Great Expectations and the End of the Depression

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— First Draft —

Abstract

This paper argues that the recovery from the Great Depression was driven by a shift in expectations. This shift was caused by President Franklin Delano Roosevelt's (FDR) policy actions. On the monetary policy side, FDR abolished the gold standard and – even more importantly – announced an explicit policy objective of inflating the price level to pre-depression levels. On the fiscal policy side, FDR expanded government real and deficit spending which made his policy objective *credible*. The economic consequences of FDR are evaluated in a dynamic stochastic general equilibrium model assuming sticky prices and rational expectations.

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If we cannot do this [reflation] one way we will do it another. Do it, we will.

President Franklin Delano Roosevelt, October 22th, 1933[1]

1 Introduction

What ended the Great Depression in the United States? This paper argues that the recovery was driven by a shift in expectations. This shift was triggered by President Franklin Delano Roosevelt (FDR) policy choices. On the monetary policy side, FDR abolished the gold standard and – even more importantly – announced an explicit policy objective of inflating the price level to pre-depression levels. On the fiscal policy side, FDR expanded government real and deficit spending which made his policy objective *credible*. The key to the recovery was the successful management of expectations about *future policy*.

Franklin Delano Roosevelt was elected President in the fall of 1932 and inaugurated in March 1933. This was at the height of the Great Depression, when the short-term nominal interest rate was close to zero and deflation ran at double digits (output contracted by 13.4 percent in 1932 and CPI by 10.4 percent). FDR immediately implemented several radical policies which included an aggressive fiscal expansion and a change in monetary policy. These policy changes violated three policy dogmas of the time (i) the gold standard, (ii) a balanced budget, and (iii) that real government spending should not be used to increase demand. I interpret this as a *policy regime change*, as defined by Sargent (1983), which implied a coordination of monetary and fiscal policy to increase demand. Coordinated monetary and fiscal policy ended the Great Depression by engineering a shift in expectations from being "contractionary", i.e. the private sector expected future economic contraction and deflation, to being "expansionary", i.e. the public expected future economic expansion and inflation. The channel is that the expectation of higher future inflation lowered the real rate of interest, thus stimulating demand, while the expectation of higher future income stimulated demand through the permanent income hypothesis.

It is hard to overstate how radical the regime change was. "This is the end of Western civilization," declared Lewis Douglas, Director of the Budget, for example.[2] During FDR's first year in office several senior government officials resigned in protest. Interestingly the end of the gold standard and the fiscal expansion were largely unexpected. Both policy measures violated the Democratic presidential platform. Their effect, therefore, should not be found in the data until FDR took office and announced the details of the "New Deal".

The FDR regime shift is clearly evident in the data. When FDR was inaugurated in March 1933 excessive deflation turned into modest inflation. There was little change in the trend growth of the monetary base around this turning point. Money growth did not start on a sustained upward trend until several months after prices started to rise. Similarly, the fiscal expansion happened with a substantial lag. Both

[1] See Roosevelt (1933c).

[2] Cited in Davis (1986), p. 107.

evidence suggest that the recovery was driven almost exclusively by expectations about future policy. The comparison between FDR's first term in office (1933-37) and President Herbert Hoover's last (1929-33) is striking. Hoover's last term resulted in 26 percent deflation, while FDR's first registered 13 percent inflation. Similarly output declined by 30 percent from 1929-1933. This was the worst depression in US history. In contrast, 1933-1937 registered the strongest output growth (39 percent) of any four year period in the US history outside of war.[3] The historical evidence is discussed in more detail in the next section.

I evaluate the economic consequences of FDR in a dynamic stochastic general equilibrium (DSGE) model assuming rational expectation and sticky prices. The Great Depression is due to structural shocks that make the natural rate of interest – the real interest rate that would clear the market – temporarily negative. If these shocks are coupled with a policy regime which I call the Hoover regime the model predicts an output collapse and deflation of the same order as the Great Depression. The Hoover regime leads to this disastrous outcome because it entails (i) the central bank aims for price stability and (ii) the treasury balances the budget (balanced budget dogma) and refuses to stimulate spending by a government expansion (real spending dogma). The Gold Standard – another notable dogma that Hoover subscribed to – is not needed to explain the Great Depression, although taking it into account can explain an even larger contraction in the model.[4] The reason for the collapse is that the central bank cannot lower interest rates enough to accommodate deflationary shocks, due to the zero bound on interest rates, and is unable to change expectations about future policy. This creates a strong deflation bias. The deflation bias helps explain the severity of the Great Depression because real interest rates were excessively high in 1929-33 due to double digit deflation. This chocked spending, especially investment. "Money was king" during this period – no-one was interested in investing when the returns of stuffing money under one's mattress were 10-15 percent in real terms. People gained more, in other words, from holding money than spending it.

The short-term nominal interest rate was close to zero during the Great Depression. The yield on three month Treasuries, for example, was only 0.05 percent in January 1933. Further interest rate reductions were clearly not feasible. Open market operations, in themselves, had no effect, since money and government bonds were perfect substitutes. This explains why several observers at the time were skeptical of the effectiveness of monetary policy and believed that open market operations were just like "pushing on a string". Despite this, however, monetary policy was far from powerless. While increasing the money supply at zero interest rate has no effect, expectations about higher future money supply (once deflationary pressures have subsided and interest rates are positive again) have large effects because they change people's expectations about the future price level, thus reducing real interest rates. What was needed to end the Depression was a regime shift that changed expectations about future policy in a credible way. This is precisely what FDR achieved.

[3] See e.g. Friedman and Schwarts (1963) that present data dating back to 1869.

[4] This is a major strength of the model because many authors, such as Hsieh and Romer (2001) and Bordo, Choudhri and Schwartz (2000), have argued that the Gold Standard did not impose serious constraints on policy in 1930-33. The model is not subject to this criticism, while it indicates that the gold standard may have made the outcome even worse.

The FDR policy regime, in contrast to the Hoover regime, implied a sustained increase in both the monetary base and government spending. The permanent increase in the monetary base was made credible by an aggressive fiscal expansion. This expansion was publicly announced as a major shift in policy in a campaign of public propaganda – the "New Deal" – so that it was well understood by the public and expected to endure until the economy would recover. Government spending on goods and services increased by 65 percent in FDR's first full year in office relative to Hoover's last year in office. This counteracted the deflationary shocks directly through higher spending. The spending spree was not financed by tax increases but through deficit spending (which is the difference between government spending on goods and services and tax revenues). The deficit spending during FDR's first year in office was 14 percent of GDP, the highest in US history outside of war. This made a permanent increase in the money supply credible because it was a crucial strategy to finance the government's debt payments, thus firming up inflation expectations. Both real and deficit government spending were crucial to changing expectations from being deflationary to inflationary, which was key to the recovery. While the excessive deflation in 1929-1933 implied very high real interest rates that strangled the economy, the modest inflation in 1933-1937 made real interest rates negative. This was a major boost to spending.

A policy regime is defined by a policy objective and a set of constraints that limits the government's ability to achieve it. I assume that both President Hoover and FDR maximized social welfare. The only difference between their regimes is that Hoover was constrained by the policy dogmas outlined above. I assume that neither president was able to commit to *future* policy (because, for example, that policy in the future might be set by a new president and a different congress) apart from through the issuance of government debt. The FDR *regime change* is defined as the elimination of the policy dogmas that constrained Hoover's actions. This paper differs from many other theoretical papers on the zero bound, such as Eggertsson and Woodford (2003,2005)), by modeling policy regime changes.[5] Furthermore, because I assume no commitment, I analyze a Markov Perfect Equilibrium (MPE), while Eggertsson and Woodford (2003,5) study optimal policy under commitment. The assumption of MPE is important because it implies that the policy regime change is *credible*.[6]

Friedman and Schwartz indicate that the recovery from 1933-1937 was driven by money supply increases. Nominal interest rates, however, were close to zero during this period. As shown by Eggertsson and Woodford (2003) this implies that the evolution of the monetary base was irrelevant. Nevertheless Eggertsson and Woodford (2003) and this paper indicate that *expectations* about future monetary aggregates mattered a great deal. In this sense the main point of Friedman and Schwartz is confirmed in this paper: Appropriate monetary policy was essential to end the Great Depression. Consistent with the theme of this paper Temin and Wigmore (1990) also argue that FDR's presidency signalled a regime shift that changed expectations about future policy. While their analysis is narrative, however, I use a general

[5] For other work on the zero bound see e.g. Auerbach and Obstfeld (2005) and Svensson (2004) for a survey of the literature.
[6] Eggertsson (2005) and Jeanne and Svensson (2005) also study optimal policy without commitment.

equilibrium model to evaluate this hypothesis. Romer (1992) also emphasizes that positive demand shocks (through monetary policy in her case) ended the Great Depression. Some of my results regarding the importance of expectations are anticipated in an insightful discussion by Romer (1992), who, while not explicitly modelling them, discusses their importance.

There are several papers that study the Great Depression in DSGE models.[7] The current paper shares many elements with these papers with the main difference that I focus on the regime shift associated with FDR's rise to the presidency and its implication on output and prices. While many of these papers recognize the importance of expectations they do not model why and how they changed in 1933 with FDR's election. The strong emphasis on expectations is complementary to a recent study by Harrison and Weder (2005) who argue that the dynamics of the Great Depression were driven by fluctuations in expectations. The key difference between that study and the current paper is that I model shifts in expectations endogenously as being due to policy shifts, while Harrison and Weder assume that they are due to exogenous nonfundamental sunspot shocks.

A surprisingly large part of the literature on the Great Depression treats the recovery from the Great Depression as inevitable and unrelated to, or even in spite of, FDR's inauguration. Cole and Ohanian (2005), for example, take the recovery as a given and focus on inefficencies created by FDR's "New Deal". Another example is Kindelberger (1986) who states that "the fact that gross investment has a limit of zero is useful in explaining that the depression had to end .... At some point gross investment turns up again and the accelerator principle comes back into its own." The problem with Kindelberger's hypothesis is that it has little predictive power. Why did the recovery happen exactly in the months after FDR took power? Another explanation for the recovery is that by abandoning the gold standard FDR devalued the US dollar relative to other currencies. This encouraged exports and stimulated demand for domestic products relative to foreign ones. The expansion in 1933, however, cannot be attributed to an increase in net export. Sumners (1997), for example, documents (citing New York Times in October 1933) that exports increased by only 3 percent in the first five months after the devaluation, whereas imports soared by 20 percent, suggesting that rising domestic aggregate demand, not improved terms of trade, was the key to the recovery. Furthermore exports, as a fraction of GNP, remained less than three percent during this period so they could hardly be expected to be responsible for the robust recovery.

Cole and Ohanian (2005) argue that the recovery from 1933 to 1939 was excessively slow. They explain this by monopoly and cartelization regulations introduced by the New Deal. In the next section I argue that slowness of the recovery is to a large extent explained by a short but severe recession in 1937-38. As argued by Friedman and Schwartz (1963), and discussed in better detail in the next section, this recession is most plausibly explained by monetary policy mistakes which are not taken into account by Cole and Ohanian.[8] While Ohanian and Cole's conclusion is different in tenor than mine the two are not inconsistent.

[7] There are numerous examples, see e.g. Bordo, Erceg and Evans (2000) and Christiano, Motto and Rostagno (2003).

[8] Footnote 1 of Cole and Ohanian's paper claims that monetary policy during 1933-39 was accommodative based on that "the monetary base increases more than 100 percent between 1933 and 1939". This ignores the role of monetary policy in

Their model shows that some aspects of the New Deal lowered the natural level of output. This paper, in contrast, shows that other aspects of the New Deal, i.e. monetary and fiscal policy, eliminated the output gap, which is the difference between actual output and the natural level. While FDR's New Deal ended the Great Depression by closing the output gap, it may have reduced the natural level of output in the process.[9]

2 The Great Depression in the US and Franklin Delano Roosevelt: A brief historical narrative

According to the theory suggested in this paper both nominal and real variables should have taken an abrupt turn in March 1933 when FDR was inaugurated. On the nominal side, figure 2 shows that prices measured by CPI rebounded around March 1933 after a long and persistent decline in previous years. Figure 4 shows the time series for a few leading commodity prices, but the reflation of commodity prices were of primary concern to the FDR administration. Furthermore these prices were determined on spot markets and should thus be expected to react more strongly than CPI to expectations about future policy. Consistent with this commodity prices rebounded even more strongly than CPI. The price of wheat, for example, nearly doubled in the remaining months of 1933. On the real side figure 1 shows the remarkable turnaround in GNP in 1933. The recovery was led by a rebound in investment. Investment nearly doubled in 1933 with the turnaround in March that year. Figure 3 (from Temin and Wigmore (1990)) shows investment in a one year window around FDR's inauguration.

