented here may have forestalled any structural shifts and thus the Depression.

The final potential shortcoming of our approach is whether implementation of the counterfactual policy would have alerted agents to a change in the policy regime, an issue raised by the Lucas critique. If so, our model estimated with data ending in 1930:12 might not be relevant for the 1930s if the policy signaled to agents that the new policy regime would alter the prior relationships among the variables. We employ the "modesty statistic" introduced by Leeper and Zha (2003) to evaluate whether our policy interventions would have likely been viewed by agents as "modest."

The Leeper and Zha theoretical approach is a Markov-switching model, with each regime a linear model of the economy (a VAR in their case). The effect of a policy intervention is

described by the first term on the right-hand side of our equation (3), where our policy interventions are input as the residual of the M2 equation, altering the path of the system variables relative to the base projection. Specifically, picking a policy sequence $\{\varepsilon_{t+1}, \varepsilon_{t+2}, ..., \varepsilon_{t+n}\}$, computing the expression $\sum_{s=0}^{n-1} D_s \varepsilon_{t+n-s}$ and then scaling by $\sqrt{\sum_{s=0}^{N-1} D_s^2}$ provides the "modesty statistic." We note that Leeper and Zha use the ε shock to the policy equation as the policy innovation, and assume as we do that "although the policy advisor chooses [the ε -innovation], private agents treat it as random" (Leeper and Zha 2003, p. 1678).

Leeper and Zha (2003) argue that the "modesty statistic" has a standard normal distribution, so a computed statistic of less than two implies that the policy innovation embedded in the ε path does not cause agents to alter their assessments about the policy regime in place.[19]

We have computed the Leeper-Zha modesty statistic in the context of our counterfactual experiments, making one adjustment to the computation. Specifically, we use the randomly drawn disturbances to the other equations, with our policy interventions conditional on these disturbances, rather than assuming that the shocks to the nonpolicy equations are all zero. We do so since our computed policy interventions are conditioned on the drawn residuals in each trial. Under this condition, in 11 percent of our trials, we computed a modesty statistic for the policy equation exceeding 2.00; the largest in absolute value was 4.80 and the median of those in excess of 2.00 was 2.36. Accordingly, there is weak evidence that the Lucas critique may hold, though the preponderance of the evidence is that the price level target adopted here likely would have succeeded in avoiding the Great Depression.

[19] Of course, alternative policy regimes can be "close" to each other, so that distinguishing between these regimes may be difficult. Thus, a modesty statistic of less than 2 is necessary but not sufficient to claim that no important Lucas-critique effects are present.

To provide additional context, we note that our simulations extend over 96 months, so with 1,000 trials, we have a total of 96,000 months in our experiment. In our base-case experiment, no intervention was needed to maintain the price level within the specified bounds in 93,953 of these months; in these months, the residual for the M2 equation, our policy shock, was just the value drawn from the set of estimated residuals. The mean of these draws was 0.000015 with standard deviation of 0.008 (with the value of the mean consistent with a zero expected value from least-squares regressions). For the 2,047 months in which we computed a policy intervention (as detailed in appendix 2), the mean policy innovation we imposed had a value of .0357 and a standard deviation of .035. Aside from these statistics, we note that relatively infrequent interventions would have been needed to avoid the Depression if our model is a reasonable representation of the economy in the period leading up to the 1930s.

VII. Sensitivity Results

We have undertaken several additional experiments to examine the sensitivity of the results above to changes in key variables. Specifically, we have examined (a) targeting a return to the average price level in 1926, the peak year for prices in our data, rather than year-end 1929 as in the base model; (b) a model in which the AAA corporate bond rate is employed rather than the commercial paper rate; (c) a model in which the consumer price index in the base model is replaced with a wholesale price index as suggested by Goldsborough; (d) a model using the variables in the base case but with M2 last in the ordering; and (e) a model in which the monetary base replaces M2. Below, we show the plots for output and briefly discuss the strengths and weaknesses of each of these alternative experiments. Full sets of data plots are included in the appendices 3A through 3E; we note here that the other plots for the alternative

experiments discussed in this section are all nearly indistinguishable from the corresponding plots for the base case presented above.

Figure 10 below shows the output results when the price level target in the base model is replaced with a path that asymptotically approaches the average price level for 1926, the year of the peak price level in the 1920s. In contrast with the base case, the output level here gradually rises throughout the 1930s and produces output significantly above recessionary levels in the late 1930s. For this simulation, the minimum cover ratio is .50. Since the base regressions are the same as in the base case, here as well there is no evidence of shifts in the equations prior to the onset of the targeting policy. However, in this case, the frequency of Leeper-Zha statistics that are greater than 2.0 is about 53 percent.[20] Not surprisingly, a higher price level target requires a more aggressive monetary policy.

Figure 10: Actual Output, Average Counterfactual Output, and Confidence Bands, Price Level Target Set for Average 1926 Price Level

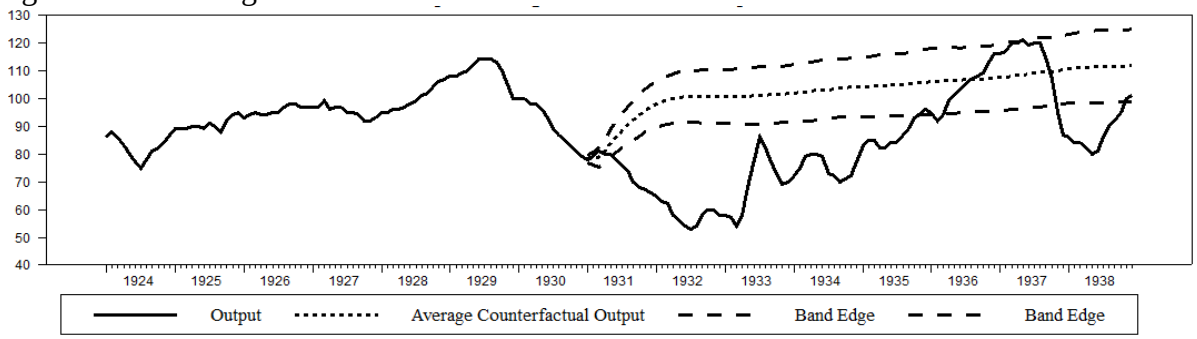


Figure 11 below shows the output results when the commercial paper rate is replaced with the AAA corporate bond rate in the base model. As with the base case, output gradually

[20] Of the 96,000 months in the exercise with 1,000 trials, in this case we had to intervene in 11,826 of the months to attain the price level objective of the average price level in 1926. These interventions had a mean of 0.044 and a standard deviation of 0.036.

rises for the first year or so during the simulation period and then remains roughly constant, in contrast with the continued growth in the alternative model immediately above. In this model, the minimum cover ratio is .58. The Leeper-Zha statistics are greater than 2.0 about 16 percent of the time, marginally higher than in the base case. The Chow test suggests that only the currency equation exhibits some instability, beginning in 1930:11.[21]

Figure 11: Actual Output, Average Counterfactual Output, and Confidence Bands, Price Level Target for December 1929; AAA Corporate Bond Rate Replacing Commercial Paper Rate

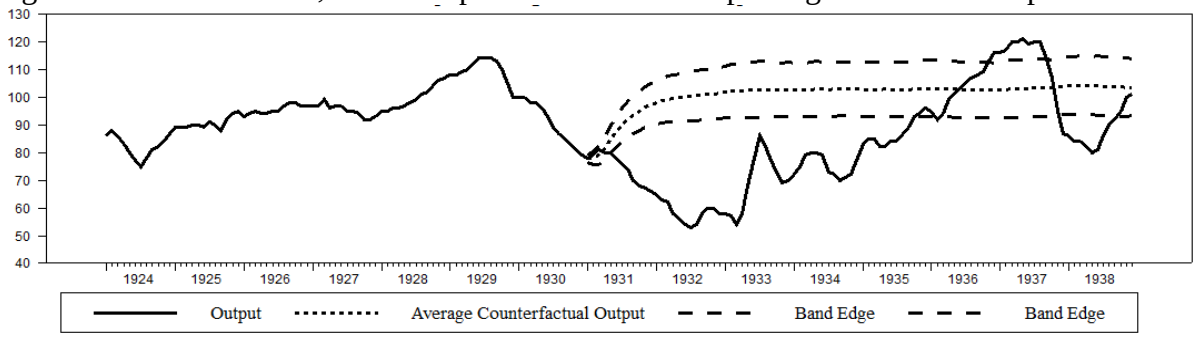


Figure 12, below, shows the output results when the wholesale price index is substituted for the consumer price index in the base model. In this model, we aim for the 1930:6 wholesale price level to be asymptotically approached at the end of the decade. Clearly, the confidence bands are substantially wider than in the cases using the consumer price index, though the depths of the Depression are still avoided. The minimum cover ratio is .47. However, the Leeper-Zha statistics suggest that the Lucas critique would be valid (98% being greater than 2.0), and the model exhibits more instability than those discussed above, with the interest rate equation shifting in 1930:2, the WPI equation in 1930:6 (which is why we use this mid-1930 price level as

[21] In this case, we had 3,216 months with policy interventions, with a mean of 0.035 and standard deviation of 0.032.

the target rather than the 1930:12 value as in the other examples), and the currency equation in 1930:11.[22]

Figure 13 shows the output results for the case in which M2 is last in the ordering. The results here are nearly identical to those of the base case, with a minimum cover ratio of 0.55, 12 percent of Leeper-Zha statistics in excess of 2.0, and the same statistics on structural shifts in the equations.[23]

Figure 12: Actual Output, Average Counterfactual Output, and Confidence Bands, Price Level Target for Wholesale Prices, June 1930

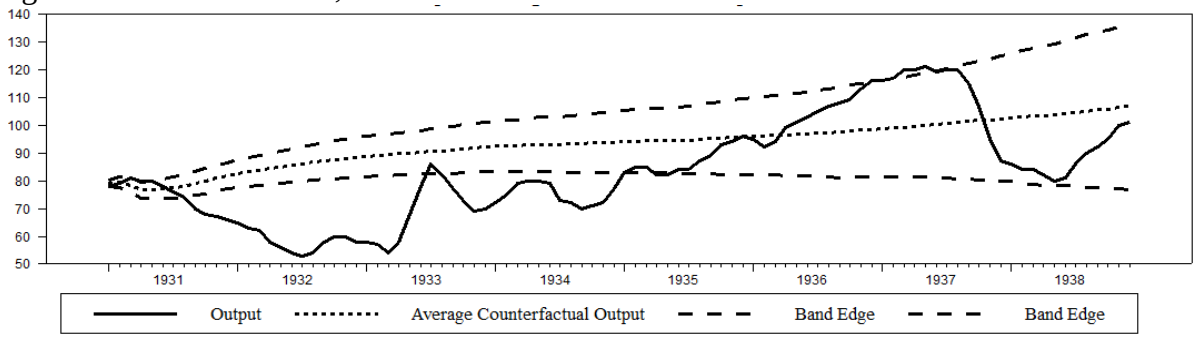
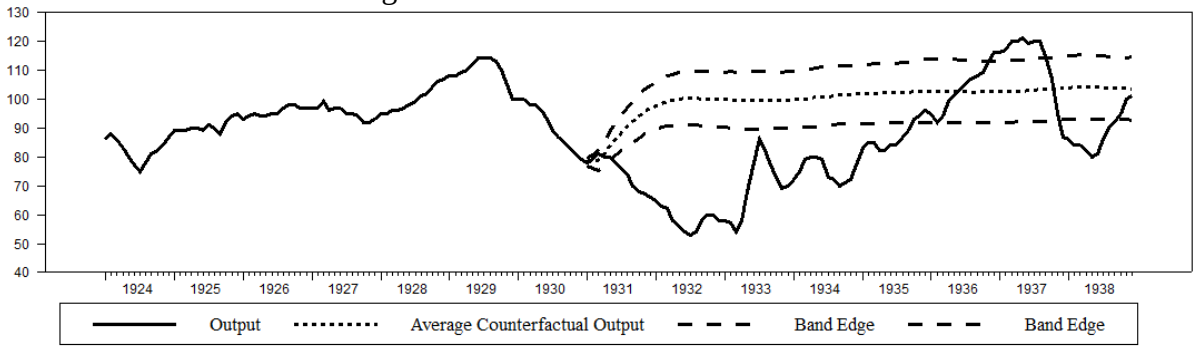


Figure 13: Actual Output, Average Counterfactual Output, and Confidence Bands, Base Case Model with M2 Last in Ordering

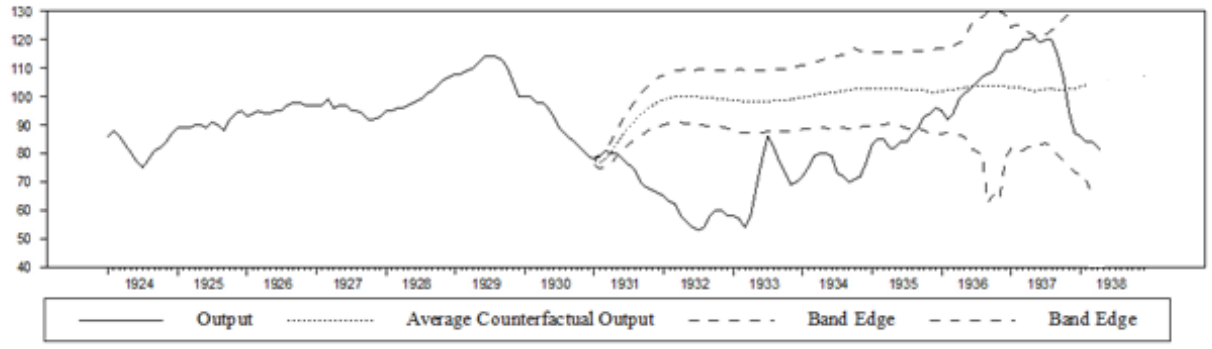


[22] For this experiment with the wholesale price index, we required 15,181 months of active policy intervention, with a mean of 0.073 and a standard deviation of 0.062.

[23] Similar to the base case in which M2 was next-to-last in the ordering, maintaining the price level with the specified bounds required 2,118 months with interventions, with a mean of 0.037 and a standard deviation of 0.037.

Finally, Figure 14 shows the output results using the monetary base in place of M2. In this case, the confidence bands widen substantially in the late 1930s.[24] However, the expected output path, as in the other cases presented above, avoids the downturn as well. The minimum cover ratio for the monetary base case did violate the gold standard minimum in one trial, with a value of .01. This ratio implies that virtually all gold would have left the country. However, only 0.4 percent of the 96,000 monthly trials suggest that the cover ratio was violated, so the probability of the price level targeting policy provoking a gold standard crisis is exceedingly small.[25] We also note that 19.7 percent of Leeper-Zha statistics were in excess of 2.0, and several of the equations (those for commodity prices, industrial production, currency, and the monetary base) shifted just prior to the onset of the counterfactual experiments, though the interest rate equation shifted earlier, in 1930:3.

Figure 14: Actual Output, Average Counterfactual Output, and Confidence Bands, Model with Monetary Base



[24] This appears to be a result of several outliers in the residuals, which are randomly selected several times toward the end of the simulations. If these particular residuals are excluded, the confidence bands for the monetary base case appear roughly the same as for the other cases.

[25] As with the abnormal behavior of the confidence bands around the expected output path, this appears to be the result of the unusual outlier in the residuals, a conclusion buttressed by the absence of such extreme results in the other experiments.

VIII. Conclusion

With some confidence, we answer in the affirmative the following question: Would a price level target for monetary policy have avoided the Great Depression? At its most basic level, had Irving Fisher's plan been implemented, just using the money supply to target a desired price level "as speedily as possible" and then maintaining it "as nearly as . . . possible through monetary and credit policy," the economy would likely have avoided the Great Depression. That is, had the policy maker merely started targeting the price level using available policy tools and kept the price level within a fairly wide tolerance band, reacting only when the price level breached the edge of the band, the bulk of the evidence suggests that the Great Depression would have been avoided. The Federal Reserve would not have needed the econometric tools we currently possess, nor the computational power available today. Even assuming insufficient intuition among agents on the concepts of the Lucas critique, policy makers would not have needed "immodest" policy interventions to achieve this objective. Furthermore, Fisher's plan reflected economic thought at the time in the form of a targeting plan developed and implemented in Sweden and embodied in legislation approved in the House of Representatives after a decade of such proposals.

Our advantage in evaluating the Goldsborough/Fisher plan is the availability of VAR techniques and more-than-adequate computing power. The model we estimated and employed mimicked Fisher's proposed implementation plan and only used data through 1930, with the simulations beginning in January 1931. We also confirm that a policy of price level targeting could have been conducted without raising serious Lucas critique issues.

Our results provide empirical context for Fisher's proposed plan and for Meltzer's conjecture that the failure to enact legislation requiring the Federal Reserve to conduct monetary

policy in order to target the price level was indeed, as Meltzer stated, a “missed opportunity.” Furthermore, Friedman and Schwartz were correct that “alternative policies were available and were being seriously proposed for adoption by leading Figures in the System. At all times, the System was technically in a position to adopt the alternative policies.” An alternative policy of price level targeting would have produced superior economic results throughout the 1930s.

References

Balke, Nathan S., and Robert J. Gordon. 1986. "The American Business Cycle: Historical Data." In *The American Business Cycle: Continuity and Change*, edited by Robert J. Gordon, 781–850. Chicago: University of Chicago Press.

Bernanke, Ben S. 1983. "Nonmonetary Effects of the Financial Crisis in the Propagation of the Great Depression." *American Economic Review* 73(3): 257–76.

Bernanke, Ben S. 1986. Alternative Explanations of the Money-Income Correlation." In *Real Business Cycles, Real Exchange Rates and Actual Policies*. Carnegie-Rochester Conference Series on Public Policy vol. 25, edited by Karl Brunner and Allan H. Meltzer. 49-99.

Blanchard, Olivier J., and Danny Quah 1989. "The Dynamic Effects of Aggregate Demand and Supply Disturbances." American Economic Review 79 (4): 655-73.

Board of Governors of the Federal Reserve System. 1943. *Banking and Monetary Statistics*. September.

Bordo, Michael D., Ehsan U. Choudhri, and Anna J. Schwartz. 1995. "Could Stable Money Have Averted the Great Contraction?" *Economic Inquiry* 33(3): 484–505.

Brainard, William C. 1967. "Uncertainty and the Effectiveness of Policy." *American Economic Review* 57(2): 411–25.

Butkiewicz, James. 2007. "Interview Comments." In *The Economics of the Great Depression: A Twenty-First Century Look back at the Economics of the Interwar Era*, edited by Randall E. Parker, 177–90. Northampton, MA: Edward Elgar Publishing.

Chow, Gregory C., 1960. "Tests of Equality between Two Sets of Coefficients in Two Linear Regressions." *Econometrica* 28(3): 591-605.

Christiano, Lawrence J. 1998. "Discussion." In *Beyond Shocks: What Causes Business Cycles?* Federal Reserve Bank of Boston Conference Series No. 42, edited by Jeffrey C. Fuhrer and Scott Schuh, 161–70.

Eichengreen, Barry. 1992. *Golden Fetters: The Gold Standard and the Great Depression, 1919–1939.* Oxford: Oxford University Press.

Fackler, James S., and Randall E. Parker. 1994. "Accounting for the Great Depression: A Historical Decomposition." *Journal of Macroeconomics* 16(2): 193–220.

Fackler, James S., and Randall E. Parker. 2005. "Was Debt Deflation Operative during the Great Depression?" *Economic Inquiry* 43(1): 67–78.

Fernandez-Villaverde, Jesus, Juan F. Rubio-Ramirez, Thomas J. Sargent, and Mark W. Watson. 2007. "ABCs (and Ds) of Understanding VARs." *American Economic Review* 97 (3): 1021–26.

Fisher, Irving. 1933. "The Debt-Deflation Theory of Great Depressions." *Econometrica* 1(4): 337–57.

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

Friedman, Milton, and Anna J. Schwartz. 1982. *Monetary Trends in the United States and the United Kingdom*. Chicago: University of Chicago Press.

Gospodinov, Nikolay, Ana Maria Herrera, and Elena Pesavento. 2013. "Unit Roots, Cointegration and Pre-Testing in VAR Models." In *Advances in Econometrics: VAR Models in Macroeconomics—New Developments and Applications: Essays in Honor of Christopher A. Sims*, edited by Thomas B. Fomby, Lutz Killian, and Anthony Murphy, 32, 81–115. Bingley, UK Emerald Group.

Ireland, Peter N. 2007. "Changes in the Federal Reserve's Inflation Target: Causes and Consequences." *Journal of Money, Credit and Banking* 39(8): 1851–82.

Johnston, J., 1972. Econometric Methods (2nd Edition). New York: McGraw-Hill.

Joint Economic Committee, United States Congress. 2004. "Price Stability and Inflation Targets: A Legislative History." Washington, DC.

Jonung, Lars. 1979. "Knut Wicksell's Norm of Price Stabilization and Swedish Monetary Policy in the 1930s." *Journal of Monetary Economics* 5(4): 459–96.

Krooss, Herman E., ed. 1969. *Documentary History of Banking and Currency in the United States.* New York: Chelsea House.

Leeper, Eric M., and Tao Zha. 2003. "Modest Policy Interventions." *Journal of Monetary Economics* 50(8): 1673–1700.

Lin, J.-L., and R. S. Tsay. 1996. "Cointegration Constraint and Forecasting: An Empirical Examination." *Journal of Applied Econometrics* 11: 519–38.

Mack, Ruth P. 1959. "Inflation and Quasi-Elective Changes in Costs." *Review of Economics and Statistics* 41(3): 225–31.

McCallum, Bennett T. 1990. "Could a Monetary Base Rule Have Prevented the Great Depression?" *Journal of Monetary Economics* 26(1): 3–26.

Meltzer, Allan H. 2003. *A History of the Federal Reserve, Volume I.* Chicago: University of Chicago Press.

Meltzer, Allan H. 2007. "Interview Comments." In *The Economics of the Great Depression: A Twenty-First Century Look back at the Economics of the Interwar Era*, edited by Randall E. Parker, 224-41. Northampton, MA: Edward Elgar.

National Archives II, Record Group 83, College Park, MD.

Romer, Christina D. 1988. "World War I and the Postwar Depression: A Reinterpretation Based on Alternative Estimate of GNP." *Journal of Monetary Economics* 22(1): 91–115.

Sayre, Robert A. 1948. *Consumers' Prices: 1914–1948.* New York: National Industrial Conference Board.

Sims, Christopher A. 1980. "Macroeconomics and Reality." *Econometrica* 48(1): 1–49.

Sims, Christopher A. 1998. "The Role of Interest Rate Policy in the Generation and Propagation of Business Cycles: What Has Changed Since the 1930s?" In *Beyond Shocks: What Causes Business Cycles?* Federal Reserve Bank of Boston Conference Series No. 42, edited by Jeffrey C. Fuhrer and Scott Schuh, 121–60.

Tavlas, George S. 2011. "Two Who Called the Great Depression: An Initial Formulation of the Monetary-Origin View." *Journal of Money, Credit and Banking* 43(2–3): 565–74.

Temin, Peter. 1976. *Did Monetary Forces Cause the Great Depression?* New York: W.W. Norton.

Temin, Peter. 1989. *Lessons from the Great Depression*. Cambridge, MA: MIT Press.

Temin, Peter. 2007. "Interview Comments." In *The Economics of the Great Depression: A Twenty-First Century Look back at the Economics of the Interwar Era*, edited by Randall E. Parker, 29–51. Northampton, MA: Edward Elgar.

US Government Printing Office. 1932. "Suggestions for a Bill for Restoring to Normal, and thereafter Stabilizing, the Price Level by Methods Fitted to Operate Successfully under Substantially All Circumstances." Hearings on H.R. 10517 for Increasing and Stabilizing the Price Level of Commodities, and for Other Purposes, pp. 382–89, 72nd Congress, Washington, DC.

Wicksell, Knut. 1898. "The Influence of the Rate of Interest on Commodity Prices." In *Nationalekonomiska Foreningens Forhandlingar*, 47–90. Translated by E. Lindahl as *Knut Wicksell: Selected Papers on Economic Theory*. London: Allen and Unwin, 1958.

Appendix 1: Further Discussion of the Congressional Debate on Price Level Targets

It was the volatility in the price level and the purchasing power of the dollar that Fisher, Strong, Goldsborough, and many others who testified for the Goldsborough Bill thought was by far the main culprit in the cause and continued propagation of the Great Depression. For many of the congressional representatives advocating price level stabilization legislation, it was a fight to establish a task for the Federal Reserve that they felt had been inappropriately stripped from the original draft of the Federal Reserve Act. That is, the draft of the Federal Reserve Act originally charged the Fed with regulating money and bank credit in quantities "which shall be made with a view to accommodating the commerce of the country, and promoting a stable price level." The impending arrival of World War I and the inflation of wartime finance led the House to strike this price stability provision. After WWI, the deflation of 1920–21 was sufficiently severe that some in Congress immediately sought to prohibit a repetition of that episode. As noted, Goldsborough began his quest for price stabilization legislation as early as 1922 (H.R. 11788).[1] He viewed one purpose of the legislation to be the establishment of a policy charge to the Fed that should have been there in the first place.

Legislation charging the Federal Reserve with price stability reflected the declining patience many members had with the institution's apparent inactivity. The Goldsborough Bill was a mandate imposing the stabilization of wholesale commodity prices as the goal of Federal Reserve policy. Goldsborough, Strong, and Congressman Jeff Busby (Mississippi) were three of the five members of the Subcommittee of the Committee on Banking and Currency conducting the hearings on the Goldsborough Bill (the other members, Representatives Prall of New York and Beedy of Maine, seldom attended or spoke during the hearings when present). Congress had

[1] Goldsborough ended the quest in 1939 with his last piece of price stability legislation, H.R. 5520.

been told previously that if the Glass-Steagall Act of 1932 was passed and the Reconstruction Finance Corporation (RFC) was created, then things would be different and reflation would commence. Congress complied, but, at least in the eyes of this subcommittee, the promises of Glass-Steagall and the RFC were not kept regarding reflation. For Goldsborough, Strong, and Busby, time had run out. They were intent on *making* the Fed do something about the deflation whether it wanted to or not.[2]

Economically, the clear theme of the testimony during the hearings on the Goldsborough Bill was the ruinous effects of debt deflation, or as Fisher put it, the "dollar disease" leading to the "debt disease."[3] Contracting nominal fixed-interest debt at one price level and then trying to service and pay back that debt after a subsequent deflation was an economic burden from which many groups were seeking relief, particularly farmers who were hit the hardest in terms of relative price declines. Such real debt burdens, Fisher argued, were growing rather than declining, even as principal and interest were being repaid, since prices were falling faster than debt repayment. Moreover, since deposits were being used to repay debt faster than new loans and investments were being created by commercial banks, the boom and depression cycle was further deflating the economy by reducing the supply of money, which further perpetuated deflation. Although Fisher claimed that few realized this last point, he called it the "key to the whole situation." His solution was to fix the purchasing power of the dollar and thereby eliminate both the dollar disease and the debt disease.