The hypothesis of the paper is that the recovery was triggered by a shift in expectations about prices and output. While there is no direct data on expectations the available estimates confirm that there was an abrupt change in expectations in 1933. Using very different estimation methods Hamilton (1992), who uses commodity price futures data, and Cecchetti (1992), who uses interest rate and CPI data, find a large change in expectations about future inflation in the spring of 1933, a conclusion that is not surprising given the large movements in the price level in figures 2 and 4.[10] Expectation about future output also appears to have rebounded in the spring of 1933. One evidence is the stockmarket. The stockmarket increased by over 66 percent during FDR's first 100 days with a turning point in March 1933. Figure 5 shows the evolution of the stockmarket in a one year window around FDR's inauguration. To the extent that the

the depression of 1937-38 emphasized by Friedman and Schwartz (1963) and discussed in the next section.

[9] The effect of the New Deal is ambiguous on the natural rate of output. While the introduction of monopoly and cartelization regulations tended to reduce the natural rate of output the increase in government consumption increased it.

[10] Hamilton (1992) devides each year into trimesters and finds that expectations changed from -6 percent to +6 percent in the second trimester of 1933 (see table 7 in his paper. Note that in the paper inflation expectations for 1933:3 are formed in the trimester 1933:2). Cecchetti (1992) finds that inflation expectations starts improving around FDR election in the fall of 1932 (see figure 5 in his paper) when they are in negative double digits and that they peak around FDR inauguration at close to 10 percent. The model presented in the next section indicates that the effect on some other variables that are sometime used to infer inflation expectations, such as long-term interest rate, is ambigious in the model. The reason for this is that the optimal commitment is to commit to lower real interest rates in the future. This can be achieved by either keeping short-term interest rates low for a substantial period or by increasing inflation expectations (with possibly higher short-term nominal interest rates in the future).

stockmarket is driven by expectations about future GNP the figure indicates that FDR's inauguration resulted in a shift in expectations about future output.

Much of the previous literature, such as Friedman and Schwartz (1963), has focused on changes in the money supply as responsible for the recovery. Figure 6 shows that there was no abrupt change in the trend growth of the money supply at the time FDR assumed office. There was a temporary increase in currency in circulation in March and February 1933, due to the banking crises, but this increase was reversed the next month as the crises subsided (and was in any case mostly offset by changes in non-borrowed reserves thus leaving the money stock unchanged). As the figure shows the money stock in the fall of 1933 was still below its level from the beginning of the year (prior to the banking crisis). It was only in later years that the monetary base started a strong upward trend as can be seen in Table 1. According to this paper's hypothesis the money supply changes were unimportant in 1933 because the interest rate was close zero at that time. Expectations about the future money supply were all that mattered.

FDR made several announcements in the early months of his administration that helped shape expectations about future policy. The overriding objective of monetary policy, according to FDR, was reflation, i.e. to increase the price level, even at the expense of more traditional objectives (such as the stable price of gold which FDR declared would be "subservient" to domestic recovery). FDR's goal was to increase prices to their pre-Depression levels and wanted to achieve this in 1-3 years. He stated this objective on several occasions. One example is that at a press conference on April 19th FDR stated the "definitive objective" of raising commodity prices. This press conference was called after Congress had passed a bill (the Thomas Amendment) that gave FDR broad powers to inflate.[11] Another example is that after a joint meeting with the Prime Minister of Canada on the 1st of May of 1933 Roosevelt said in the *Wall Street Journal*:

> We are agreed in that our primary need is to insure an increase in the general level of commodity prices. To this end simultaneous actions must be taken both in the economic and the monetary fields.

FDR reiterated this in a radio address to the nation in one of his "fireside chats" on May 7th.[12] By late spring there could be no doubt in the minds of market participants that the administration was aiming to inflate.

Roosevelt did more than simply announce his desire to raise prices. He also took direct *actions* to achieve it, actions that can be interpreted as having made the policy objective of reflation *credible*. Table 1

[11] See FDR (1933a). In his press conference on April 19th FDR stated: "Here is a team that has a perfectly definite objective, which is to make a touchdown, so far as commodity prices go. The basis of the whole thing really comes down to commodity prices. And, this is entirely off the record, the general thought is that we have got to bring commodity prices back to a recent level, but not to the 1929 level except in certain instances. You take, for instance, city real estate in 1929. It was then altogether too high, and you ought not to bring city real estate back to the 1929 level. That is obvious. On the other hand, farm commodity prices were comparatively low in 1929 and have been going down since rather steadily for five or six years. So that it has got to be a definitely controlled inflation, because the man on the street does not understand it any more than the average banker understands it. It has got to be a controlled price level."

[12] See FDR (1933a) "Radio Address of the President May 7".

shows several policy measures that made an increase in the price level credible (this point will be formalized in the model that I present in coming sections). Apart from the elimination of the gold standard the most important was an aggressive fiscal expansion.

As revealed in Table 1 government spending on goods and services was 65% percent higher (in nominal terms) in 1934, FDR's first full year in office, than in 1932, Hoover's last full year in office. As a fraction of GNP government spending was 12% in 1934 relative to 8% in 1932. By historical standards this was a very large increase. Government spending in 1932 was already exceptional. At the onset of the Great Depression government spending was only 3% of GNP. The new spending was not financed by tax increases. Instead FDR ran significant budget deficits.

I define deficit spending as the increase in the government's nominal liabilities in a given year. Hence deficits are the difference between the government's revenues and spending. They can be financed by either printing money or government bonds. As a fraction of GNP, deficit spending was 14 percent in 1934. In nominal terms it was five times the size of the deficit in 1931 and three times the size of the deficit in 1932. But even this masks the policy regime shift indicated by these numbers. The deficits in 1931 and 1932 were almost entirely due to the output collapse and the inability of the Treasury to predict the fall in revenue due to the Depression, and despite Presidents Hoover efforts to balance the budget by large tax rate *increases*[13]. FDR's deficits, in contrast, were deliberate. The deficits may have been more important than the real government spending side because they made the permanent monetary expansion (made possible by the elimination of the gold standard) *credible* – thus raising inflation expectations of the public. Or rather: they made FDR's announcement of higher future prices credible. FDR actions thus satisfied Sargent's (1983) criteria for a regime change:

> There must be and abrupt change in the continuing government policy, or strategy, for setting deficits now and in the future that is sufficiently binding to be believed.

It is quite likely that it was the deficit side of fiscal policy which was mainly responsible for firming up inflation expectations, since it was well understood at the time that deficit financing could lead to future inflation. In fact the belief that deficits caused inflation was one of the foundations of the "balanced budget dogma" of the time. This is evident in the writings of many commentators at the time, especially in the conservative press, that were worried that FDR's deficit spending would in fact be *too inflationary.*[14] As proof, many "sound money men" pointed towards the deficits of several European countries after WWI and the resulting hyperinflation.[15]

[13] Hoover successfully sponsored a massive tax increase in late 1931 to recoup the decline in federal tax revenues. The maximum personal income tax rate rose from 25 to 63 percent. Corporate income taxes rose, estate taxes were doubled and gift taxes reintroduced. See Temin and Wigmore (1990).

[14] See e.g. and opinion piece in the Wall Street Journal on the 2cond of November 1933, p. 6 under the heading "Unconvincing Reassurance". See also Davis (1986) p. 107 who writes that Lewis Douglas, the Director of the Budget, "scoffed at the notion that there could ever be a "mild" or "controlled" inflation; public knowledge that greenback issuance was an available executive option would of itself alone set off wild inflation, leading to "complete chaos"."

[15] See e.g. Davis (1986) p. 107.

The increases in government consumption was mostly responsible for the increase in deficits, as shown in Table 1. The deficits were also increased by the inflow of gold which the administration stood ready to buy at a set price. Since the gold purchases increased the deficit, they too were essential to making the reflation credible. [16] Finally a substantial part of the deficit was due to new programs that started under the New Deal and led to a substantial increase in nominal claims on the government. Many of these programs were not included in the regular budget. The breakdown of the deficit is reported in Table 1.[17]

The hypothesis of this paper is that the FDR regime change shifted expectations from being deflationary to being inflationary. This, in turn, reduced the real rate of interest and stimulated demand. Figure 7 shows some suggestive evidence that is consistent with this story. The real rate of interest – measured as the difference between the yield on 3 month US Treasury notes and certificates minus actual inflation 3 months ahead – declined substantially with the policy regime change. If this decline was responsible for the recovery, as predicted by the model in this paper, the expansion should be evident in the most interest rate sensitive components of demand, such as investment, as indicated by figure 3. Romer (1992) gives further evidence on this by showing that fixed investment and consumption durables also responded strongly to movements in real interest rates during this period.

While GNP growth in 1933-37 was the strongest in US history outside of war there is a common conception that the recovery from the Great Depression was slow. Partially this is explained by that the economy was recovering from an extremely low level of output. Figure 1 shows a trend line of 3.15 growth per year from 1927 estimated by Romer (1992). The trend indicates that the US economy did not fully recover until 1942. Another useful observation is that there was a short but severe recession in 1937-38, which resulted in a slowdown in growth in 1937 and an output contraction of 5 percent in 1938. If not for this contraction the economy could have fully recovered as early as 1938. In this case a full recovery from the worst depression in US history, which reduced output by a third, left a quarter of the population unemployed, and devastated the capital stock, would have taken only 5 years. Explaining the slow recovery, therefore, is to explain the depression in 1937-38.

The most convincing explanation for the depression in 1937-38 is given by Friedman and Schwartz (1963). They argue that the Federal Reserve's increase in reserve requirement of commercial banks in May

[16] This price of gold was changed througout 1933 but was fixed in 1934 (see Sumner (2004)). The administration bought the gold by issuing nominal liabilities. On the government balance sheet these purchases mainly showed up as non-borrowed reserves held by commercial banks at the Federal Reserve. Since the nominal interest rate was zero during this period, there was no meaningful difference between base money (defined as non-borrowed reserves plus currency in circulation) and short-term government debt. Both were nominal liabilities to private entities that carried zero interest. This means that the "gold program" pursued by FDR was important to make future inflation credible because it increased the inflation incentive of the government, a conclusion that is at variance with a common verdict of FDR gold purchases. The same point is made in Sumner (2004) who states that "the gold-buying program has been unfairly maligned by both contemporaneous critics and modern historians." See Eggertsson (2002) for a formal analysis of the effect of buying real asset on the inflation incentive of the government.

[17] Note that some of the off-budget items that increased nominal libilities resulted in corresponding increases in nominal assets of the government (such as loans to companies in distress). To the extent that these liabilities were nominal, and depending on their maturity and risk structure, they created a different inflation incentive than regular government debt on the one hand or gold purchases on the other. It is beyond the scope of this paper to calculate the exact impact of each budget item on the inflation incentive of the government but it is an important challenge for future research.

1937 was responsible for the contraction. Following this the economy went into tailspins of deflation and output losses. This explanation is often criticized on the grounds that banks were already holding large excess reserves so that imposing these requirement did not have any real effects (interest rates rose only modestly in response)[18]. The model of this paper, however, supports Friedman and Schwartz's hypothesis and to some extent strengthens it by taking the expectation channel into account. The increase had such a disastrous effect because it changed expectations from being inflationary to being deflationary.[19] It was the expectation that the Federal Reserve would stand ready to stamp down any further inflation that caused the collapse in 1937-38 rather than the new reserve requirement itself. Interestingly the disastrous effect of this policy had already been predicted by market participants as early as 1935. S. Parker Gilbert, a partner in J.P Morgan & Company, warned the Federal Reserve in the *New York Times* in December 1935 that an increase in reserve requirements would strangle the recovery because it would be *interpreted* as if the Federal Reserve had reversed its inflationary policies.[20] The recovery did not resume until 1938 when FDR forced the Federal Reserve to reverse its policy and the Treasury simultaneously embarked on further fiscal expansion. The growth rate in 1938-42 was even higher than in 1933-1937.

3 The Economic Environment

To model the FDR regime change I utilize a standard New Keynesian model, as e.g. in Clarida, Gali and Gertler (1999) and Woodford's (2003), with some small variations. I present the model here, to economize on space and notation, in linearized form, where I have approximated the equilibrium conditions around a deterministic steady state. I prove the existence of this steady state in the Technical Appendix. The fully non-linear model is presented in the Technical Appendix where all the results are confirmed in the non-linear model.

The equation that determines the relationship between aggregate demand and the interest rate is derived from the consumption Euler equations of households often referred to as the IS equation. This equation relates current demand to future demand and the discrepancy between the nominal interest rate and the natural rate of interest

$$\hat{Y}_t - \hat{Y}_t^n = E_t(\hat{Y}_{t+1} - \hat{Y}_{t+1}^n) - \tilde{\sigma}(\hat{\imath}_t - E_t\pi_{t+1} - \hat{r}_t^n) \tag{1}$$

where $\tilde{\sigma} > 0$, π_t is inflation, E_t an expectation operator and $\hat{\imath}_t$ is the short term nominal interest rate. The

[18] See e.g. Eccles (1951) who makes this argument.

[19] The impression that the government was reverting back to a "Hoover regime" was reinforced by fiscal policy, thus fuelling deflationary expectations. In 1936 there was a large bonus paid to veterans of WWI. In 1937 there was not only no payment of this kind, but social security taxes were also collected for the first time.

[20] Gilbert wrote: "There is also a general consideration bearing on the whole problem of recovery, namely that any restrictive measures which were to be taken at this stage by the Federal Reserve authorities, whether by raising reserve requirements or by letting government securities run off, *might be construed* a reversal of the cheap money policy which has been pursued since the day of the bank holiday. This monetary policy, it may even be said, is an essential of recovery and in recent months it has really begun to work." (cited in Eccles (1951)). In a news analysis of the debate the *New York Times* (December 22, 1935) reported on the opponents of reserve requirement: "Their main point was that with recovery in its early stage the psychological effect of credit restriction might be to shock buiness confidence and start a new period of deflation."

hat denotes percentage deviation from the deterministic steady state. The term $\hat{Y}_t$ is aggregate output and $\hat{Y}_t^n$ is the natural rate of output which is the output that would be produced if prices were flexible (or alternatively the production level that would clear the market). The natural rate of output is

$$\hat{Y}_t^n = \tilde{Y}_t^n + \frac{\tilde{\sigma}^{-1}}{\tilde{\sigma}^{-1} + \omega}\hat{F}_t \tag{2}$$

where $\omega > 0$. The term $\tilde{Y}_t^n$ is an exogenous disturbance term. The effect of real government spending, $\hat{F}_t$, on the natural rate of output is well known from the RBC literature (see e.g. Baxter and King (1992)). An increase in government spending decreases consumption for a given production level. This, in turn, increases the marginal utility of consumption, thus increasing labor supply, lowering real wages and increasing production. Since $\hat{Y}_t^n$ denotes output under flexible prices, it maps directly into output analyzed in the RBC literature (which assumes flexible prices) which is the advantage of this notation. The term $\hat{r}_t^n$ is the natural rate of interest, i.e. it is the real interest rate that would be consistent with market clearing if prices were flexible. It can be expressed as

$$\hat{r}_t^n = \frac{1-\beta}{\beta} + \frac{1}{\beta}\tilde{r}_t^n + \frac{\tilde{\sigma}^{-1}\omega}{\tilde{\sigma}^{-1} + \omega}E_t(\hat{F}_t - \hat{F}_{t+1}) \tag{3}$$

where $\tilde{r}_t^n$ is an exogenous disturbance term that is only a function of preference and technology shocks. Real government spending also directly increases the natural rate of interest because government spending changes the intertemporal price of consumption in the RBC block of the model. Equation (1) relates current output gap $\hat{Y}_t - \hat{Y}_t^n$ (which can be interpreted as a demand slack if negative) to expectations of future output gap and the discrepancy between the real interest rate and the natural interest rate. Demand can thus be increased by either real interest rate reductions or expectations of higher future income.

The Euler Equation of firms gives rise to the New Keynesian Phillips curve, often referred to as the AS equation:

$$\pi_t = \kappa(\hat{Y}_t - \hat{Y}_t^n) + \beta E_t \pi_{t+1} \tag{4}$$

where $\kappa, \beta > 0$. This equation relates current inflation to the output gap (the measure of demand slack in the economy) and expected inflation. Nominal interest rate cuts increase demand by the IS equation. This increase in demand does not feed one to one to the price level because prices are sluggish. The AS equation indicates by how much demand pressures increase prices. Expectations of future inflation also have an effect on current inflation because firms are forward looking in their price setting so that expected future demand conditions also feed into their pricing decisions.

Monetary policy is the determination of money supply, M_t, which can be changed by open market operations in government bonds. It does not change the results to assume that the policy, instead, is the determination of the real monetary base, i.e. the nominal stock of money deflated by the price level,

$m_t \equiv \frac{M_t}{P_t}$.[21] While money does not enter directly into the IS and AS equations it changes the equilibrium through the nominal interest rate. The nominal interest rate, in turn, has to satisfy a money demand equilibrium condition that is derived from the household optimization problem. Money demand can be approximated by

$$\hat{m}_t \geq \eta_i \hat{\imath}_t + \eta_y \hat{Y}_t \tag{5}$$

where $\eta_i < 0$ and $\eta_y > 0$. The inequality applies with equality when the interest rate is positive. When the interest rate is zero, however, money demand is indeterminate. This is because the household is satiated in liquidity at zero interest rate so that it makes no difference whether it holds money or government bonds as an asset. Both are government nominal liabilities with zero return so that the inequality above does not need to hold with equality at zero interest rates. The assumption of no arbitrage (complete markets) implies that there is a zero bound on the short term nominal interest rate. No one would lend one dollar unless he/she gets at least 1 dollar in return! Since I express the interest rate in terms of deviation from steady state this bound can be expressed as:

$$i_t = \frac{\hat{\imath}_t}{\beta} + \frac{1-\beta}{\beta} \geq 0 \tag{6}$$

There is a detailed discussion in Eggertsson and Woodford (2003) and Eggertsson (2005) on the accuracy of a first order approximation of each of the equilibrium conditions above and the complications posed by the zero bound on the short-term interest rate.

Fiscal policy is subject to the government budget constraint. For simplicity I assume that the government can only issue one period nominal debt B_t. At the end of each period t, total government liabilities carried to the next period are then given by the sum of the stock money stock and nominal bonds, $W_{t+1} = (1+i_t)B_t + M_t$. The budget constraint in each period is then given by $B_t + M_t = W_t + P_t(F_t - T_t)$. Defining $w_t \equiv \frac{W_{t+1}}{P_t}$ as government nominal liabilities deflated by the price level (I date this variable at date t because it is determined at that date) I can write the government budget constraint as:

$$w_t = (1+i_t)\{\frac{w_{t-1}}{1+\pi_t} + F_t - T_t\} - i_t m_t \tag{7}$$

At any date t (taking the debt w_{t-1} as given) the government can pay off the real value of its debt by cutting spending, increasing taxes or engineering inflation that reduces the real value of outstanding nominal debt (although if the inflation is anticipated this will be reflected in a higher interest rate at time $t-1$ so that no gain in tax reduction will be realized in equilibrium due to this channel). The last term in equation (7) is seigniorage revenues. These revenues are increasing with the nominal interest rate and the value of the real monetary base. Rather than express the budget constraint in a linearized form, I prefer to show the fully nonlinear constraint in (7), since the non-linear interaction between inflation at time t and debt

[21] See Eggertsson (2005) for more discussion.

dated $t-1$ will be important in the paper. A key assumption in the model is that I assume that there is an output cost of taxation so that for every dollar collected in taxes some fraction $s(T_t)$ is wasted on tax collection. This gives the government an incentive to minimize taxation required to finance a given level of expenditures. Total government spending F_t is therefore the sum of $s(T_t)$ and government consumption G_t.

The welfare consequences of different policies can be evaluated by a second order expansion of the utility of the representative household (see Woodford (2003)). For initial condition of zero debt at time t, it is equal to[22]

$$U_t = -\frac{1}{2}\sum_{s=t}^{\infty}\beta^t\{\pi_s^2 + \lambda_y(\hat{Y}_s - \hat{Y}_s^n)^2 + \lambda_F(\hat{F}_s - \hat{F}_s^n)^2 + \lambda_T(\hat{T}_s - \hat{T}_s^n)^2\} \tag{8}$$

where the weights $\lambda_y, \lambda_F, \lambda_T > 0$. The derivation of this expression is shown in the Technical Appendix. Utility can can be expressed as deviation of inflation, output, government spending and taxes from their target values. The target value for inflation is zero while the other target values are time-varying. The terms $\hat{F}_t^n$ and $\hat{T}_t^n$ are both functions of exogenous shocks defined in the Technical Appendix while $\hat{Y}_t^n$ is given by (2).

4 An Output Collapse and Excessive Deflation under a Hoover policy regime

In this section I outline a policy regime, coined the Hoover regime, that helps account for the large output decline observed during the Great Depression. I first present the policy regime as a *policy rule* that accords well with the historical record. In then proof in the next section that this policy rule corresponds to the optimal strategy functions of the government in a Markov Perfect Equilibrium (MPE) subject to certain policy dogmas. The FDR regime change can then be defined as the elimination of the policy dogmas in a MPE.

Two policy dogmas that constrained Hooovers policy actions form the basis of Hoovers fiscal policy rules. First, I assume a "balanced budget dogma" so that $T_t = F_t$.[23] This dogma represents Presidents Hoover's views at the time. In a press statement at the early stages of the Depression on July 18th 1930, for example, he stated (Hoover (1934)):

> For the Government to finance by bond issues deprives industry and agriculture of just that much capital for its own use and for employment. Prosperity cannot be restored by raids on

[22] Here I abstract from the utility of holding real money balances, see Technical Appendix for discussion.

[23] For simplicity I abstract from seignorage revenues in the remainder of the paper but will refer to them when they are relevant. This is an innocent assumption since assuming these revenues would only strengthen my result. It would give the government an even further reason to inflate if it violates the balanced budget dogma. Given the small seignorage revenues in industrialized countries so that I conjecture that including them would have a small quantiative effect.

the public Treasury.

His views of deficits remained unchanged throughout the depression although he was unable to prevent them during parts of his presidency. Second, I assume a "no additional spending dogma" so that real government spending is constant at all times, i.e. $F_t = \bar{F}$. This viewpoint or "dogma" also captures Hoover's views on fiscal policy policy. It is for example stated in his address to the American Legion on 21st of September 1931 (Hoover (1934)):.

> Every additional expenditure placed upon our government in this emergency magnifies itself out of all proportion into intolerable pressures, whether it is by taxation or by loans. Either loans or taxes [...] will increase unemployment.[...] We can carry our present expenditures without jeopardy to national stability. We can carry no more without grave risks.

On the monetary policy side I assume that the interest rate (or alternatively the money supply by the money demand equation) is set to ensure that inflation is zero. If there are deflationary shocks that prevent this to be feasible, I assume that the central bank set policy (money supply) so that the nominal interest rate is zero. While the Federal Reserve was formally bound by the gold standard, one of its main objectives was price stability.[24] Taken together these policy rules characterize the Hoover policy regime. To summarize:

Definition 1 The Hoover Policy Regime. *Monetary Policy: The Central Bank sets* i_t *so that* $\pi_t = \pi_t^* = 0$ *if possible so that* $i_t = \tilde{r}_t^n$ *in equilibrium. If this is not possible the central bank sets* $i_t = 0$. *Fiscal Policy:* $F_t = \bar{F}$ *and* $T_t = F_t$ *at all times so that* $w_t = \bar{w}$.

The exogenous components of the natural rate of output $\tilde{Y}_t^n$ and the interest rate $\tilde{r}_t^n$ completely summarize all the shocks in the AS and the IS equation of the model. To replicate the output collapse and excessive deflation during the Great Depression, I consider the effects of shocks to the exogenous component of the natural rate of interest (as in Eggertsson and Woodford (2003)) so that the zero bound is temporarily binding as during the Great Depression. To be more specific, I assume a simple stochastic process for $\tilde{r}_t^n$ and $\tilde{Y}_t^n$:

A1: The Great Depression structural shocks $\tilde{r}_t^n = \tilde{r}_L^n < 0$ *at* $t = 0$. *It returns back to steady state with probability* α *in each period. Furthermore,* $\tilde{Y}_t^n = 0 \ \forall \ t$. *The stochastic date the shock returns back to steady state is denoted* τ. *To ensure a bounded solution the probability* α *is such that* $\alpha(1 - \beta(1-\alpha)) - \sigma\kappa(1-\alpha) > 0$

For simplicity I have assumed that $\tilde{Y}_t^n$ is constant so that the dynamics of the model are driven by the exogenous component of the natural rate of interest $\tilde{r}_t^n$. There are several possible sources for a temporary

[24] See e.g. discussion in Meltzer (2003) p. 275 who points out that the gold reserve requirements were not binding in most of the 20's or early 30's and that much of its actions in the 1920's can be interpreted as actions intended to stabilize inflation.

decline in this term. It can be negative due to a series of negative demand shocks (i.e. shifts in the utility of consumption) or expectations of lower future productivity (i.e. shift in the disutility of working or technology). A temporary collapse in some autonomous component of aggregate spending (that is separate from private consumption) can also be interpreted as a preference shock. More generally, the most plausible reason for a collapse in aggregate spending is a collapse in investment. A host of candidates could lead to an investment collapse, such as problems in financial intermediation, adverse shocks to the balance sheets of firms, or a productivity slowdown that may lead to a capital overhang (and thus excess capital, leading to a decline in the natural rate of interest). These shocks are not modelled in detail at this level of abstraction but could be studied in a model with capital and financial intermediation frictions. I can now compute the predicted output contraction due to the Hoover policy regime under the assumption about the structural shocks in A1.