Fisher made the point that all weights and measures are standardized except money's value. Now was the time to standardize money's value, too. Reflation was the answer. Fisher

[2] As we shall see below, Governor Harrison of the New York Fed neither wanted to be bound by the Goldsborough Bill nor thought that the Fed could achieve its aims.
[3] See Fackler and Parker (2005) for a more complete discussion of the debt-deflation mechanism.

also knew that calling it "reflation" was the correct label to use and that this was better than calling it inflation because (1) people of the time remained deathly afraid of inflation even in an economy that was devastated by deflation, and (2) reflation justifies inflation after a deflation.[4] The options facing policy makers were either reflation or making debtors dispose of their debts through bankruptcy. It is well known that many leaders of the Federal Reserve, along with Treasury Secretary Mellon, were "liquidationists" wanting to start with a clean slate through bankruptcy. The Goldsborough Bill was trying to force the choice to be reflation.

The advances he and others had made in index number theory and construction since the 1890s convinced Fisher that the price level could be managed "scientifically" for the first time. He felt that economists and the government had the apparatus to establish a fixed purchasing power for money. Both Fisher and Professor Wilford I. King of New York University testified that if the Fed would persistently increase the supply of money, the inevitable consequence would be inflation.[5] Moreover, the 1932 Glass-Steagall Act had given them the latitude to do it.[6] Once the desired price level was achieved, index numbers could be used as the guiding measure to stabilize it at the desired level.

[4] Fisher also speaks of the asymmetry of the gold standard regarding inflation and deflation. The gold standard will stop inflation but has no safeguard against deflation. From the historical record, we know this to be true given the asymmetry of the interwar gold exchange standard: gold-losing countries had to deflate, while gold-gaining countries did not have to inflate. He claimed the Goldsborough Bill provided safeguards against both inflation and deflation.

[5] Professor King did not mince words in his testimony. King said the Fed was led by bankers but that the people in power did not understand monetary economics and did not think price stability was one of their functions. "I really think there is no more connection necessary between being a good banker and being a good monetary economist, and being a good shoemaker and being a good monetary economist. I think these things are not related. These men are experts in banking, but they are not interested in monetary economics." King went further to say that the people in charge at the Fed should either learn monetary economics and do something about it or get out of the way.

[6] It is necessary to distinguish between the 1932 Glass-Steagall Bill, which allowed the Federal Reserve to use government securities as collateral for the issuance of Federal Reserve notes, from the more famous Glass-Steagall Act of 1933, which separates commercial and investment banking activities. The 1932 bill, allowing a bond-backed currency, was at odds with the real bills doctrine that was the foundation of policy in the Federal Reserve Act.

One of the main upshots is that Fisher and others were advocating a "commodity" backed currency rather than a gold backed currency. In modern terminology, they wanted the wholesale prices of commodities and not the fixed price of gold to be the nominal anchor. Fisher and others repeatedly pointed to the examples of Japan and England, which both left the gold standard, reflated, and commenced recovery. The writings of Cassel and Wicksell were also put forth as ideas supporting the soundness of the Goldsborough Bill. Indeed, Fisher pointed out that this idea of a commodity standard was more than just a theoretical curiosity, as Sweden had adopted Wicksell's norm of price stabilization after leaving the gold standard in September 1931. After that, the focus of Swedish monetary policy was the preservation of the domestic purchasing power of the krona using "all means available." People were not just talking about it internationally: they were doing it.[7]

There was a wave of resistance to the Goldsborough Bill. Much of it came from Federal Reserve officials who were testifying against the bill. Governor Harrison led off the negative testimony. There was seemingly no end to the reasons why the Goldsborough Bill should not be passed. Harrison made the real bills doctrine argument that the Fed was currently doing all it could (though he refused to detail what it was doing) to affect the economic situation. Harrison claimed that the Fed's operations had only an indirect influence on the total volume of credit, and the Fed mostly could only encourage or discourage banks to alter credit availability. Moreover, there was only a very loose and totally unreliable link between money and prices. Far too many factors other than money and credit influenced prices. Forcing the Fed to adopt a price level objective would be imposing a goal that it did not have the power to achieve. The subsequent failure to achieve its goals would cause a crisis of confidence.

[7] Fisher claims that people still badgered him about England, saying it was a matter of time before it fell back into depression, and of a much worse kind, because it abandoned the gold standard.

Looking back at the interchanges between Goldsborough and Harrison, one sees the precursor to many of the post-WWII monetary/macro debates and the post-WWII research agenda of the monetary economics profession. Rules versus discretion, transparency and communication versus secrecy, accountability versus maximum flexibility, the time inconsistency problem, and credible commitments to nominal anchors versus total discretion were undercurrents in the sometimes contentious discourse between the members of the subcommittee and Governor Harrison. Ultimately, Goldsborough wanted the Fed to be committed to price stability, and Harrison wanted no part of it. Harrison thought not only that it couldn't be done, but that it shouldn't be done. He tried to encourage Goldsborough that if Congress would leave the Fed alone, they would get their desired result, since open market operations in the early summer of 1932 had commenced in earnest. But Harrison warned repeatedly that commitment to a price level objective would be unwise, since something might happen that would force them to stop. As Harrison put it, "Conditions may arise to make it unwise or impossible for us to proceed further." As any student of this period knows, that is just another way to say that the gold standard trumps all. Similar sentiment is expressed by Eugene Meyer, Federal Reserve Board governor, and Emmanuel Goldenweiser, Federal Reserve Board director of the Division of Research and Statistics.

After more than a decade of trying, in 1932, Goldsborough was saying publicly that he was stripping the bill down to its bare minimum in order for it to be enacted. Fisher claimed that the Goldsborough Bill was "the most constructive measure that could possibly be conceived of" in providing relief from the Depression. It passed the House and went to the Senate.

Carter Glass was one of the main authors of the Federal Reserve Act, which was crafted to make the Federal Reserve a real bills institution, and he intended to keep it that way. Glass

almost certainly did not even want the 1932 Glass-Steagall bill passed and was deeply disturbed when the Fed actually used it with aggressive open market purchases in the beginning of the summer of 1932. Glass cosponsored the Glass-Steagall bill and allowed it to be passed for "psychological effects" only, and the bill was passed with an explicit one-year time fuse attached to the legislation. There was not going to be a bond-backed currency for long. But worse, in Glass's mind, it was an unthinkable and radical notion for monetary legislation to see the light of day that would actually unleash bond-backed currency issue to alleviate the Depression. For a vast many others, especially those in the Fed and the Hoover administration, any legislation that threatened the sanctity of the gold standard was to be vigorously opposed; see Butkiewicz (2007) and Temin (2007).[8] The Goldsborough Bill did both and was defeated in the Senate, and the Depression continued to grind on.

[8] Letters were sent to Goldsborough telling him that either he did not know what he was doing or that his bill was "a deliberate effort to force the United States off the gold standard by subterfuge" (National Archives, Record Group 83, Box 144). After reading section 3 of H.R. 10517, the original House version of the Goldsborough Bill, where it explicitly allows for altering the price of gold, one wonders why Goldsborough was repeatedly accused of "subterfuge."

Appendix 2: Implementing Price Level Target Simulations

Our counterfactual experiments use innovations to the money supply to force the price level to follow a specified path from 1931:1 to the end of the horizon. We then examine the implications of this path for the entire system of equations representing the model of the macroeconomy. In this appendix, we outline the framework for the counterfactual analysis.

We start with a text equation (3), denoted below by appendix equation (A1). At time *t*, for period $t + n$, we have:

$$y_{t+n} = \sum_{s=0}^{j-1} D_s \varepsilon_{t+n-s} + \sum_{s=j}^{\infty} D_s \varepsilon_{t+n-s} \qquad \text{(A1)}$$

which is the historical decomposition. The second term on the right-hand side represents the expectation of y_{t+n} given information available at time *t*, the base projection of the vector *y*. The first term on the right-hand side shows the difference between the actual series and the base projection due to the structural innovations in the variables subsequent to period *t*; that is, it shows that the gap between an actual series and its base projection is the sum of the (weighted) contributions of the structural innovations to the individual series in the analysis. Thus, the actual data at period $t + n$ is the sum of the base projection and the weighted structural innovations to the system variables. Under the usual assumption that the covariance matrix of the structural residuals is diagonal, these innovations are orthogonal to one another.[9]

We next use equation (A1) to construct counterfactual (CF) paths for the variables in the system. To construct a CF path, given a base projection as computed from the estimation through 1930:12, we draw randomly from the estimated residuals and apply them to the initial term on the right-hand side of equation (A1) beginning in 1931:1. As detailed below, we replace the drawn

[9] Although we use a Choleski decomposition to identify the monetary policy shock, we note that the approach we outline can also be implemented with alternative identifying schemes, including the long-run restriction approach of Blanchard and Quah (1989), the short-run identification technique of Bernanke (1986), the signs restriction approach of Uhlig (2005), or a blend of the alternative identification methods.

shocks to the money supply equation, as needed, to keep the price level within the specified target band.

We construct the counterfactual shocks to the money supply that force the price level along the specified path in the following way. Text equation (1) shows the historical decompositions in terms of model parameters and structural shocks. Text equation (3), reproduced above as appendix equation (A1), shows the decomposition for a particular period $t + j$ in terms of the base projection conditional on the historical shocks to that point and the contributions of shocks subsequent to time t. Consider equation (A1) for $j = 1$:

$$y_{t+1} = D_0\, \varepsilon_{t+1} + \sum_{s=j}^{\infty} D_s \varepsilon_{t+1-s} = D_0\, \varepsilon_{t+1} + BP_t \qquad \text{(A2)}$$

Note that the j^{th} equation of this system is:

$$y_{j,t+1} = d_{0,jk}\, \varepsilon_{k,t+1} + \sum_{i \neq k} d_{0,ji} \varepsilon_{i,t+1} + BP_{1,j,t} \qquad \text{(A3)}$$

where $BP_{m,j,t}$ is the m-period-ahead base projection for the j^{th} equation at time t and where $d_{s,ij}$ is the (i,j) element of the matrix D_s. Suppose we want to find the shock to the k^{th} variable to this equation that will produce a predetermined value for $y_{j,t+1,}$ denoted by $y^*_{j,t+1}$, given values for the other shocks. To so do, solve the following equation for $\hat{\varepsilon}_{k,t+1}$:

$$y^*_{j,t+1} = d_{0,jk}\, \hat{\varepsilon}_{k,t+1} + \sum_{i \neq k} d_{0,ji} \varepsilon_{i,t+1} + BP_{1,j,,t'} \qquad \text{(A4)}$$

the solution for which is

$$\hat{\varepsilon}_{k,t+1} = (d_{0,jk})^{-1}\left[y^*_{j,t+1} - BP_{1,j,t} - \sum_{i \neq k} d_{0,ji} \varepsilon_{i,t+1}\right]. \qquad \text{(A5)}$$

Proceeding in a similar manner, the structural residual needed to achieve a particular value for $y_{j,t+2}$, denoted by $y^*_{j,t+2}$ is

$$\hat{\varepsilon}_{k,t+2} = (d_{0,jk})^{-1}\left[y^*_{j,t+2} - BP_{2,j,t} - \sum_{i \neq k} d_{0,ji} \varepsilon_{i,t+2} - \sum_{i \neq k} d_{1,ji} \varepsilon_{i,t+1} - d_{1,jk} \hat{\varepsilon}_{k,t+1}\right] \qquad \text{(A6)}$$

Similar iterations produce a path of structural shocks that generate a path for $y_{j,t+n}$ that matches a target path $y^*_{j,t+n}$ for $n = 1,\ldots, T$, where T is the desired horizon.

From equation (A6), note first that the innovation to variable *k* in period *t* + 1 is carried forward to period *t* + 2 (and beyond for later periods); the policy innovation in *t* + 1 affects the size of the innovation in period *t* + 2 and subsequent periods. Note second that the period *t* + 1 policy innovation to variable *k* also affects the paths of all the other system variables as well; in equation (A1) the sequence of shocks to the $\hat{\varepsilon}_{\mathrm{k}}$ terms needed to achieve the price level objective affects subsequent values for other system variables through the usual system dynamics. As a result, policy interventions alter the paths of all system variables, the counterfactual paths shown in our plots relative to the actual paths of the system variables. Third, note that the counterfactual paths constructed here are intuitively simple for a policy maker to construct; given the estimated VAR, all that must be done to produce the counterfactual path for the system is to specify the desired path for the variable of interest.

The computations of the policy innovations needed to attain the target values assume that the objective is to produce these values exactly. In our experiments, however, we only impose a policy intervention if the price level implied by the draw from the historical residuals lies outside the specified band. That is, in equation (A6), we only compute a value for $\hat{\varepsilon}_{\mathrm{k}}$ when $\mathrm{y}_{\mathrm{j,t+n}} > y^*_{j,t+n} + \tau$ or when $y_{j,t+n} < y^*_{j,t+n} - \tau$, in which case we compute the policy innovation needed to return the price level to the edge of the band. If $y^*_{j,t+n} + \tau > \mathrm{y}_{\mathrm{j,t+n}} > y^*_{j,t+n} - \tau$, we do not impose a policy innovation and instead just maintain the value for the policy shock drawn from the historical residuals.