Proposition 1 ***The Hoover Regime Output Collapse and Deflation****. If A1 then output and inflation under the Hoover regime are:*

$$\hat{Y}_t^H = \frac{1-\beta(1-\alpha)}{\alpha(1-\beta(1-\alpha))-\tilde{\sigma}\kappa(1-\alpha)}\sigma\tilde{r}_L^n < 0 \text{ if } \tilde{r}_t^n = \tilde{r}_L^n \text{ and } \hat{Y}_t^H = 0 \text{ otherwise} \tag{9}$$

$$\pi_t^H = \frac{1}{\alpha(1-\beta(1-\alpha))-\tilde{\sigma}\kappa(1-\alpha)}\kappa\sigma\tilde{r}_L^n < 0 \text{ if } \tilde{r}_t^n = \tilde{r}_L^n \text{ and } \pi_t^H = 0 \text{ otherwise} \tag{10}$$

Proof. Consider first the solution at date $t > \tau$. The policy regime mandates that $\pi_t = \hat{Y}_t = 0$. Then, conditional on the natural rate of output being negative (i.e. $t < \tau$), the simple assumption made on the natural rate of interest implies that inflation in the next period is either zero (with probability α) or the same as at time t i.e. π_t (with probability $(1-\alpha)$). Then the expectation of future inflation is $E_t\pi_{t+1} = (1-\alpha)\pi_t$ and similarly the expectation of future output is $E_t\hat{Y}_{t+1} = (1-\alpha)\hat{Y}_t$. Substituting this into (4) and (1) and taking account of the fact that $i_t = 0$ when $t < \tau$ one obtains the solution above. The restriction on α in A1 is needed for the model to converge. If it is violated the output collapse and deflation are unbounded and a linear approximation is no longer valid. ■

Figure 8 shows the output contraction and deflation predicted by the model assuming particular calibration of the parameters taken from Eggertsson and Woodford (2003).[25] In the figure it is assumed that the natural rate of interest is -2% in the r_L^n state and then reverts back to steady state with 10% probability in each period. The figure shows the realization of the endogenous variables in the case that the natural rate of interest returns back to steady state in period $\tau = 10$ (which is the expected duration of the shock). The model predict a collapse in output that lasts as long as the duration of the shock. The contraction at time t is created by a combination of the deflationary shock in period $t < \tau$ – but more importantly – the *expectation* that there will be deflation and output contraction in future periods periods

[25] The parameters are $\tilde{\sigma} = 0.5$, $\omega = 2$, $\kappa = 0.02$, $\beta = 0.99$. There is a more detailed discussion in the Technical Appendix about the calibration.

$t+j < \tau$ for $j > 0$. The deflation in period $t+j$ in turn depend on expectations of the deflation and output contraction in periods $t+j+i < \tau$ for $i > 0$. This creates a vicious cycle that will not even converge unless the restriction on α in A1 is satisfied. The overall effect is an output collapse as shown in figure 8 that is in double digits, i.e. roughly of the same order as observed during the Great Depression, for a relatively small shock to the natural rate of interest.[26]

The extent of the output collapse is mostly driven by the IS equation (1). This equation can be forwarded to yield

$$\hat{Y}_t = \hat{Y}_t^n - \tilde{\sigma} E_t \sum_{s=t}^{T-1} \{\hat{\imath}_s - \pi_{s+1} - \hat{r}_s^n\} + (\hat{Y}_T - \hat{Y}_T^n). \tag{11}$$

The expectation hypothesis indicates that the long-term interest rate is simply the sum of current and expected future short-term rates. Hence the above equation indicates that demand depends on long-term real interest rates and the output gap at time T. The contraction is caused by a discrepancy between long-term real interest rate and the long-term natural interest rate. Due to the zero bound this difference cannot be reduced by nominal interest rate cuts. This difference increases with expectations about future deflation, since expected deflation increases the short and long-term real interest rates. While the model here is stylized, e.g. there is no capital and the Euler Equation of the household is of the most simple form (e.g. no internal or external habit persistence), almost any model would predict that equilibrium output should depend on current and expected real interest rates. It is also a conventional wisdom in most central banks (see e.g. Blinder (1998)). Real interest rates can be particularly high when there is expected deflation, since the real interest rate is the difference between nominal interest rate and expected inflation. Figure 7 shows that during the Great Depression the real rates were of the order of 10-15 percent – and the Federal Reserve was unable to lower these rates further in 1933 since then the nominal interest rate was close to zero.

The duration of the contraction can be several years in the model, or as long as the shock lasts, even if the degree of price flexibility is high. Indeed the formulas in (9) and (10) reveal a puzzling conclusion, that the higher the price flexibility (i.e. the higher the parameter κ) the stronger the output collapse. This is paradoxical because when prices are perfectly flexible output is constant by assumption A1. The forces at work here were first recognized by Tobin (1975) and De Long and Summers (1986). These authors show that if prices are more flexible this can lead to the expectation of further deflation in a recession. If demand depends on expected deflation, as in equation (11), this indicates that higher price flexibility can lead to ever lower demand in recession, thus increasing output volatility. This dynamic effect, what these authors call the "Mundell effect", must be weighted against that higher price flexibility reduce the static output inflation trade-off in the AS curve. These author show that the Mundell effect can dominate, depending on the parameters of the model, while formula (*9*) indicates that the Mundell effect will always dominate

[26] The sense in which the shock is "small" is that the real rate of interest (which is equal to $\tilde{r}_t^n$ in the absence of an output slack) has been of this order several times in US history, such as the 70s (see e.g. Summers (1991) for discussion). On those occasions, however, there has been positive inflation so that negative real rate of interest has easily been accomodated.

at zero interest rates.

Figure 11 shows the implied long run money stock under the Hoover regime in the numerical example reported in figure 8. In the long run the nominal stock of money will be proportional to the price level and output. The long-run stock of money would be equal to 1 in the figure in the absence of shocks. The figure reveals that the deflationary bias under the Hoover regime implies that the Federal Reserve will accommodate any deflation by an contracting the long-term monetary stock once the deflationary shocks subside.

The Hoover regime proposed in Definition 1 is too simplistic to account for the Federal Reserve actions in 1929-33. The definition states that if the Federal Reserve is unable to stabilize inflation at zero it will reduce the nominal interest rate to zero immediately. Instead of doing this the Federal Reserve reduced the interest rate more gradually as can be seen in figure 7. Since the interest rates were close to zero at the time FDR took office, however, this does not change the central point of the paper. By failing to move faster, however, there is no doubt that the Federal Reserve exaggerated the output decline and propagated the deflationary shocks. To show this I extend the Hoover regime in Definition 1 to allow for a more gradual decrease in the nominal interest rate. Suppose that instead of setting the interest rate zero when the central bank misses its inflation target it instead sets $i_t = \epsilon_t$ where ϵ_t is some noise terms that must be strictly positive (otherwise the zero bound would be violated). If I interpret ϵ_t as a policy shock (e.g. due to policy mistakes or considerations related to maintaining other objectives such as the gold standard) there is an even larger collapse in output because this will increase current and expected real interest rates at dates $t < \tau$.[27] This suggests that other policy objectives (such as the gold standard), institutional inertia, and policy mistakes made the Hoover policy regime even more deflationary.

4.1 The Liquidity Trap under the Hoover Regime

Would unlimited open market operations increase inflation in the model? Under the Hoover regime this policy would not have been effective. The reason for this is that money supply has its effect through the short-term interest rate and in 1932 they were already close to zero. Any money supply above $\eta_i \hat{i}_t + \eta_y \hat{Y}_t$ during the period of zero interest rates is thus consistent with equilibrium. More importantly, open market operations will not change expectations either. Since the private sector expect inflation to be $\pi^* = 0$ as soon as the deflationary shock subsides, it will expect the central bank to reverse any money supply increase as soon as the shock subsides, no matter how large it is at time $t < \tau$. Any monetary expansion will thus be expected to be transitory. Hence Proposition 1 remains valid even if I allow for an aggressive expansion in the monetary aggregate at times when nominal interest rates are zero. To summarize:

Proposition 2 ***The liquidity trap***. *Suppose the government expands M_t by arbitrary large amounts by*

[27] There are a few spikes in the interest rates in the early 30's that are usually attributed to the Feds concerns about the gold standard (e.g. there is a notable spike in the short term interest rate when Britain went off the golds standard in 1931 and Fed wanted to signal its intention to defend it).

open market operations when the interest rate is zero. Assume that all other aspects of policy are determined by the Hoover regime. Then the equilibrium is still given by equation (9) and (10) in Proposition 1 and is independent of the by how much M_t is expanded.

This proposition follows from Eggertsson and Woodford (2003). That paper shows that the level of the monetary base at zero interest rate has no effect on the equilibrium outcome when the central bank follows an interest rate rule. It is easy to verify that the Hoover regime is a special case of the general policy rule specified in that proposition. Eggertsson and Woodford (2003) furthermore show that this result is unchanged even if the central bank can purchase a variety of other assets with the money printed, such as long term government bonds (another example is foreign exchange). This proposition may thus appear to support a famous statement made by Marriner Eccles, governor of the Federal Reserve, in front of the Senate Banking committee in 1935 (see Eccles (1935) p. 377):

> One cannot push on a string. We are in the depths of a depression and, as I have said several times before this committee, beyond creating an easy money situation through reduction of discount rates and through the creation of excess reserves, there is very little, if anything, that the reserve organization can do toward bringing about recovery.

Monetary policy is not as impotent in the model of this paper as Eccles suggests. The next section shows that a credible expansion of *future money supply* can be very effective. The policy is not effective, however, by creating excess reserves at the time of the policy easing. Instead it is effective due to the expectation that monetary policy will be kept loose even as inflation and interest rates increase.

5 The Inflation Target Multiplier and the Deflation Bias

The simplest way to see the fallacy of Eccles famous comment is to consider a policy regime in which the government targets a higher inflation rate.[28] Consider a policy regime, as the Hoover regime, but in which $\pi_t^* = \pi^* > 0$. In this case the expression in Proposition 1 becomes

$$\begin{aligned} \hat{Y}_t^{IT} &= \hat{Y}_t^H + \frac{\alpha\tilde{\sigma}\pi^*}{\alpha(1-\beta(1-\alpha)) - \tilde{\sigma}\kappa(1-\alpha)} < 0 \text{ if } \tilde{r}_t^n = \tilde{r}_L^n \ < -\pi^* \\ \hat{Y}_t^{IT} &= (1-\beta)\kappa^{-1}\pi^* \text{ otherwise} \end{aligned}$$

The solution above reveals that the liquidity trap is not a real trap in the sense described by Eccles. What is required, however, is not to "create and easy money situation through reduction of discount rates and excess reserves" but increasing expectations about future inflation. A commitment to future inflation increases demand because it reduces the real rate of interest and increases expectations about

[28] As e.g. suggested by Summers (1991) and Krugman (1998) to avoid the zero bound.

future output. These effects can be very large for the converse of the reason described in the last section. Higher expectations about future inflation reduce the real rate of interest and thus stimulate demand by making consumption cheaper relative to the future; this effect is captured by the second term on the right hand side of the IS equation (1). Furthermore expectations of higher future income also stimulates demand by the permanent income hypothesis; this is captured by the first term on the right hand side of the IS equation. The overall effect can be summarized by an inflation target multiplier

$$MP_{IT,H}(\pi^*) = \frac{\hat{Y}_t^{IT} - \hat{Y}_t^H}{\pi^*} = \frac{\alpha\tilde{\sigma}}{\alpha(1-\beta(1-\alpha)) - \tilde{\sigma}\kappa(1-\alpha)}$$

This statistic answers the question: By how much does a permanent increase in the inflation target by 1 percent increase output when the interest rate is zero? In the numerical example from last section one percent increase in the inflation target increases output by 6.6 percent. This number depends on the assumed stochastic process for the natural rate of interest which give rise to zero interest rates. In the absence of the shocks, so that interest rates are positive, the multiplier is only 0.13 percent.

An increase in the inflation target is an example of a *regime change*. It does not imply any increase in the monetary base in period $t < \tau$ when interest rate is zero. What is important, however, is the expectation that the money supply will be increased in periods $t > \tau$ at a constant rate that is proportional to the inflation target.[29] A regime change from the Hoover regime to an inflation targeting regime can therefore have a very large effect. This is helpful to understand why FDR announcements to inflate had such a large and immediate effect in March 1933. To describe the FDR regime change as a movement to inflation targeting, however, is much to simplistic. While FDR public commitment to inflate was undoubtedly helpful to shape expectations it is unlikely that it would have been sufficient alone if not followed by concrete actions.

One potential problem of making statements about future policy is that they may not be deemed as credible. In the words of Sargent "a regime change must be sufficiently binding to be believed." This is a problem FDR faced. Sumner (1997), for example, notes that "financial markets initially seemed reluctant to accept these announcements as official administrative policy" when discussing FDR commitment to increase the price level. Furthermore, as can be seen in figure 2, FDR never in fact fulfilled his promise to inflate to the pre-recession price level. Was it rational for the public to believe his statements *ex ante* in the absence of other actions? A formal way to evaluate this question is to make the extreme, but transparent, assumption that FDR's words carried no weight and that he was unable to commit to future policy. This leads me to consider a Markov Perfect Equilibrium (MPE).

The MPE is relatively standard in macroeconomics and was first applied in Kydland and Prescott (1977) classic exposition of the inflation bias. The idea is that the government cannot make any commitment about

[29] An exception to this is if the inflation target is high enough so that $\pi^* > -\tilde{r}_t^n$ in which case negative real rates of interest can be accommodated with positive interest rates. In this case the central bank need to support this equilibrium by a corresponding increase in the monetary base in periods $t < \tau$.

future policy but instead reoptimizes every period taken the state (which may be endogenous) as given. The assumption here is that the government seeks to maximize social welfare which is given by the utility of the representative household (8). Following Stokey and Lucas (1983) I also assume that the government has some ability to commit by supposing that it can commit to pay back the nominal value of any debt issued (e.g. because it is very costly to renege on government debt payments).

5.1 Markov Perfect Equilibrium under the Hoover Regime

Consider first the Markov Perfect Equilibrium under the Hoover fiscal policy dogmas. In this case the last two terms in the government's objective (8) are exogenous and the system of equation that determine equilibrium (equations (4)-(6)) are completely forward looking. This implies that there is no intrinsic state variable in the model so that the expectations $E_t\pi_{t+1}$and $E_t\hat{Y}_{t+1}$ are taken by the government as being exogenous since they refer to expectations of variables that will be determined by future governments (for a formal definition of the MPE in the nonlinear model see Technical Appendix). One can then derive the equilibrium by forming a Lagrangian for the government's maximization problem

$$\begin{aligned} L_t &= -E_t[\frac{1}{2}\{\pi_t^2 + \lambda_y(\hat{Y}_t - \hat{Y}_t^n)^2 + \lambda_F(\hat{F}_t - \hat{F}_t^n)^2 + \lambda_T(\hat{T}_t - \hat{T}_t^n)^2\} \\ &\quad +\phi_{1t}(\pi_t - \kappa(\hat{Y}_t - \hat{Y}_t^n) - \beta\bar{\pi}) \\ &\quad +\phi_{2t}(\hat{Y}_t - \hat{Y}_t^n - \bar{Y} + \hat{Y}_{t+1}^n + \sigma(\hat{\imath}_t - \bar{\pi} - \hat{r}_t^n)) \\ &\quad +\phi_{3t}(\frac{\hat{\imath}_t}{\beta} + \frac{1-\beta}{\beta})] \end{aligned} \tag{12}$$

and obtain the three first order conditions and one complementary slackness conditions

$$\pi_t + \phi_{1t} = 0 \tag{13}$$

$$\lambda_y(\hat{Y}_t - \hat{Y}_t^n) - \kappa\phi_{1t} + \phi_{2t} = 0 \tag{14}$$

$$\tilde{\sigma}\phi_{2t} + \beta^{-1}\phi_{3t} = 0 \tag{15}$$

$$\phi_{3t} \geq 0,\ \phi_{3t}i_t = 0 \tag{16}$$

where in the last first order condition, for simplicity, I have substituted out for $\hat{\imath}_t$ in terms of i_t. It is now easy to verify that the solution is the one given by the Hoover policy regime in Definition 1 and Proposition 1.

Proposition 3 ***Hoover's Deflation Bias****. Assuming the Fiscal Policy Dogma $F_t = \bar{F} = T_t$ and A1 the Hoover Regime is a Markov Perfect Equilibrium*

Proof. To prove this consider first the solution at positive interest rates. In this case then $\phi_{3t} = 0$ for equation (16) to be satisfied. Then equation (13)-(15) imply the unique bounded solution $\hat{Y}_t = \hat{Y}_t^n$ and

$\pi_t = 0$ and $\hat{\imath}_t = \hat{r}_t^n$. This proves the first part of the proposition, namely the form of the policy regime when $t > \tau$. This, however, cannot be an equilibrium when $\hat{r}_t^n < -1 - \beta$ because this would violate (16). We now need to show that in this case we must have $i_t = 0$. This is easy to do by a proof by contradiction. Suppose this was not the case. Then $\phi_{3t} = 0$. But this would, according to (13)-(15) and the IS and AS equation, imply that $\hat{Y}_t = \hat{Y}_t^n$ and $\pi_t = 0$ and $\hat{\imath}_t = \hat{r}_t^n$ which violates (16). In contrast, the solution with $i_t = 0$ satisfies all the conditions for equilibrium. Note that the monetary aggregate plays no role in the analysis because the money supply only appears in the money demand equation so that the value of the Lagrangian multiplier with respect to $\hat{m}_t$ is always zero. ■

This proposition shows that the Hoover regime in Definition 1 corresponds to a Markov Perfect Equilibrium if one imposes the fiscal policy dogmas. An alternative definition of the Hoover regime, which is equivalent to Definition 1, is therefore that it corresponds to a government that maximizes social welfare, cannot commit to future policy and is constrained by the fiscal policy dogmas.

Definition 2 The Hoover Policy Regime (Alternative Definition): *The government maximizes (8) subject to the fiscal policy dogmas $F_t = \bar{F} = T_t$ and cannot commit to future policy.*

The proposition has strong implication for the FDR policy regime. If we assume that President Roosevelt could not commit to future policy the proposition indicates that his announcement about inflating the price level had no effect. It was not credible. While it is optimal in the model to increase inflation expectations FDR had an incentive to promise future inflation and then renege on this promise once the deflationary shocks subsided. To see this, one only needs to observe that the objective of the government depends both on inflation and output gap. Even if increasing inflation expectations at date $t < \tau$ is optimal for the government at that time, it has an incentive to renege at time τ when deflationary pressures have subsided because at that time it can achieve zero inflation without any output gap. Hence positive inflation expectations cannot be sustained under rational expectations about discretionary policy. This is what Eggertsson (2005) coins the deflationary bias of discretionary policy. While it is extreme to assume that FDR words carried no weight it is an useful assumption because it allows us to give some further interpretation to some of the subsequent *actions* he took. These actions can be interpreted as having made his inflation program credible and thus more effective to increase demand. In the next section I will show that FDR's abolishment of the fiscal policy dogmas are examples of policies that made his inflation program credible.[30]

[30] It is worth pointing out that open market operations have no effect on the inflation incentive of the government and will therefore not be helpful in the model. Because open market operations involves exchanging one government liability for another, the inflation incentive of the government is unchanged (i.e. w_t in the model remains unchanged). Any change in the money supply by open market operation is expected to be undone as soon as interest rate increase. The reason for the difference between the result here and Auerbach and Obstfeld (2005), who come to the opposite conclusion, is that these authors assume that an open market operations permanently change the private sector expectations about future money supply. Proposition 3 illustrates that this assumption is inconsistent with a MPE so that permanent money expansion by open market operations is not credible in the model.

6 An Economic Expansion under a FDR Policy Regime

In this section I outline the consequences of relaxing the policy dogmas of the Hoover policy regime. To clarify the effect of each policy instrument I first study the effect of real government spending, holding deficit spending constant. Then I study the effect of deficit spending holding real government spending constant. I calculate a policy multiplier which is a summary statistic that shows by how much output increases for each dollar of fiscal spending. Finally I study the optimal policy regime using both instruments. This is the FDR policy regime.

6.1 The Multiplier of Real Government Spending

Consider first changing the Hoover policy regime so that the government expands real government spending to increase demand. In particular consider a countercyclical policy rule so that real government spending is increased in proportion to the decline in the natural rate of interest. Under assumption A1 the policy regime is then of the form

$$\hat{F}_t = -f_r \tilde{r}_t^n \tag{17}$$

Recall that under assumption A1 the term $\tilde{r}_t^n$ is negative in period $t < \tau$ (when the interest rates are zero) but zero at time $t \geq \tau$. This policy regime then implies that fiscal policy will be expanded during the periods in which the zero bound is binding and kept constant at its steady state when the deflationary shocks have subsided. This is consistent with how FDR thought about the real spending side of fiscal policy. The main goal of his government spending was temporary relief programs to battle the unemployment of the Great Depression. I call this policy regime FDRa. To summarize:

Definition 3 The Roosevelt Regime Part A (FDRa), Countercyclical Real Government Spending. *Fiscal Policy is set so that* $\hat{F}_t = -f_r \tilde{r}_L^n$ *when* $t < \tau$ *and* $\hat{F}_t = 0$ *when* $t \geq \tau$.

Figure 8 illustrates the effect of choosing f_r that is consistent with MPE discussed in better detail below while deficit spending is still subject to the balanced budget dogma that $F_t = T_t$. Monetary policy sets the nominal interest rate to targets zero inflation, if possible, as in the Hoover Policy regime, but sets the interest rate at zero if it is unable to reach the target by interest rate cuts. The evolution for each of the variables is shown by the dotted line in this figure. As can be grasped by the figure, countercyclical real government spending reduces the output contraction by about half and reduces deflation by about a quarter. The policy works through two separate channels. Real spending increases the natural level of output through the first channel. This channel has been extensively documented in the RBC literature (see e.g. Baxter and King (1993) and references therein). In the context of our model, just as in Baxter and King, the natural rate of output increases if government expenditures increase as can be seen by equation (2). This increase is due to a higher willingness of people to work. Higher government spending increases the marginal utility of consumption (for given level of consumption) which induces people to work more to

equate the marginal utility of private consumption and the disutility of working.

Government spending increases output through another channel. I call this the *Keynesian channel* of government spending. The Keynesian channel only works if prices are sticky, i.e. if the real rate can be different from the natural rate of interest (recall: it is the real interest rate if prices are flexible). To see the Keynesian channel note that an increase in government spending (holding everything else constant) increases the natural rate of interest by equation (3). Then if the nominal interest rate is held fixed and expectations about future inflation are held constant, a wedge opens between the real interest rate and the natural rate of interest. By the IS equation (holding expectation about future output gap constant) a positive wedge between $\hat{r}_t = \hat{\imath}_t - E_t\pi_{t+1}$ and $\hat{r}_t^n$ stimulates demand; this is the Keynesian channel for government spending.

One aspect of figure 8 that may be surprising is that only 2 percent of government spending (as a fraction of GNP when the zero bound is binding) increases output by about 7 percent. This large effect of a small amount of government spending is due to the expectation channel. The main cause of the large decline in output and prices is the expectation of a future slump and deflation. Consider the outcome from the perspective of period 0. If the private sector expects even a small increase in government spending in all future states when the zero bound is binding, deflation and output expectation are changed in all these states, thus having a large effect on output in period 0. A useful summary statistic is what I coin the policy multiplier of government spending. This measure answers the question: How much does each dollar of real spending increase output moving from one policy regime to the other? This statistic is well defined because the only difference between the Hoover regime and FDRa is that in the latter real government spending can be increased while under the Hoover fiscal dogmas it is constant.

Proposition 4 ***The Real Spending Multiplier.*** *The multiplier of real government spending is*

$$MP_{FDRa,H}(F) \equiv \frac{E_0 \sum_{t=0}^{\infty} \beta^t (\hat{Y}_t^{FDRa} - \hat{Y}_t^H)}{E_0 \sum_{t=0}^{\infty} \beta^t (\hat{F}_t^{FDRa} - \hat{F}_t^H)} = \frac{[\frac{1}{1-\alpha} - \beta]\tilde{\sigma}^{-1} - \alpha^{-1}\kappa \frac{\tilde{\sigma}^{-1}}{\tilde{\sigma}^{-1}+\omega}}{[\frac{1}{1-\alpha} - \beta]\tilde{\sigma}^{-1} - \alpha^{-1}\kappa} > 1$$

where Y_t^{FDRa} is output under the Roosevelt A regime and Y_t^H under the Hoover regime. The multiplier is always greater than 1 and the fraction due to the RBC channel is always less than 1. The fraction of the multiplier due to the RBC channel is $\frac{\tilde{\sigma}^{-1}}{\tilde{\sigma}^{-1}+\omega} < 1$.