We note, in conclusion, that the counterfactual approach detailed above is informative to when the model is not subject to structural shifts subsequent to the estimation period and when the imposed policy innovations are not sufficiently large and/or frequent to signal to agents in the

economy that a policy regime shift has occurred. For our particular application, the text includes some statistical analysis to address these issues.

Appendix 3A: Base Model with 1926 Price Level Target

The following are the results for the base case model variable with the price level variable, the Sayre CPI, returning to the average 1926 price level. Figures are numbered to correspond to analogous Figures in the main text.

Minimum cover ratio: .503

Leeper-Zha statistics: 52.7 percent in excess of 2.0

Chow test results are the same as those of regressions of the base case.

Figure 1: Price Level, Target Price Level, and Target Band

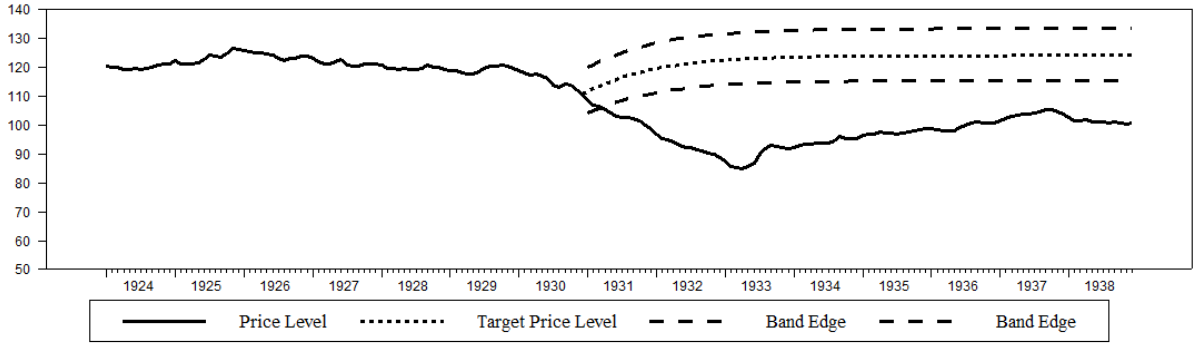


Figure 3: Price Level, Average Counterfactual Price Level, and Target Band

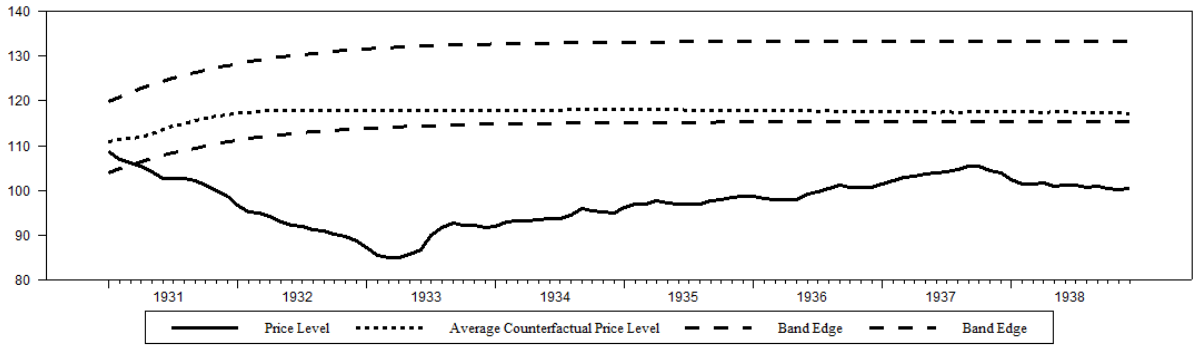


Figure 4: Example Counterfactual Trials: Price Level; Trial Path and Target Bands

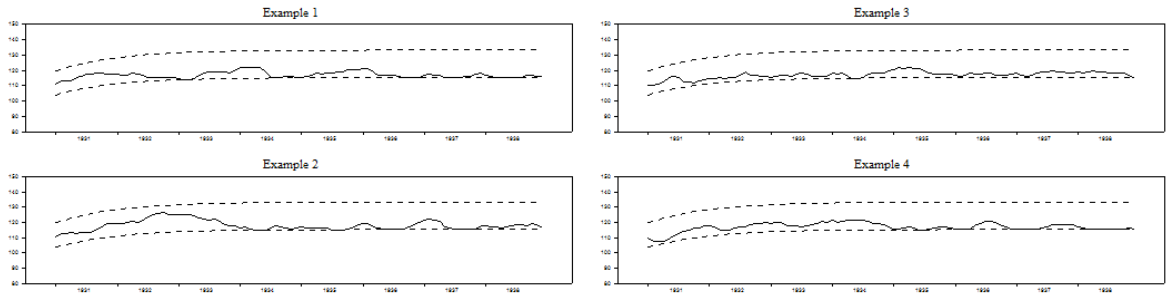


Figure 5: Actual Output, Average Counterfactual Output, and Confidence Bands

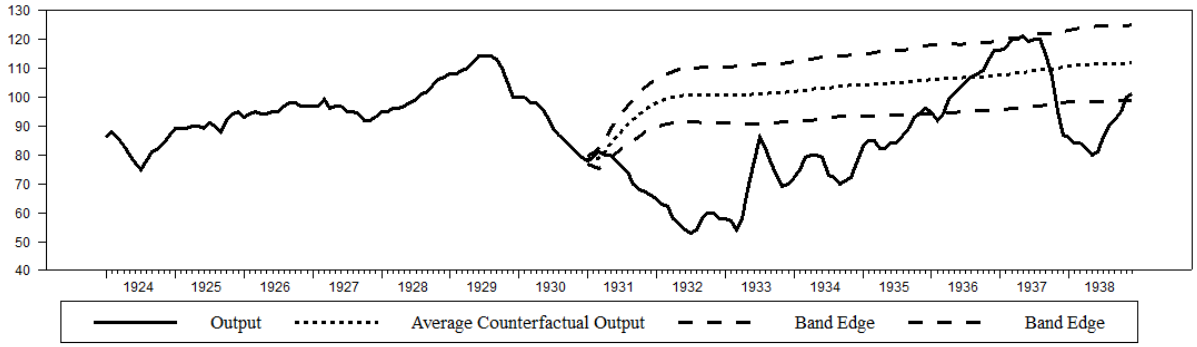


Figure 6: Actual M2 and Average Counterfactual M2

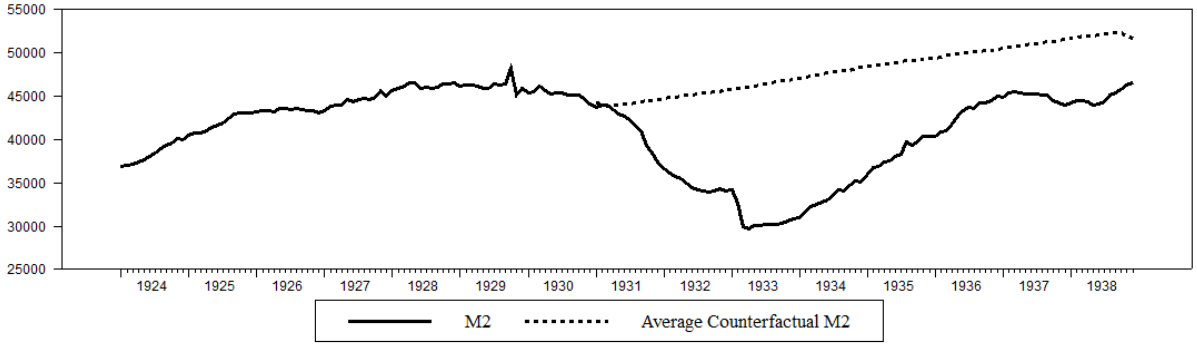


Figure 7: Actual Currency Holdings and Average Counterfactual Holdings

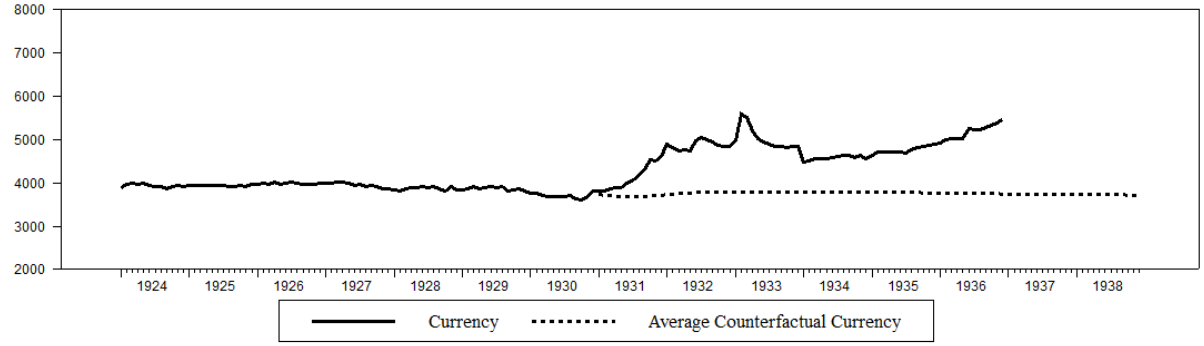


Figure 8: Actual Interest Rate and Average Counterfactual Interest Rate

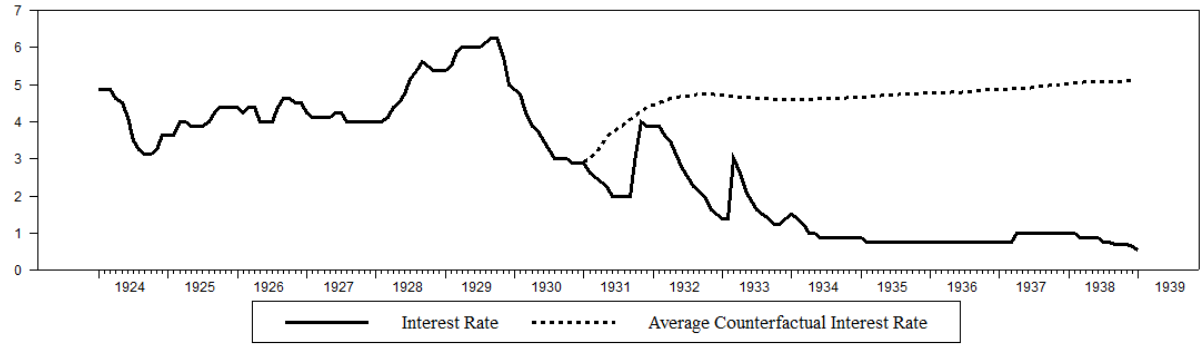


Figure 9: Actual Gold Ratio and Average Counterfactual Gold Ratio

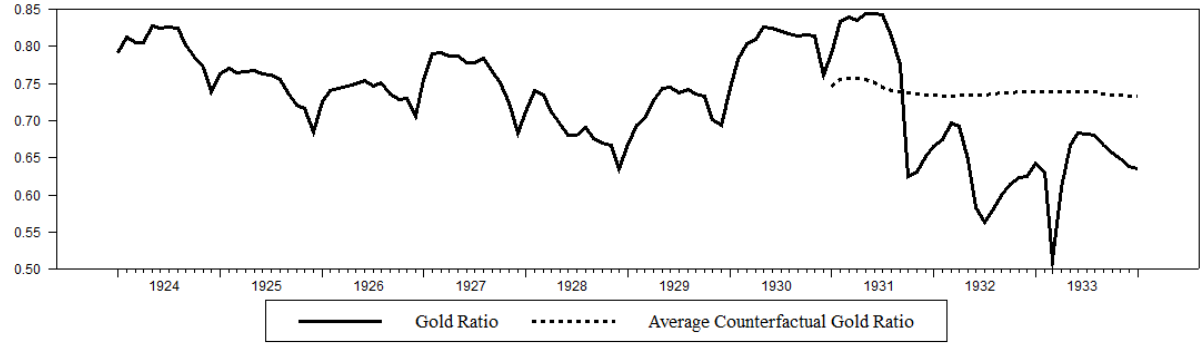
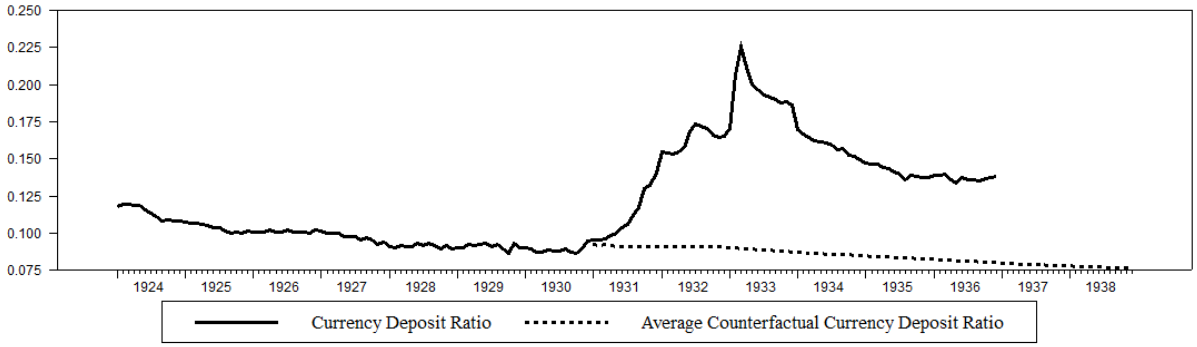


Figure 10: Currency Deposit Ratio and Average Counterfactual Currency Deposit Ratio



Appendix 3B: Base Model with Price Level Target Set to 1929:12; Commercial Paper Rate Replaced with AAA Corporate Bond Rate

The following are the results for a new model where the base case model interest rate variable (the commercial paper rate) is replaced with the AAA bond rate. The price level variable is the Sayre CPI, returning to average the December 1929 level. Figures are numbered to correspond to analogous Figures in the main text.

Minimum cover ratio: .582

Leeper-Zha statistics: 15.7 percent in excess of 2.0

Chow test results: The currency equation shifts in 1930:11.

Figure 1: Price Level, Target Price Level, and Target Band

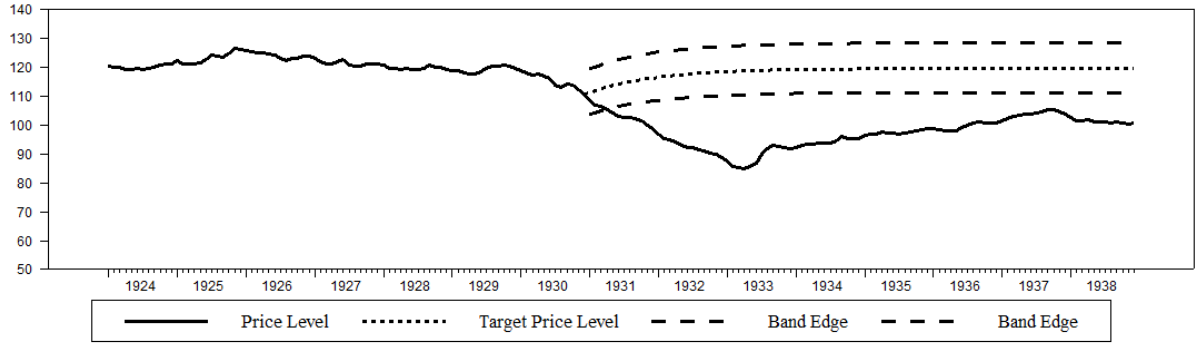


Figure 3: Price Level, Average Counterfactual Price Level, and Target Band

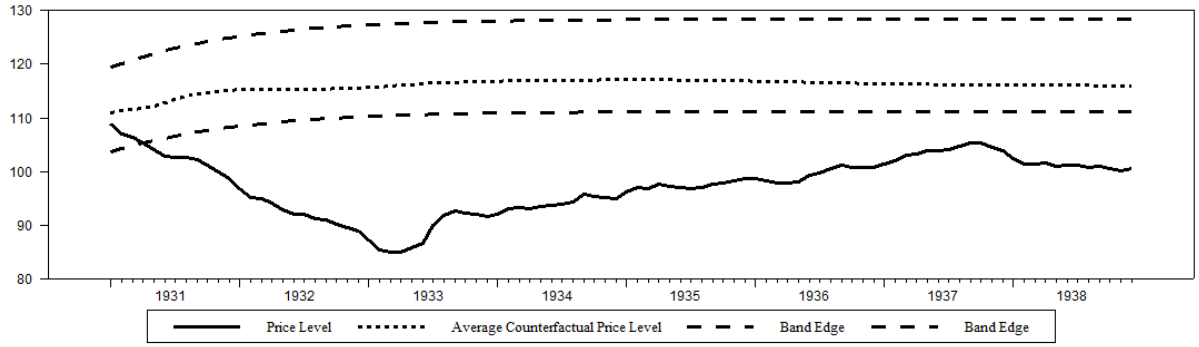


Figure 4: Example Counterfactual Trials: Price Level; Trial Path and Target Bands

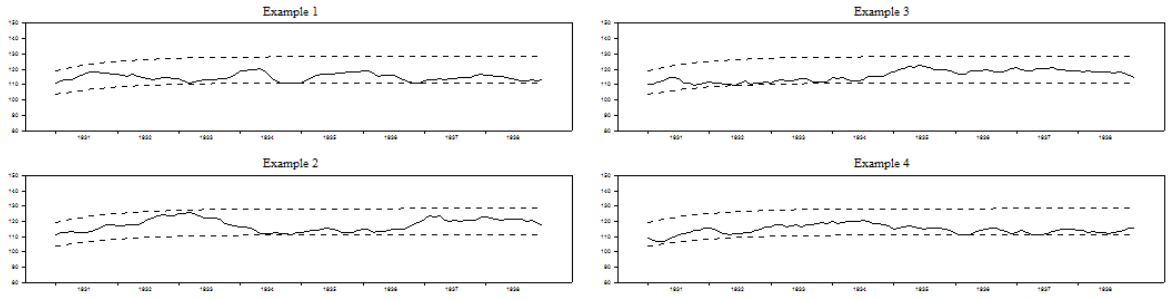


Figure 5: Actual Output, Average Counterfactual Output, and Confidence Bands

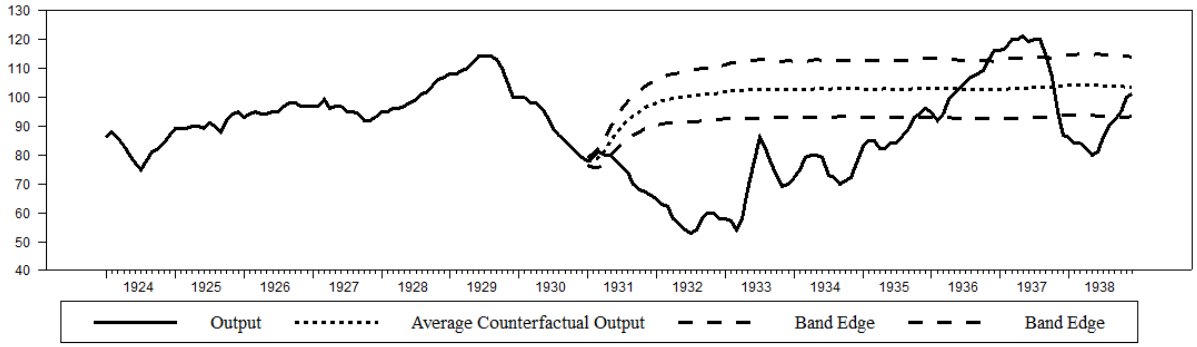


Figure 6: Actual M2 and Average Counterfactual M2

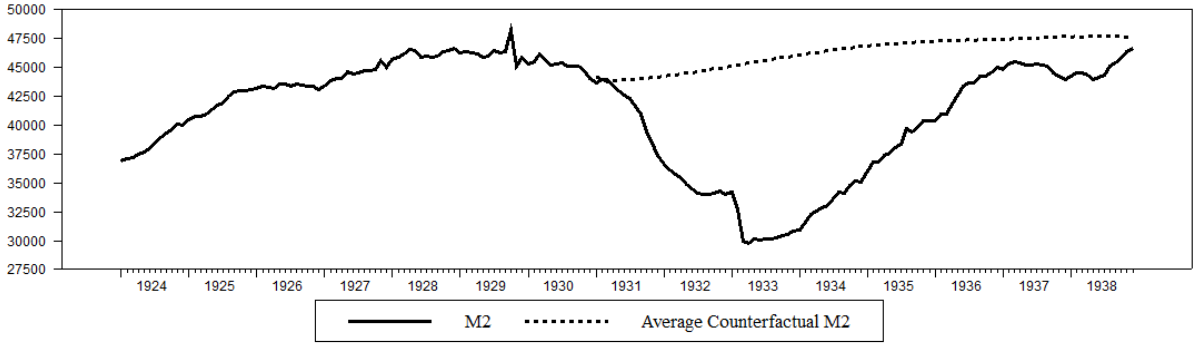


Figure 7: Actual Currency Holdings and Average Counterfactual Holdings

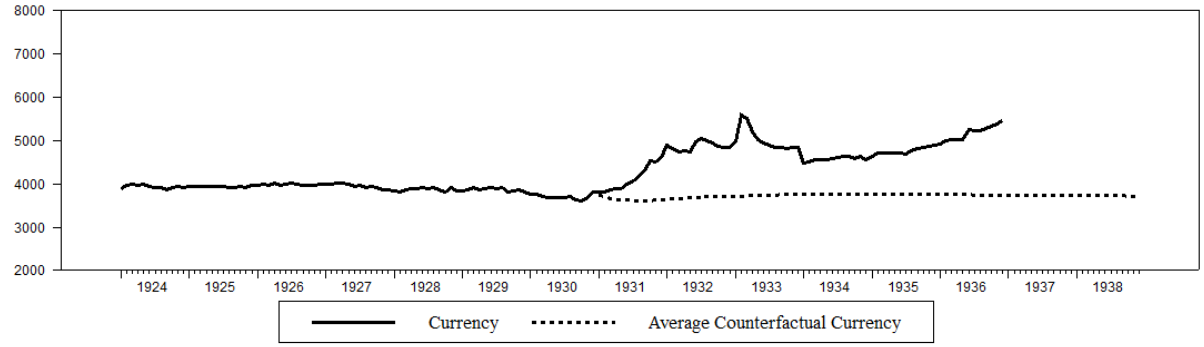


Figure 8: Actual Interest Rate and Average Counterfactual Interest Rate

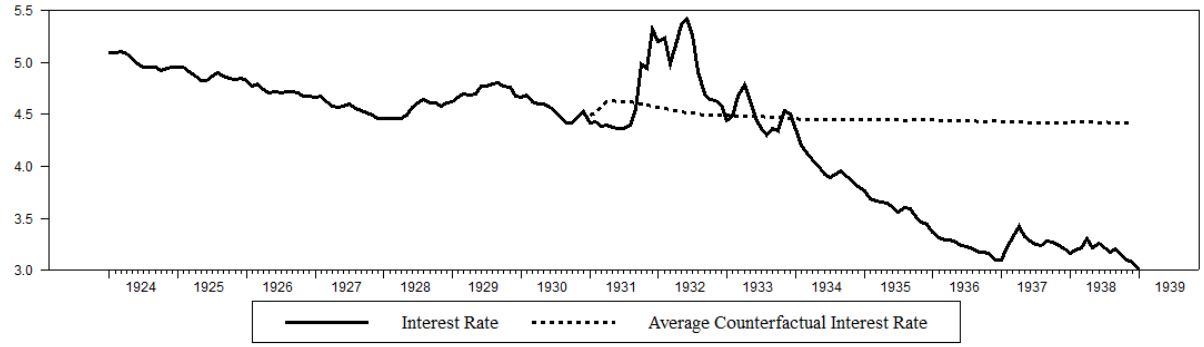


Figure 9: Actual Gold Ratio and Average Counterfactual Gold Ratio

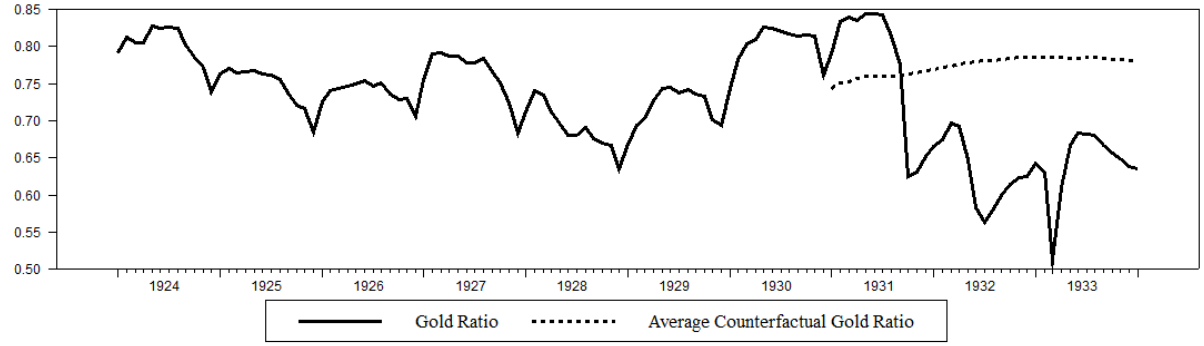
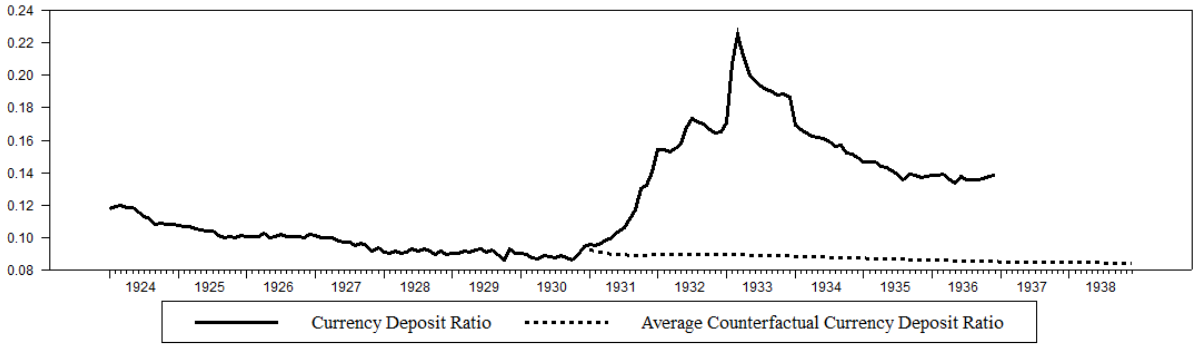


Figure 10: Currency Deposit Ratio and Average Counterfactual Currency Deposit Ratio



Appendix 3C: Base Model with 1926 Price Level Target

The following are the results for the base case model variable with the price level variable, replaced with the wholesale price index with a target of June 1930. Figures are numbered to correspond to analogous Figures in the main text.