Proof. To prove this proposition write equation (4) in terms of output under the FDRa and Hoover regime, conditional on that the natural rate of interest is negative, i.e. $t < \tau$. This yields

$$\pi^{FDRa} - \pi^H = \kappa(\hat{Y}^{FDRa} - \hat{Y}^H) - \kappa(\hat{Y}^{nFDRa} - \hat{Y}^{nH}) + \beta(1-\alpha)(\pi^{FDRa} - \pi^H).$$

Similarly substituting into (1) and rearranging yields

$$\alpha(\hat{Y}^{FDRa} - \hat{Y}^H) - \alpha(\tilde{Y}^{nFDRa} - \tilde{Y}^{nH}) = \tilde{\sigma}(1-\alpha)(\pi^{FDRa} - \pi^H) + \tilde{\sigma}(\hat{r}^{nFDRa} - \hat{r}^{nH}).$$

Using (2) I can solve $(\hat{Y}^{nFDRa} - \hat{Y}^{nH}) = \frac{\tilde{\sigma}^{-1}}{\tilde{\sigma}^{-1}+\omega}(\hat{F}^{FDRa} - \hat{F}^{H})$ and using (3) I obtain $(\hat{r}^{nFDRa} - \hat{r}^{nH}) = \alpha\frac{\omega\tilde{\sigma}^{-1}}{\tilde{\sigma}^{-1}+\omega}(\hat{F}^{FDRa} - \hat{F}^{H})$. Substituting these two values into the two equations above, solving for the ratio $\frac{(\hat{Y}^{FDRa}-\hat{Y}^{H})}{(\hat{F}^{FDRa}-\hat{F}^{H})}$ and observing that $\hat{Y} = \hat{F} = 0$ when $t \geq \tau$, one obtains the multiplier. ■

The policy multiplier measures how one unit of real government spending increases output. I measure each variable in net present value. In the baseline calibration the value of the multiplier is 3.2. This means that in moving from one regime to the other, each dollar of real government spending increases output by about 3 dollars on average. This large number may perhaps be somewhat surprising. If consumers completely offset an increase in government spending by cutting back on their own consumption, for example, the value of this multiplier is zero. Another interesting aspect of this multiplier is that it is always strictly greater than 1. The old fashion Keynesian literature, for example, predicted "a balance budget" multiplier of 1. This large effect is mostly due to the expectation channel.

Figure 9 decomposes the size of the multiplier between the RBC channel and the New Keynesian channel. As the figure reveals about 85 percent of the multiplier can be attributed to the New Keynesian channel and 15 percent to the RBC channel. This multiplier is computed under A1 so that it is assumed that the zero bound is binding and that inflation is below the central banks target. This implies that monetary policy will always accommondate the increase in demand due to fiscal spending. The size of the multiplier when interest rate are positive is also included as a comparison. In this case the multiplier is much smaller. The reason is that at positive interest rates inflation is at target (by the assumption about the policy regime) and the central bank will offset any inflationary consequences of the fiscal expansion. In contrast, since inflation is below the central bank target at zero interest rates, it will fully accommodate any inflationary consequences of the fiscal expansion.[31]

Figure (11) shows the implied long run stock of money under the policy regime FDRa for $\tau = 10$ studied in figure (9). The FDRa policy regime implies a commitment to a higher future money stock than the Hoover regime. Nevertheless it still implies that the central bank will contract the monetary base relative to its level prior to the recession. The reason for this is the same as before. The regime mandates a zero inflation as soon as the deflationary pressure subside. The central bank's long run money stock will therefore accommodate any deflation that occurred in period $t < 10$. The extent of the deflation, however, is smaller than under the Hoover regime because government spending increases demand in period $t < 10$ so the central bank need to accommodate less deflation than in the Hoover regime.

6.2 Real Government Spending in a MPE

Consider optimal policy in a MPE when the government can increase real government spending but is subject to the balanced budget dogma. In this case the government can have an effect on both the natural rate of interest and the natural rate of output. The problem of the government can be analyzed by writing

[31] In computing the multiplier at positive interest rate I assumed the same shock but that the central bank was not constrained by the zero bound.

up the Lagrangian (12) but in this case I substitute equation (2) and (3) into the constraints (4) and (1). Once again one obtains the first order conditions (13)-(16). In addition one obtains a first order condition with respect to $\hat{F}_t$ which gives

$$\frac{\tilde{\sigma}^{-1}}{\omega+\tilde{\sigma}^{-1}}\lambda_y(\hat{Y}_t-\hat{Y}_t^n)+\lambda_F(\hat{F}_t-\hat{F}_t^n)+\lambda_T(\hat{F}_t-\hat{T}_t^n)-\frac{\tilde{\sigma}^{-1}}{\omega+\tilde{\sigma}^{-1}}\kappa\phi_{1t}-\phi_{2t}=0 \tag{18}$$

If the zero bound is not binding (i.e. shocks are small enough) both Lagrangian multipliers ϕ_{1t} and ϕ_{2t} are zero, $\hat{Y}_t=Y_t^n$ and $\pi_t=0$. In this case one obtains

$$\hat{F}_t=\frac{\lambda_F}{\lambda_T+\lambda_F}\hat{F}_t^n+\frac{\lambda_T}{\lambda_T+\lambda_F}\hat{T}_t^n$$

This equation says government spending is increasing in the natural rate of government spending $\hat{F}_t^n$. Because variations in $\hat{F}_t$ result in an increase in taxation (by the balanced budget dogma) this implies that the optimal size of the government will also depend on shifts in optimal target for taxes. If taxation is "cheap" i.e. the term $\hat{T}_t^n$ is positive, this increases the size of the government because I have assumed that the budget must be balanced in each period. For simplicity $\hat{F}_t^n$ and $\hat{T}_t^n$ are are assumed to be such that fiscal policy is constant in the absence of zero interest rates. This is useful because it isolates the use of fiscal policy for stabilization purposes. This assumption is summarized below:

Assumption 2 (A2) *The natural rate of fiscal spending and taxation is such that* $\hat{F}_t^n=-\frac{\lambda_T}{\lambda_F}\hat{T}_t^n$.

I can now proof that under A4 the policy rule (17) is a Markov Perfect Equilibrium.

Proposition 5 *Assuming the Balanced Budget Dogma* $\hat{T}_t=\hat{F}_t$ *and A1 and A2 the FDRa regime is a MPE for a value of* f_r *that satisfies (13)-(16) and (18).*

Proof. To prove this proposition I can use A1 and A4 to write (18) as

$$\frac{\tilde{\sigma}^{-1}}{\omega+\tilde{\sigma}^{-1}}\lambda_y(\hat{Y}_t-\frac{\tilde{\sigma}^{-1}}{\omega+\tilde{\sigma}^{-1}}\hat{F}_t)+\lambda_F\hat{F}_t+\lambda_T\hat{F}_t-\frac{\tilde{\sigma}^{-1}}{\omega+\tilde{\sigma}^{-1}}\kappa\phi_{1t}-\phi_{2t}=0 \tag{19}$$

Consider first the optimal policy at $t>\tau$. Using the same argument as in the proof of Proposition 3 we see that the equilibrium is $\pi_t=\hat{Y}_t=\phi_{1t}=\phi_{2t}=0$. The equation above then implies that $\hat{F}_t=0$. Consider now the case in which $t<\tau$. Using the same argument as in the last proof (proof by contradiction) I can once again show that in this case $i_t=0$. What remains to be shown is that fiscal policy takes the form $\hat{F}_t=-f_r\tilde{r}_t^n$. To see this recognize that equations (4), (2), (1), (3), (13)-(16) and (19) can be solved to yield a solution for $\hat{F}_t$ in terms of $\tilde{r}_t^n$. ■

The proposition above indicates that the policy rule suggested under Roosevelt Policy Regime A is incentive compatible. This means that if the government announces that it will use real government spending to stabilize the price level to the extent suggested by policy regime FDRa, this policy is credible.

The reason is that real government spending involves concrete actions at the time of the shocks, not a commitment to a future action which are not optimal at that future date. In contrast a positive inflation target, as discussed in last section, involves a commitment to an expansionary policy once deflationary shocks have subsided and the government has an incentive to renege on it.

6.3 The Multiplier of Deficit Spending

Under the both the Hoover and FDRa policy regimes there are no expectations about positive inflation after the deflationary shocks have subsided because the governments cannot make credible commitments about inflation at that time. Even if it expands the money supply aggressively by open market operations in government bonds, the private sector expects the government to reverse this once deflationary pressures subside. Can these expectations be changed? Can a permanent increase in the money supply be credible? There is a straight forward policy tool to increase inflation expectations in a credible way in the model; and one may interpret some of FDR's actions (not captured by policy regime FDRa) as having achieved this. One way of making inflation policy credible is to expand government liabilities, i.e. the sum of the monetary base and the government debt, given by the variable w_t in equation (7) i.e. the sum of the monetary base and government bonds.

There is some evidence that Roosevelt viewed expansion of government liabilities as crucial to increase inflation. Interestingly FDR made no distinction between government debt and the monetary base which is consistent with this interpretation. In one of his fireside chats in May 1933 (Roosevelt (1933b)), for example, he stated, "in the first place, government credit and government currency are really one and the same thing." This suggestion is theoretically correct since interest rates were at zero at the time so there was *no* economic difference between government debt and the monetary base. Furthermore FDR stated that government credit would be used to increase inflation. In the same speech, when firming up his commitment that prices would be inflated he stated, "that is why powers are being given to the Administration to provide, if necessary, for an enlargement of credit [...] These powers will be used when, as, and if it may be necessary to accomplish the purpose [i.e. increasing inflation]."

If the government has outstanding nominal liabilities it has several reasons to target higher inflation. First, because the liabilities of the government are in nominal terms, a higher rate of inflation reduces the real value of government debt, thus reducing the need for taxation to finance the debt payments. Second, a higher level of debt gives the government an incentive to keep the interest rate low on the debt it rolls over, which can only be done by accommodating higher inflation in equilibrium. Third, a higher level of debt increases the government need for seigniorage revenues, which are also increasing in inflation. It makes sense, therefore, to think of a credible policy rule (in the absence of balanced budget dogma) as a function of the real value of government debt, i.e. the government sets i_t so that

$$\pi_t = \pi_t^* = \pi_w \hat{w}_{t-1} \tag{20}$$

if possible and $i_t = 0$ otherwise. The difference between this policy regime and the Hoover policy regime is that in this case the inflation target π_t^* is time-varying and depends on the level of outstanding debt. Thus for positive debt, in contrast to the Hoover regime, the FDRb regime implies a positive inflation target. If the policy regime is of this form, a straightforward way to increase inflation expectations is to increase "government credit" as FDR suggested, i.e. the sum of the monetary base and government bonds. This means that the government will engage in deficit spending when the zero bound is binding. To summarize:

Definition 4 The Roosevelt Regime Part B (FDRb), Countercyclical Deficit Spending. *Fiscal Policy: set* $\hat{T}_t$ *so that* $\hat{w}_t = d_r \tilde{r}_L^n - d_w \hat{w}_{t-1}$ *when* $t < \tau$ *and* $\hat{w}_t = s_w \hat{w}_{t-1}$ *when* $t \geq \tau$ *where* $d_w, d_r > 0$ *and* $s_w > 0$. *Monetary Policy: The Central Banks sets* $i_t = 0$ *when* $t < \tau$ *and* i_t *so that* $\pi_t = \pi_t^* = \pi_w \hat{w}_{t-1}$ *when* $t \geq \tau$

In the next section I will show that this policy regime is incentive compatible, for a particular value of d_w, d_r and s_w, and is indeed a locally unique MPE. Figure 9 illustrates the effect of a choosing this policy regime optimally and under the constraint that it is a MPE. As can be grasped by the figure, this policy regime reduces the contraction and deflation by about 90 percent. When the government uses deficit spending, the value of the real debt becomes an endogenous state variable. This allows the government to change deflationary expectations into inflationary ones by increasing nominal debt. This is exactly what is needed when the zero bound is binding.

The channel is as follows: Budget deficits generate nominal debt. Nominal debt increases inflation expectations because the government uses inflation to pay off its debt. Higher debt is undesirable for the government if there are some tax distortions. Higher inflation expectations lower the real rate of interest and thus stimulate aggregate demand.

One can alternatively think of this channel as working through the budget constraint of the household. This interpretation may be better aligned with FDR's view of "government credit" cited in the beginning of the section. The deficit spending implies that the government gives credit to the private sector (either through actual tax cuts or because taxes do not increase as much as government real spending F_t). This means that the household now holds more dollar assets either in the form of government bonds or money than it did before. It will have no effect *if* the household expects its future taxes to be increased correspondingly. Under this expectation households increase their savings one to one with the expansion of government credit; this is the principle of Ricardian Equivalence. But these savings decisions are not rational in the model, because taxation is costly the household has no reason to expect the government to increase future nominal taxes to this extent. Instead the government has an incentive to create inflation in the future to avoid raising taxes. As a consequence the household will view its net wealth as increasing with the expansion of government credit. This means that government credit increases private demand under the policy rule (20).