Minimum cover ratio: .473

Leeper-Zha statistics: 98 percent in excess of 2.0

Chow test results: The WPI equation breaks in 1930:6, the period we target; the currency equation breaks in 1930:12; and the interest rate breaks in 1930:2.

Figure 1: Price Level, Target Price Level, and Target Band

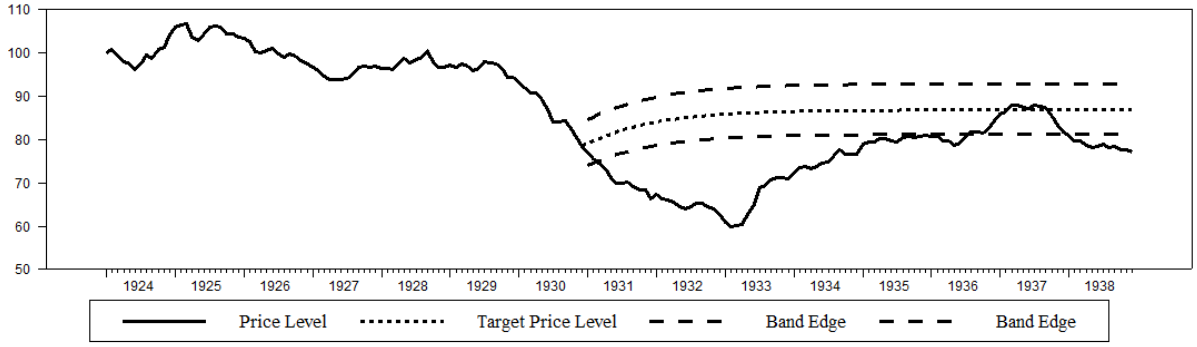


Figure 3: Price Level, Average Counterfactual Price Level, and Target Band

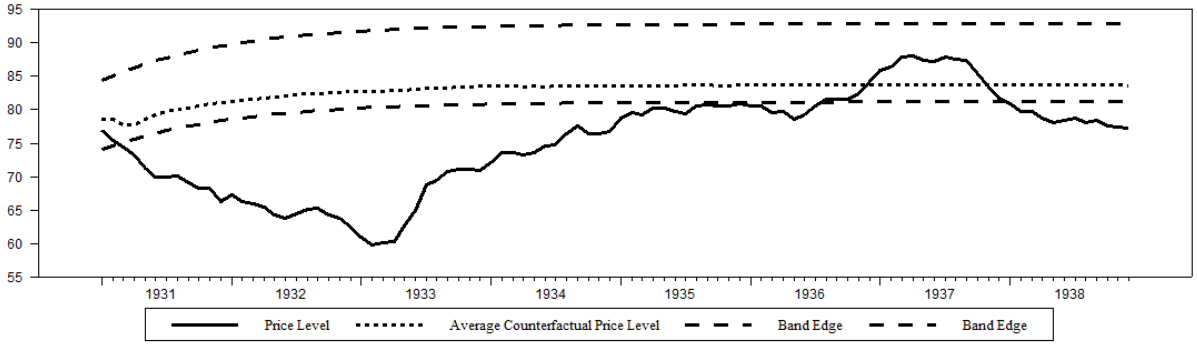


Figure 4: Example Counterfactual Trials: Price Level; Trial Path and Target Bands

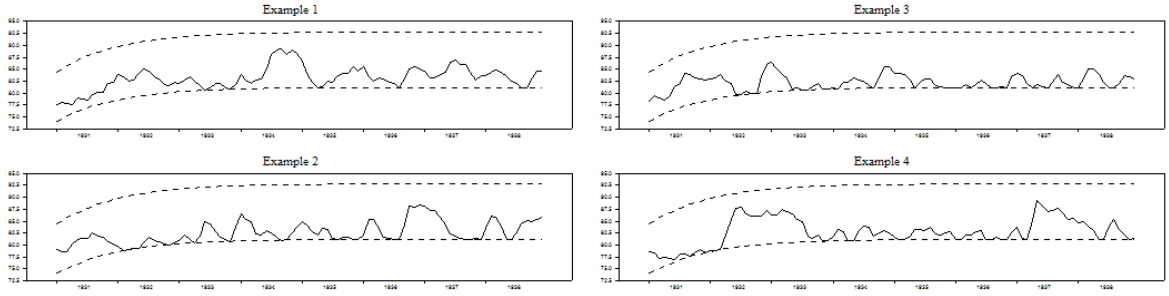


Figure 5: Actual Output, Average Counterfactual Output, and Confidence Bands

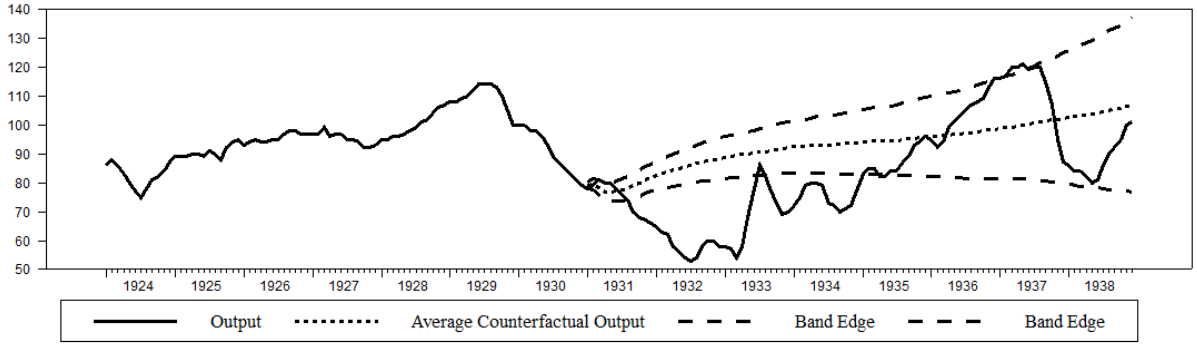


Figure 6: Actual M2 and Average Counterfactual M2

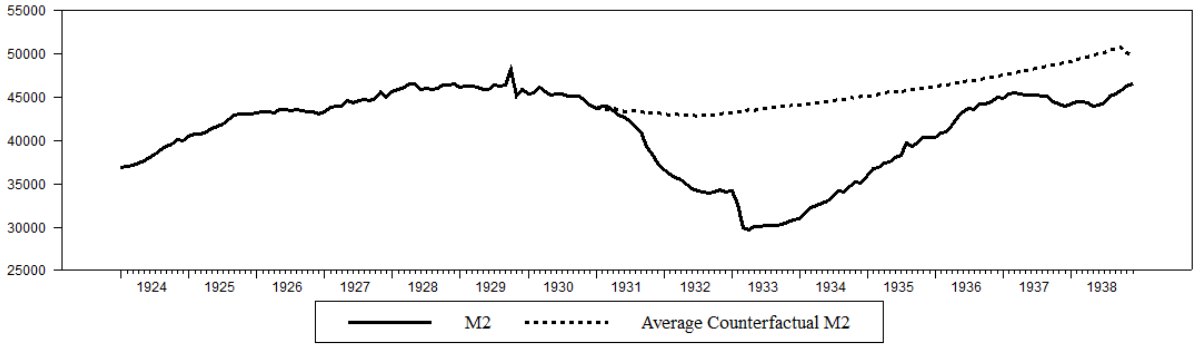


Figure 7: Actual Currency Holdings and Average Counterfactual Holdings

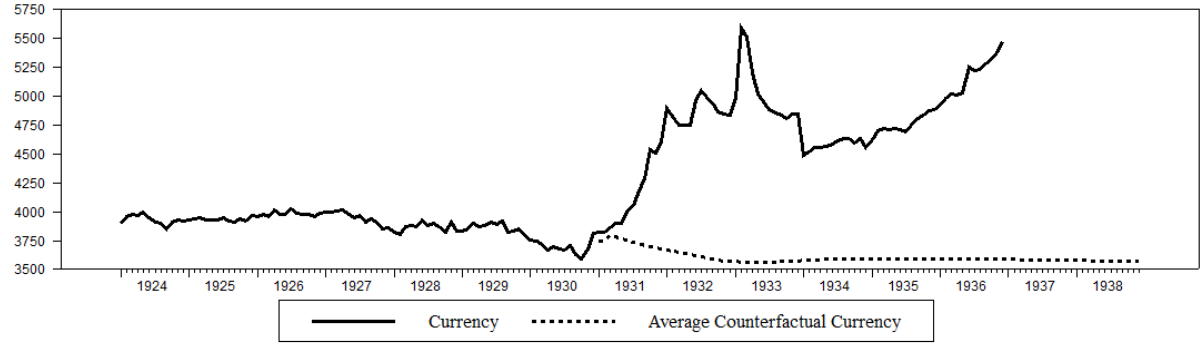


Figure 8: Actual Interest Rate and Average Counterfactual Interest Rate

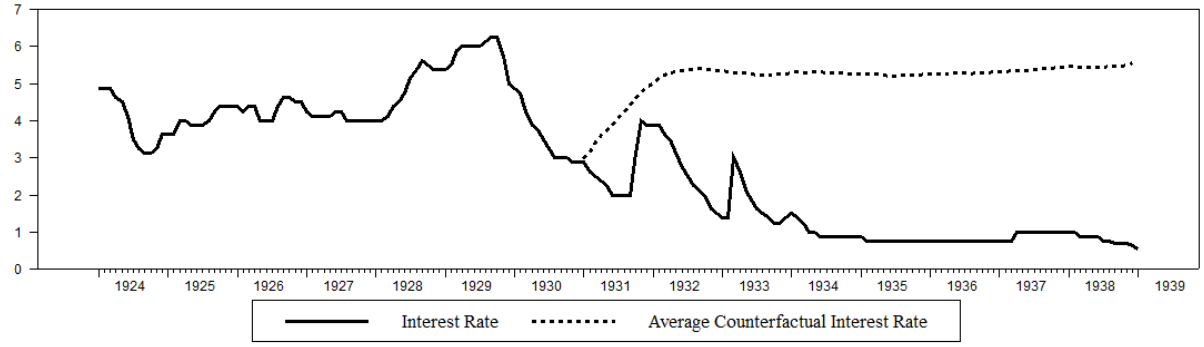


Figure 9: Actual Gold Ratio and Average Counterfactual Gold Ratio

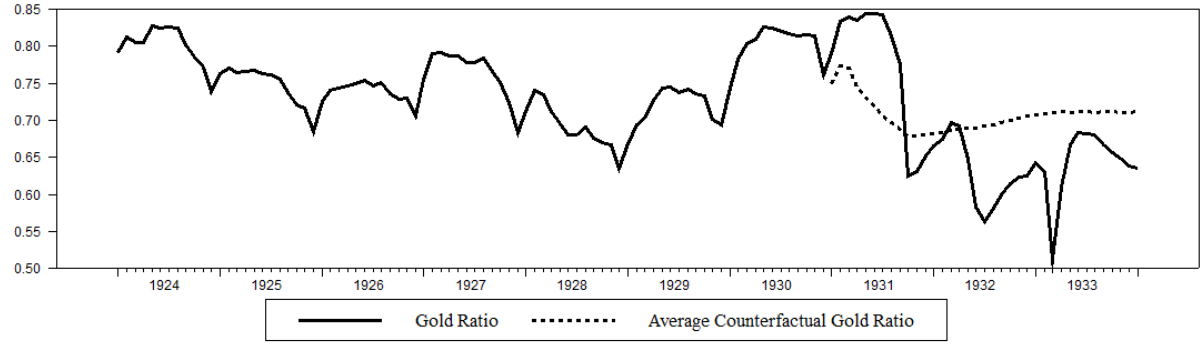
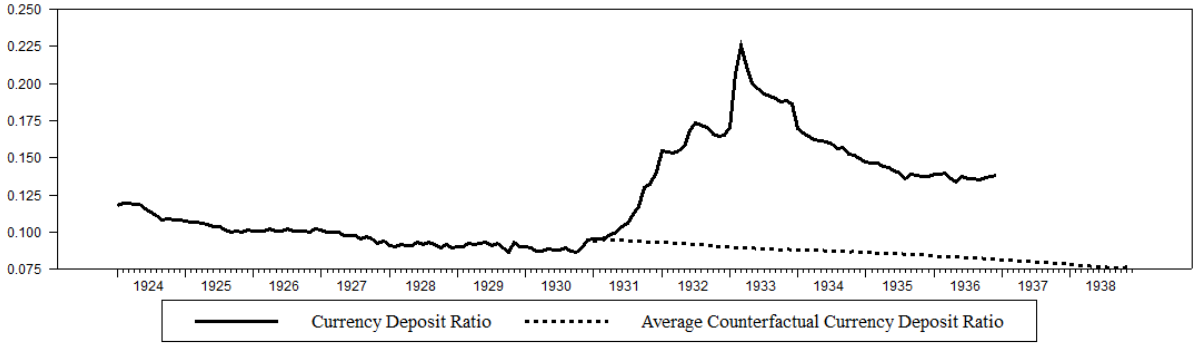