Again it is useful to summarize the effect of the deficit spending on output through the multiplier. I need to make some adjustment to the definition of the multiplier, however, for it to be useful. What I

consider instead is a variable $\tilde{T}_t$ that has the defined as $\tilde{T}_t = \hat{T}_t$ if $\tilde{r}_t^n = r_t^L$ and $\tilde{T}_t = 0$ if $\tilde{r}_t^n = 0$. (The results derived for $\hat{F}_t$ would have been unchanged if I had defined $\tilde{F}_t$ in this way because $\hat{F}_t = 0$ if $\tilde{r}_t^n = 0$). This variable captures the deficit spending used in the depression state. Hence I define the multiplier of deficit spending as[32]

$$MP_{FDRb,H}(\tilde{T}) = -\frac{E_0 \sum_{t=0}^{\infty} \beta^t (Y_t^{FDRb} - Y_t^H)}{E_0 \sum_{t=0}^{\infty} \beta^t (\tilde{T}_t^{FDRb} - \tilde{T}_t^H)}$$

The value of this multiplier answers the following question: By how much does each dollar spent on deficit spending in a liquidity trap increase output? In our baseline calibration the answer is 3.1. Figure 9 decomposes the size multiplier between the RBC channel and the New Keynesian channel. As the figure reveals no part of the multiplier can be explained by the RBC channel. The reason is that the effectiveness of deficit spending comes entirely through increasing inflation expectations, and this is only valuable if one assumes sticky prices. Since prices are flexible in an RBC model this channel has no role in that model. As a comparison I also include the size of the multiplier when interest rates are positive. In this case the multiplier is much smaller. The reason is that when interest rates are positive the central bank's actions are not constrained by the zero bound. This implies that there is a much lower gain for the bank to increase inflation and it will thus seek to offset any increase in inflation expectations by raising interest rates.[33] In contrast the central bank will keep interest rate low when the zero bound is binding due to deflationary shocks because in that case inflation is below the bank's desired inflation target.

The output benefit of deficit spending can also be interpreted as the value of increasing inflation expectations at zero interest rates. If credible commitment about future monetary policy is possible then the deficit spending in the Markov Perfect Equilibrium is *equivalent* to announcing a higher future inflation target in periods in which the zero bound is no longer binding. Franklin Delano Roosevelt used both *persuasion* (i.e. commitment by announcement of his intentions about future prices) and policy *actions* that made these announcement more credible. Thus while I mostly focus on deficit spending this does not exclude the possibility that inflation expectations were also increased by FDR's announcements about his *policy objectives*. This alternative interpretation does not invalidate the thrust of the paper, rather, it makes the implementation if monetary expansion more simple (i.e. the government can engineer a monetary expansion without making it credible by fiscal policy actions). It also changes the interpretation of the deficit multiplier. It would, therefore, be misleading to characterize the result of this paper as showing that fiscal policy is effective but monetary policy is not. Here deficit spending is effective only through monetary policy, i.e. it makes a monetary expansion credible.

One interesting aspect of deficit spending versus real spending (see figure 9) is the different time paths of these policy variables. While the real spending solution involves a permanent increase in real spending

[32] To the first order the net present value of taxes will alway be equal to zero for the transversality condition of the representative household to be satisfied. A summary statistic like the one introduced earlier will then not be defined.

[33] In computing the multiplier at positive interest rate I assumed the same shock but that the central bank was not constrained by the zero bound.

during all periods in which the zero bound is binding, deficit spending is only temporarily higher. Deficit spending is thus more consistent with the old Keynesian idea that a quick jolt of spending can "jump start" the economy. The reason is that government debt is the state variable that increases inflation expectation. Only temporary deficit spending is needed to permanently increase government debt. In contrast, stimulating demand by real government spending requires a sustained increase in government spending in all periods in which the zero bound is binding. Interestingly the deficit and real spending under FDR were broadly consistent with this pattern. Deficit spending was strongest in FDR's first full year in office, 1934, and then declined. Government consumption, on the other hand, increased permanently.

While the economic logic of debt on the inflation incentive of the government is clear one may ask: How important was this channel during the Great Depression? One problem with addressing this question is the absence of the counterfactual. We do not know what would have happened if the government had not expanded its credit. An interesting episode, which serves as close to a counterfactual as possible, is provided by the recession of 1937-38. The recession was largely due to that the Federal Reserve increased reserve requirements, which resulted in a slightly higher short-term nominal interest rate, as discussed in section 2. Given the high level of outstanding government debt at the time, this violated the policy rule FDRb. The government officials most closely monitoring that monetary policy was consistent with this policy rule were at the Treasury, the agency responsible for financing the budget deficits and debt payments. Historical evidence indicate that the Treasury reacted strongly to this action precisely because it was inconsistent with the policy regime suggested above. Marriner Eccles, the governor of the Federal Reserve, described the reaction of the Secretary of Treasury, Henry Morgenthau, to the increase in interest rates in May 1937 which was due to an increase in reserve requirements (see Eccles (1951) p. 292).

> I was out of Washington when this happened. After hurrying back to do what I could to correct the situation, I found Secretary Morgenthau understandably disturbed about the fall in government bond prices [i.e. increase in short term interest rate]. He insisted that the Federal Reserve Board rescind its order for the second part of the [reserve requirement] increase, which was to go into effect on May 1. In a tense meeting at his home on Saturday night he let it be known that if the Board failed to do what he urged, he would release a substantial amount of sterilized gold and thereby create new reserves that could be used to bolster the government bond market.

What this quote illustrates is that the Secretary of the Treasury threatened to take monetary policy away from the Federal Reserve unless it kept interest rate low. As Eccles notes the action the Secretary threatened "would indicate that the Secretary of the Treasury had taken over control of monetary and credit policy" because a release of sterilized gold would have lead to a corresponding increase in the monetary base. This narrative evidence indicates that the Treasury wanted inflationary policies to protect the low interest rate it was paying on its outstanding debt, consistent with the policy regime FDRb. It would take

some time for Secretary Morgenthau to cow the Federal Reserve into reversing its but the Federal Reserve finally reversed its policy in 1938 by order of FDR (see Meltzer (2003) p. 531).

6.4 Deficit Spending in a MPE

When the government runs budget deficits the analysis of the Markov Perfect Equilibrium is considerably more complicated. The reason is that there is a nontrivial state variable in this case. In the Technical Appendix I proof that the unique state variable in the game between the government and the private sector is the real value of government debt, which is defined as the sum of the nominal stock of money and government bonds, deflated by the price level i.e. w_t. In the Technical Appendix I also formally define the Markov Perfect Equilibrium in the non-linear model. One can see the implications of the issuance of nominal debt on the budget constraint (7). The government needs to finance a given level of debt w_{t-1} and government spending $\hat{F}_t$ by one of three ways, issuing more debt w_t, raising taxes $\hat{T}_t$ or inflating. The growth rate of the debt is limited by a transversality condition of the representative household. The choice, then, is between taxation and inflation. The objective of the government (8) depends on both inflation and taxes. This indicates that in equilibrium the government does a little of both for any given level of debt, suggesting that in a Markov Equilibrium inflation expectations are increasing in the level of nominal debt. To increase inflation expectations, therefore, the government only needs to increase nominal liabilities. While this logic is clear enough, the linear quadratic framework is insufficient to derive the strategy functions of the government (even to a first order). The reason is that the key element that increases inflation expectations is the interaction between inflation and debt.[34] This is the reason I defer the proof of the next proposition the Technical Appendix. It require the exposition of the nonlinear model which I have omitted in the main text for brevity.

Proposition 6 *Assuming Stabilization Dogma $\hat{F}_t = F$ and A1 and A2 the FDRb regime is a MPE for values of d_w, d_r and s_w consistent with the conditions stated in the Technical Appendix*

Proof: See Technical Appendix

6.5 The FDR policy regime

I am now in a position to discuss the case in which both deficit and real spending are used jointly. In this case the government chooses both the optimal coefficient in rule (17) and in rule (20) that are consistent with a MPE so it uses both deficit spending and real spending to stabilize output and prices.

Definition 7 *The Roosevelt Regime: Monetary and fiscal policy are determined by policy regime FDRa and FDRb.*

[34] Consider the budget constraint in period $t+1$. In the linearized version of the budget constraint this term is $\bar{w}\pi_{t+1}$. This term does not capture the interaction between debt issued at time t and inflation at time $t+1$ because the constraint is linearized around some debt level $\bar{w}$.

Figure 10 shows the FDR regime. I compare this policy regime with the optimal policy under commitment, i.e. the policy if the government can commit to future policy (often referred to as the Ramsey equilibrium). The figure illustrates that the policy regime under commitment takes the same general form. In particular the optimal commitment is to commit to a higher price level and an output boom. Furthermore the optimal commitment is a temporary expansion in real spending. Deficit spending, however, plays a minor role under commitment because deficits are not needed in this case to make future inflation credible.

The model suggests that an unexpected shift in the policy regime from the Hoover policy regime to the FDR policy regime results in an immediate increase in both deficit and real government spending. This policy shift is associated with a stabilization in prices and output. The model is thus successful in accounting for the movement of all these variables. To the extent the policy announcement of FDR in 1933 were not fully credible at the time, one should have observe a more gradual recovery as expectation adjusted with increasing debt and higher government spending. This can explain why prices and output recovered more gradually than predicted by the model. The reason for why the policies were not fully credible immediately when announced can for example be explained by that it took time to enact legislation to put the spending programs in practice. One could account for an even more gradual increase in output by adding further sources of inertia in the model, such as habit in consumption, adjustment cost of capital and so on. This would complicate the model and I leave these extensions to future research.

Propositions 3, 5 and 6 show that the Hoover policy regime and the FDR policy regime a and b are consistent with Markov Equilibrium under particular constraints on fiscal policy. The final proposition of this section shows that if there are no constraints on fiscal policy the full FDR policy regime is Markov Perfect. The proof of this proposition, as it requires the exposition of the fully nonlinear model, is also relegated to the Technical Appendix.

Proposition 8 *Assuming no fiscal policy dogma and A1 and A2 the Roosevelt Policy Regime is a Markov Perfect Equilibrium for values of* f_r, d_w, d_r *and* s_w *consistent with the conditions stated in the Technical Appendix.*

Proof: See Technical Appendix.

This implies that alternative definition of the FDR regime is

Definition 5 The FDR Regime (Alternative Definition). *The government that maximizes (8) free of fiscal policy dogmas and cannot commit to future policy.*

This alternative interpretation reveals an attractive feature of the model. We can interpret the FDR regime change as the elimination of the fiscal policy dogmas.

6.6 The Economic Consequences of Franklin Delano Roosevelt measured in consumption equivalence units

What is the effect of the regime shift in the policy regime on the welfare of the representative household? Table 1 gives the answer to this questions and measures the welfare consequences by evaluating the utility of the representative household. This utility is measured in terms of consumption equivalence units. It measures how much steady state consumption the household would be ready to give up in order to avoid the structural shocks which gave rise to the Great Depression in our numerical example. As the table full coordination (i.e. using both fiscal policy instruments) in a MPE implies a trivial welfare cost of the shocks (and almost as small as if the government could fully commit to future policy). Deficit spending (FDRb) is more important to increase welfare than real government spending. If the government uses only real spending the welfare cost of the shocks is quite substantial or 1.4 percent of steady state consumption per period. The welfare consequences of the shocks are very severe under the Hoover Policy Regime. In this case the households would be ready to give up 4.3 percent of their steady state consumption in each period to avoid the shocks. This also indicates that the representative household would have been ready to give up quite a lot, i.e. close to 4.3 percent (the difference between the Hoover policy regime and FDR) in order to replace Hoover in office with FDR. This is a measure of the economic consequences of Franklin Delano Roosevelt. It may also help explaining his landslide election victory in 1936.

7 Conclusions

What are lessons could modern policy makers learn from the US experience in the Great Depression? The recession in Japan in the past several years has much in common with the Great Depression in the US (even if the output contraction and deflation is not of the same order). Since 2001 the Bank of Japan (BoJ) has maintained a zero interest rate, not unlike the near zero rates when FDR came into power. At the same time, as in the US during the Great Depression, Japan's CPI has consistently registered deflation and unemployment has been high. Below I offer some speculations on the similarities and differences between the actions of Japanese policymakers and FDR.

At a superficial level the reaction of the Japanese policymakers has been somewhat similar to FDR's actions in 1933. On the real government spending side there have been many attempts to increase demand by higher government spending. On the deficit site the Ministry of Finance has run large budget deficits so that gross debt over GDP has exploded to over 140 percent of GDP (although net debt remains lower see e.g. Eggertsson and Woodford (2003b) for discussion). Both the real and deficit spending in Japan are reminiscent of FDR's fiscal expansion. In addition to this the Ministry of Finance has engaged in aggressive purchases of foreign exchange. In 2003, for example, these operations amounted to close to 5% of Japanese GDP! This policy is reminiscent of FDR gold purchase program which was of similar order in 1933-34 and was conducted on foreign exchange markets. Finally the BoJ has adopted a policy of "quantiative easing"

since 2001, a measure that is beyond what the Federal Reserve did in 1933. This policy mandates that the BoJ increases the monetary base (by targeting non-borrowed reserves) more than is required to maintain zero interest rate. The monetary base has been expanded on several occasions since 2001. Indeed, as of today, the monetary base is nearly double the size of what it was in 2001!