Figure 10: Currency Deposit Ratio and Average Counterfactual Currency Deposit Ratio



Appendix 3D: Base Model with M2 Last in Ordering

Minimum cover ratio: .55

Leeper-Zha statistics: 12.4 percent in excess of 2.0

Chow tests for structural shift: same as base model

Figure 1: Price Level, Target Price Level, and Target Band

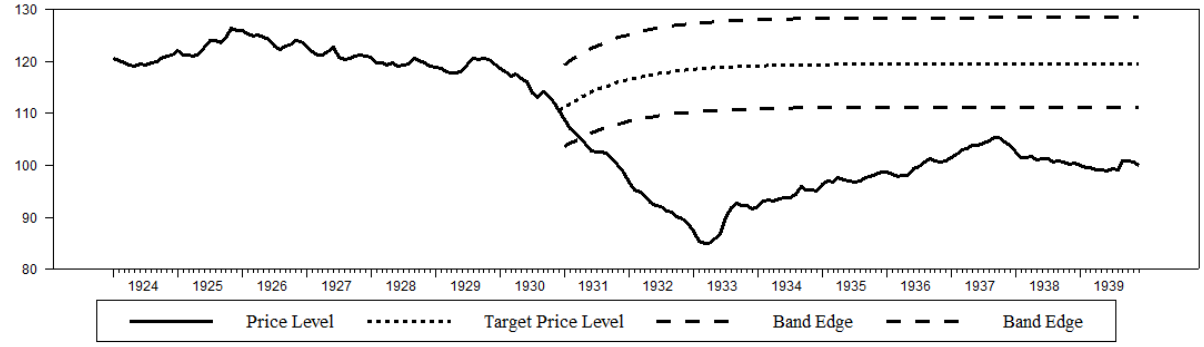


Figure 3: Price Level, Average Counterfactual Price Level, and Target Band

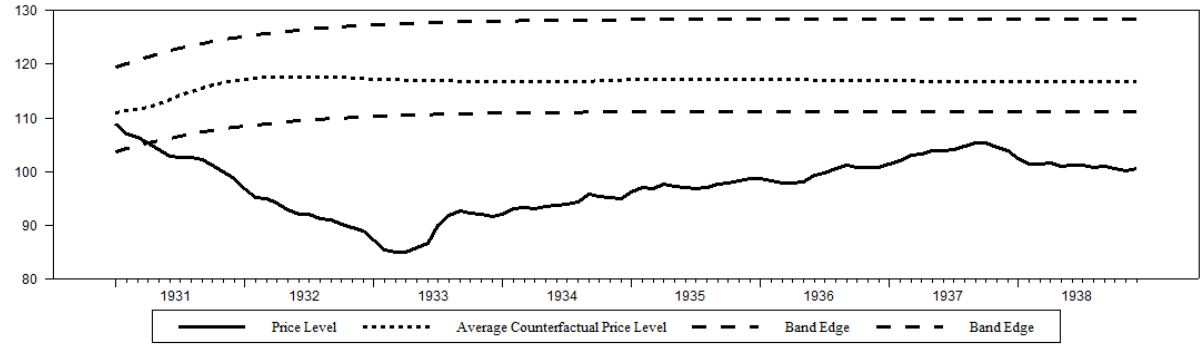


Figure 4: Example Counterfactual Trials: Price Level; Trial Path and Target Bands

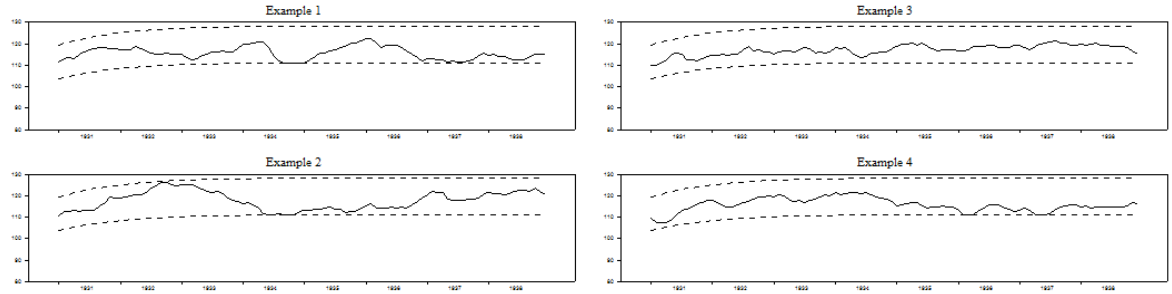


Figure 5: Actual Output, Average Counterfactual Output, and Confidence Bands

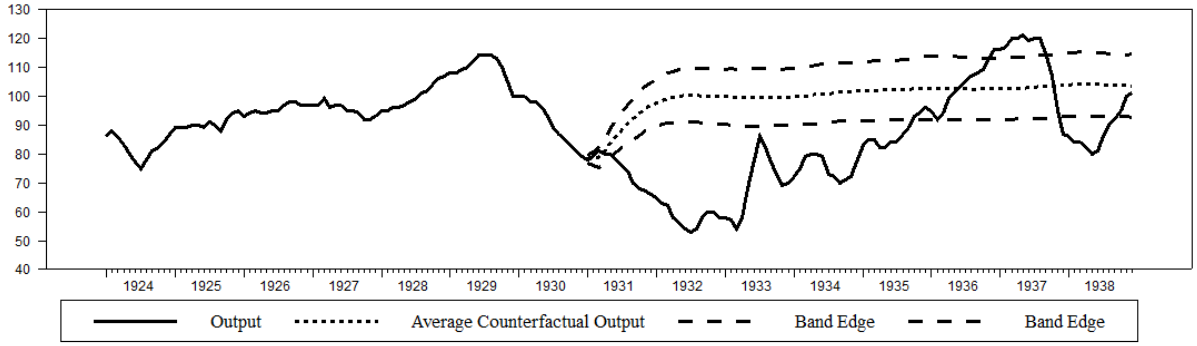


Figure 6: Actual M2 and Average Counterfactual M2

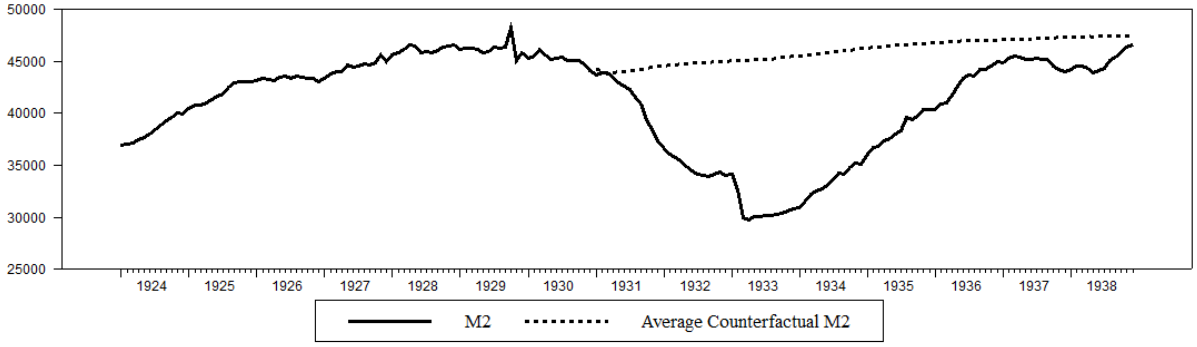


Figure 7: Actual Currency Holdings and Average Counterfactual Holdings

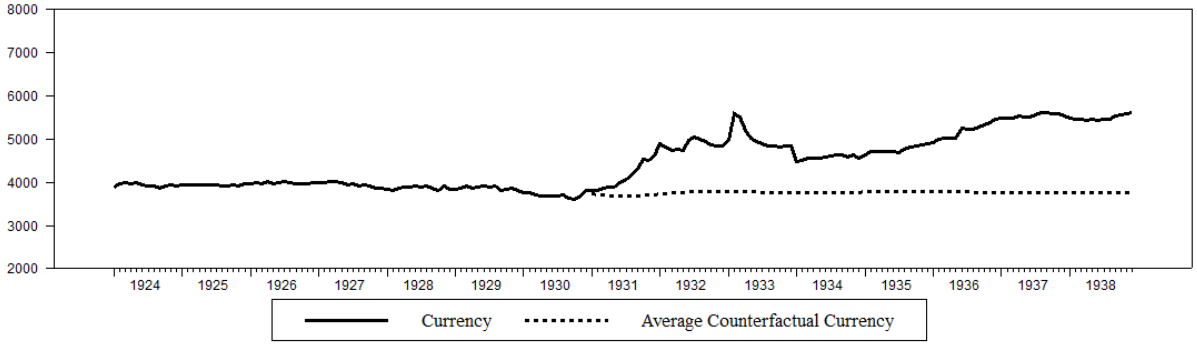


Figure 8: Actual Interest Rate and Average Counterfactual Interest Rate

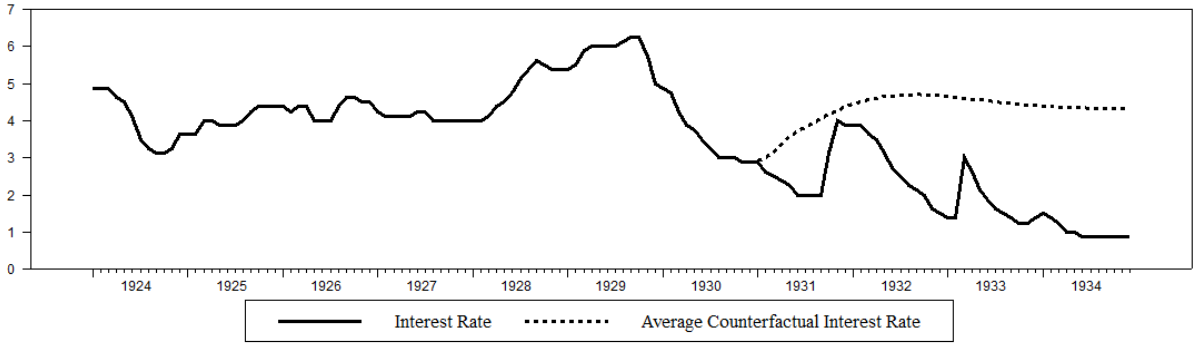


Figure 9: Actual Gold Ratio and Average Counterfactual Gold Ratio

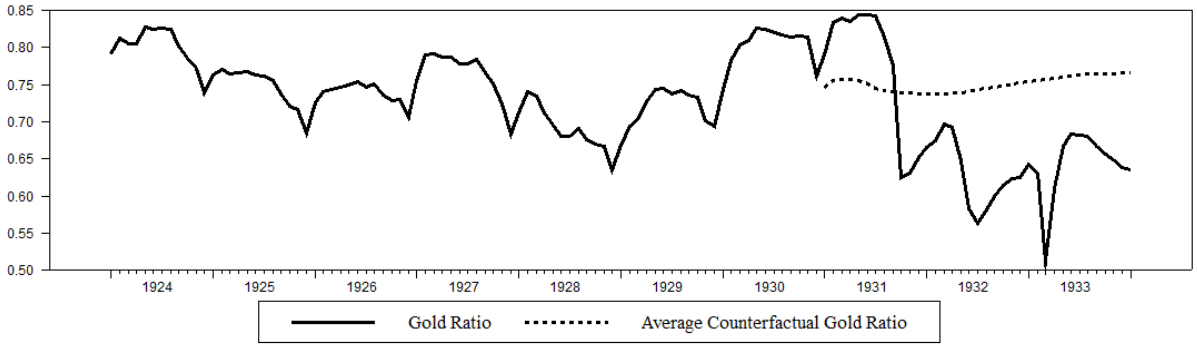
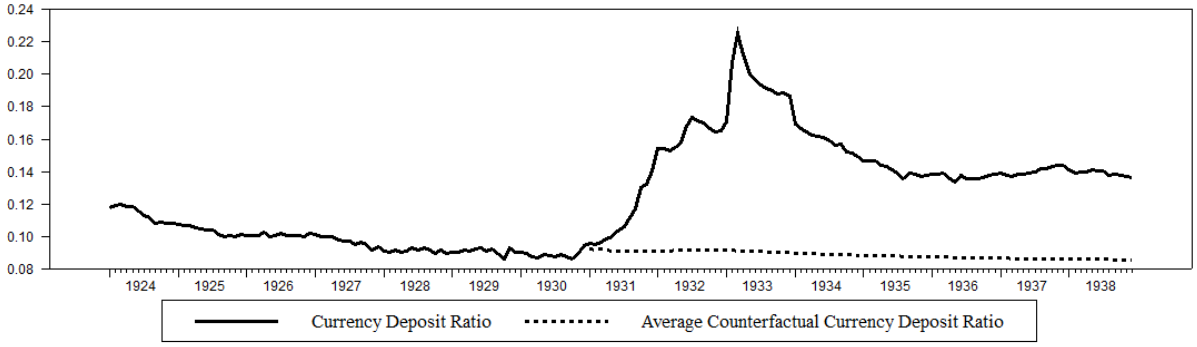


Figure 10: Currency Deposit Ratio and Average Counterfactual Currency Deposit Ratio



Appendix 3E: Model with Monetary Base Substituted for M2

Minimum cover ratio: .01; percentage of months where the cover ratio was violated was 0.41 percent; percentage where the cover ratio was < .50 was 0.69 percent.

Leeper-Zha statistics: 19.7 percent in excess of 2.0

Chow tests for structural shift: Commodity prices break in 1930:8; industrial production in 1930:7; currency in 1930:12; monetary base in 1930:12; and interest rate in 1930:3.

Figure 1: Price Level, Target Price Level, and Target Band

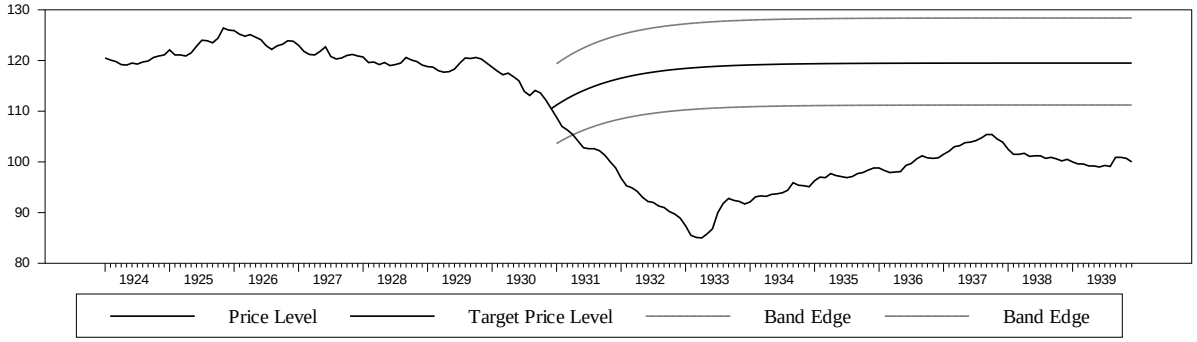


Figure 3: Price Level, Average Counterfactual Price Level, and Target Band

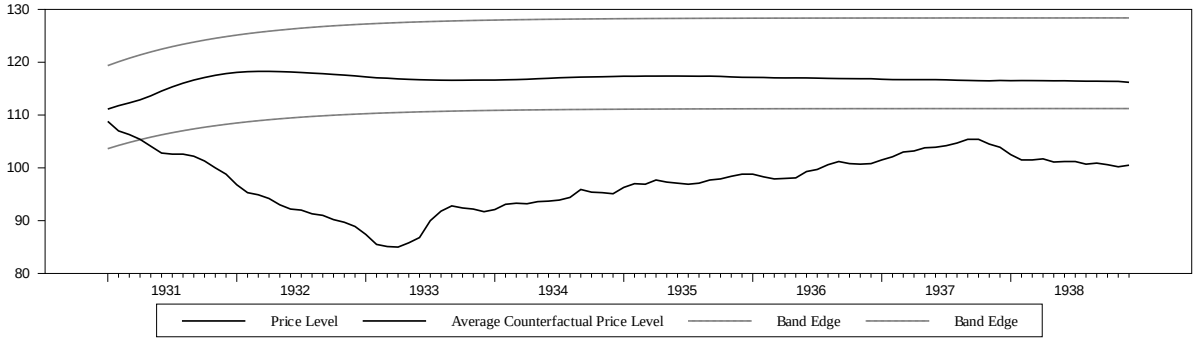


Figure 4: Example Counterfactual Trials: Price Level

Trial Path and Target Bands

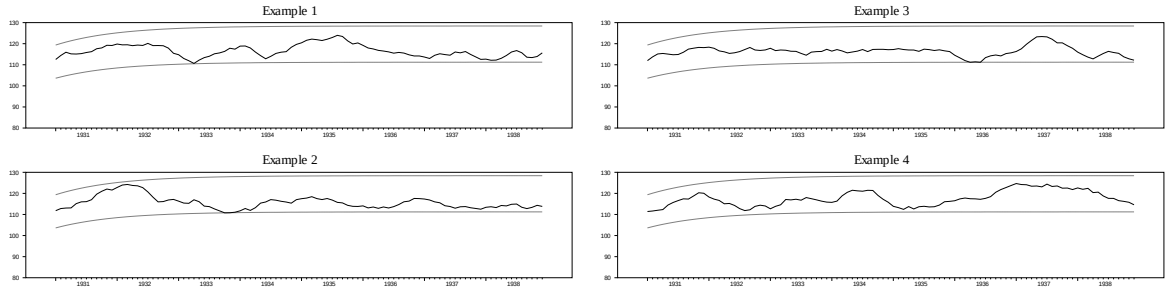


FIGURE 5: Actual Output, Average Counterfactual Output, and Confidence Bands

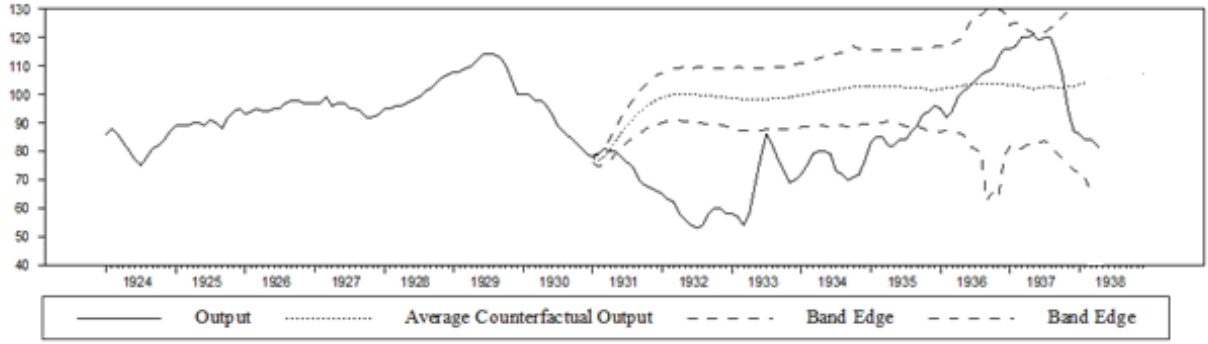


FIGURE 6: Actual M2 and Average Counterfactual M2

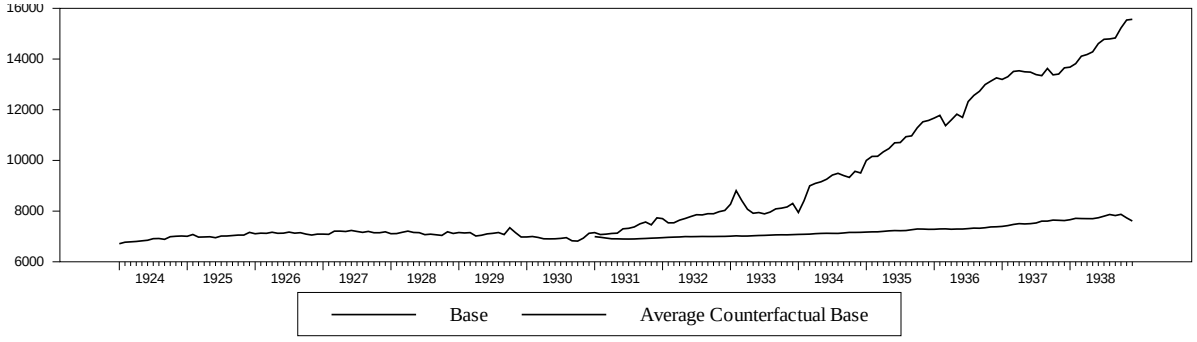


Figure 7: Actual Currency Holdings and Average Counterfactual Holdings

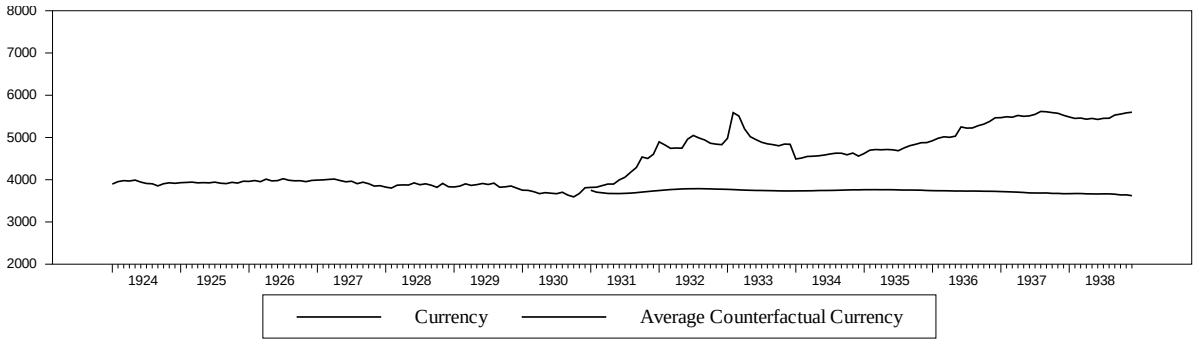


Figure 8: Actual Interest Rate and Average Counterfactual Interest Rate

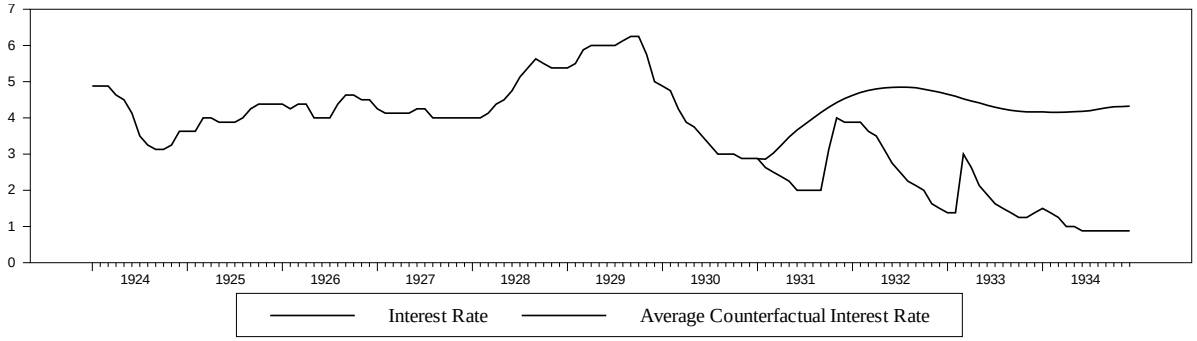


Figure 9: Actual Gold Ratio and Average Counterfactual Gold Ratio

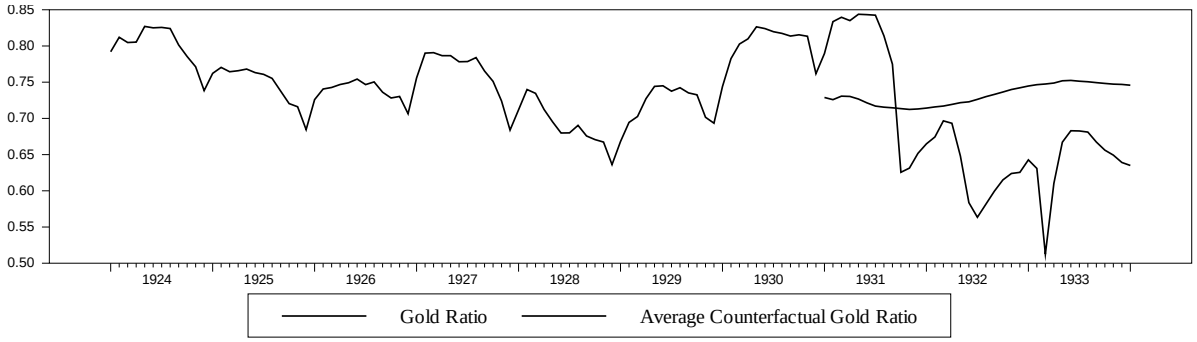
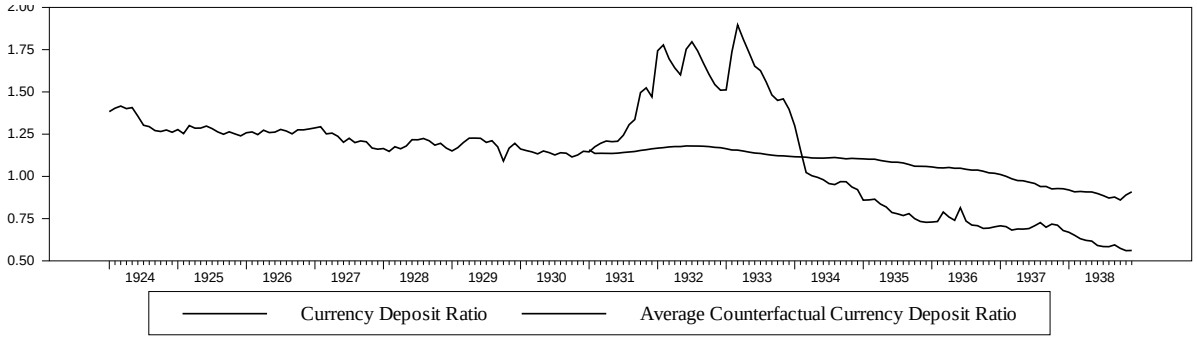


Figure 10: Currency Deposit Ratio and Average Counterfactual Currency Deposit Ratio


2.00
1.75
1.50
1.25
1.00
0.75
0.50
1924
1925
1926
1927
1928
1929
1930
1931
1932
1933
1934
1935
1936
1937
1938
Currency Deposit Ratio
Average Counterfactual Currency Deposit Ratio