Despite these policy actions inflation expectations have barely moved in Japan (see Eggertsson and Ostry (2005)) and the CPI has showed little, or at least weak, signs of reversing its deflationary trend. This stands in sharp contrast to the FDR regime change where prices and expectations responded immediately to the new policy regime in the spring of 1933 as discussed in section 2. What is the missing link? Why has CPI responded so little in Japan while it rebounded so stongly in response to FDR's policies? The most plausible explanation, as argued in Eggertsson and Ostry (2005), is that the policy actions in Japan have not been taken in the context of a clear commitment to inflate the price level. Indeed the BoJ has been very reluctant to announce any goals for the price level or inflation.[35] This is in sharp contrast to the FDR policy regime change, where FDR explicitly stated that he aimed to inflate the price level to its pre-depression level. The policy actions he took, such as the gold purchases, and fiscal expansion, where thus effective because they were conducted in the context of a coherent reflation program and worked mainly because they made the reflation credible.In Japan, in contrast, the fiscal expansion and exchange interventions have been largely conducted by the Minstry of Finance and without any coordination with the BoJ or any explicit goals of inflating the price level. Furthermore the BoJ has full goal and instrument independence and there is little reason for market participants to link the evolution of the debt postition of the Minstry of Finance to future inflation developments. For a fiscal expansion to be effective a coherent reflation program is needed with explicit coordination of monetary and fiscal policy. If such a program is implemented in Japan, it is likely that the effect will be swift and visible, much in the same way as the recovery in 1933-37 in the US under Franklin Delano Roosevelt.

[35] With a notable exeption in October 2003 when the BoJ released a statement that said that interest rate would be kept low until inflation was postitive. While this commitment was in the right direction, and there is some evidence it had some effect, it did not go nearly as far as FDR policy statments and prices did not rebound strongly.

8 Technical Appendix

Available upon request Gauti.Eggertsson@ny.frb.org.

Can also be downloaded at

http://www.ny.frb.org/research/economists/eggertsson/index.htm

where all programs and data can also be found.

9 Data Sources

Gross National Product is a splice of Christina Romer's revisions to the Kendrick-Kuznets series for 1927 and 1928 with the Bureau of Economic Analysis 1986 vintage estimates for 1929 through 1941. Romer's revisions to the real and nominal series are in table 5 of her 1988 paper. The 1986 vintage of BEA estimates are published in tables 1.1 and 1.2 in the National Income and Product Accounts, 1929-1982. Trend GDP is an extrapolated 3.15% growth rate from 1927, which matches Romer (1992).

Government consumption is the annual sum of a spliced US Federal Budget Expenditures series from the NBER Macro History database series 15005, averaging the overlapping observations.

Total government debt is the sum of gross direct debt from table 146 and total interest bearing guaranteed debt from table 148, both in section 13 of Banking and Monetary Statistics 1914-1941, less the portion of the debt held by the Federal Reserve as US Government Securities from table 101 in Section 10 of the same volume. This volume can be accessed online via the Federal Reserve Bank of St Louis' FRASER system at http://fraser.stlouisfed.org/publications/bms/.

The monetary base is measured as the end of year stock of currency held outside the Federal Reserve and Treasury plus the amount of non-borrowed reserves held by member banks of the Federal Reserve. Both series are downloaded from the NBER Macro History database, 14135 and 14123 respectively.

Total CPI is from the NBER Macro History database series 04128. The short-term interest rate is the constant maturity yield on 3 month Treasuries estimated by Cecchetti (1988). Ex-post real interest rates are deflated using the 3 month ahead annualized percent change in the Total CPI.

The monthly investment series is an index of new plant equipment orders from the 1937 Moody's Industrial Manual (a14). It is also reported in Temin and Wigmore (2002).

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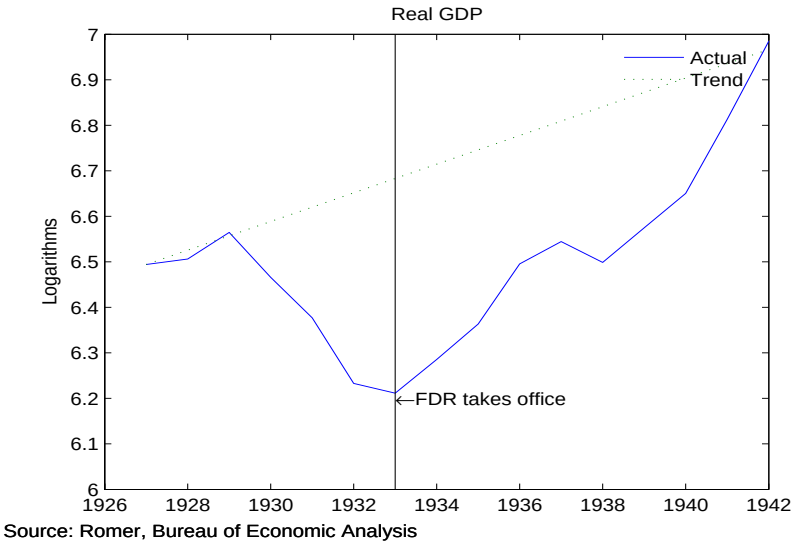

Figure 1: GDP rebounded when FDR took office.

Table 1. Nominal Liabilities of Federal Government. End of Year[1], Millions of Dollars

	1927	1928	1929	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941
Gross National Product	95,785	97,660	103,900	91,100	76,400	58,500	56,000	65,600	72,800	83,100	91,300	85,400	91,300	100,400	125,500
Government Consumption	3,004	3,196	3,331	3,546	4,300	4,572	5,116	7,556	6,844	8,533	8,235	8,453	9,320	9,794	19,053
Total Nominal Liabilities	**24,005**	**23,121**	**21,960**	**21,979**	**23,670**	**26,491**	**29,572**	**38,675**	**44,211**	**49,840**	**52,774**	**57,449**	**64,149**	**71,522**	**85,973**
Total Debt	17,419	17,082	15,790	15,297	17,009	18,950	21,557	29,112	32,620	36,639	39,360	41,855	45,079	48,742	62,002
Direct Securities[2]	17,419	17,082	15,790	15,297	17,009	18,950	21,377	26,049	28,126	31,977	34,715	36,863	39,470	42,846	55,690
Guaranteed Securities	0	0	0	0	0	0	180	3,063	4,494	4,662	4,645	4,992	5,609	5,896	6,312
Monetary Base	6,586	6,039	6,170	6,682	6,661	7,541	8,015	9,563	11,591	13,201	13,414	15,594	19,070	22,780	23,971
Currency in Circulation	4,716	4,685	4,577	4,604	5,360	5,387	5,519	5,536	5,881	6,543	6,551	6,856	7,597	8,731	11,159
Member Bank Non-borrowed Reserves	1,870	1,354	1,593	2,078	1,301	2,154	2,496	4,027	5,710	6,658	6,863	8,738	11,473	14,049	12,812
Total Deficit Spending[3]	**-1,113**	**-884**	**-1,161**	**19**	**1,691**	**2,821**	**3,082**	**9,103**	**5,536**	**5,629**	**2,934**	**4,675**	**6,700**	**7,373**	**14,451**

[1] Figures are end of period except for those in monetary base, which are monthly averages of daily December figures.

[2] This is total direct debt less the amount held by the Federal Reserve.

[3] Deficit spending is defined as the annual change in total nominal liabilities

Key monetary and fiscal statistics from the Great Depression

Table 2.

	Consumption Equivalence Units Per Quarter
Ramsey Equilibrium	-0.0029
FDR Policy Regime	-0.0348
FDRa	-1.4175
FDRb	-0.0425
Hoover Policy Regime	-4.3364

Figure 2: Prices started on an upward trend when FDR took office.

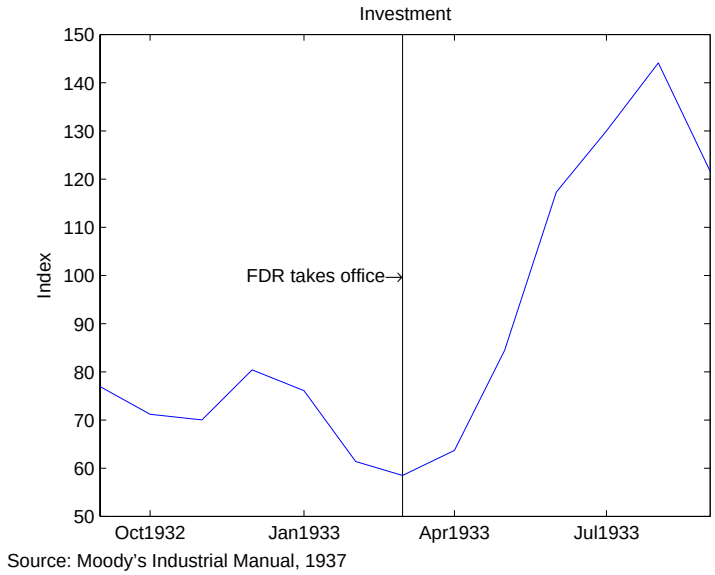

Figure 3: Investment responded most strongly to the FDR regime change consistent with the theory of the paper.

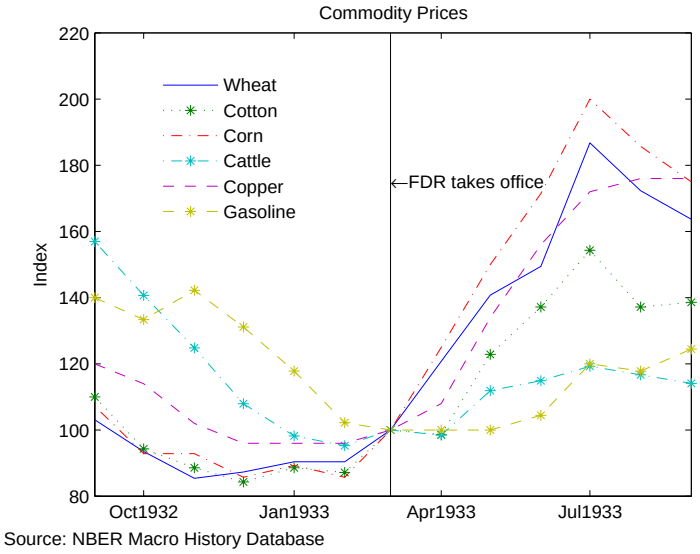

Figure 4: Prices determined on auction markets, and thus most sensistive to change in expectation, responded even more strongly than the CPI to the FDR regime change. The figure shows a one year windows around FDR inauguration.

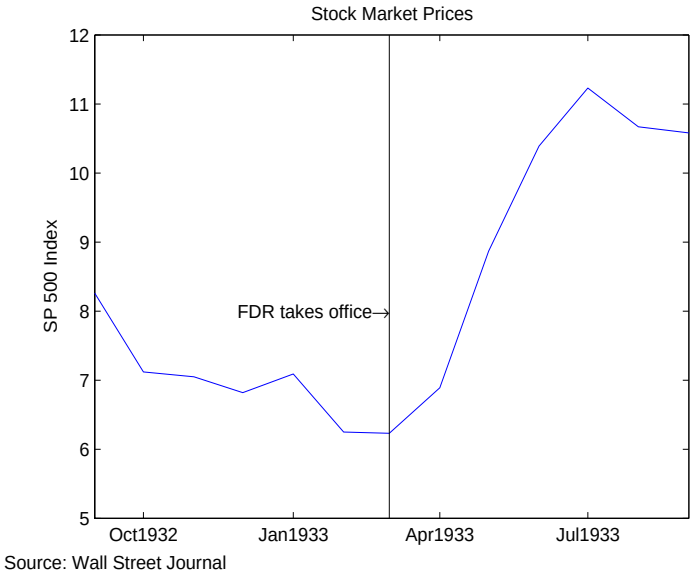

Figure 5:

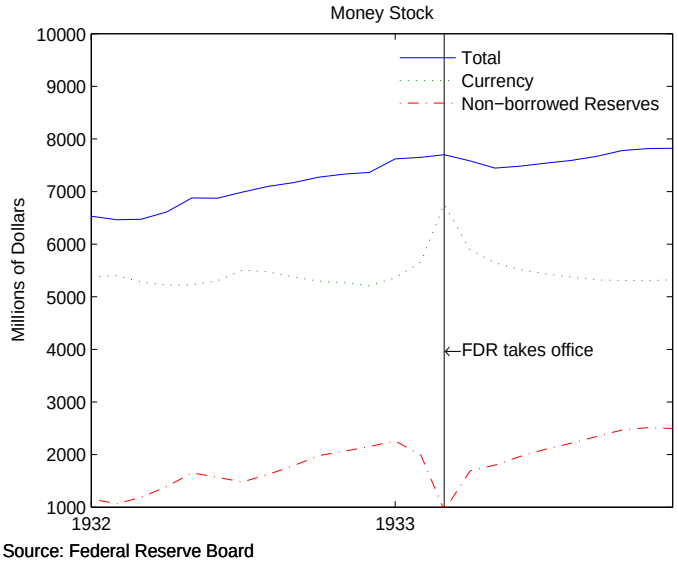

Figure 6: There is no evidence that the rebound in prices and output due to FDR rise to power was due to an increase in the money stock.

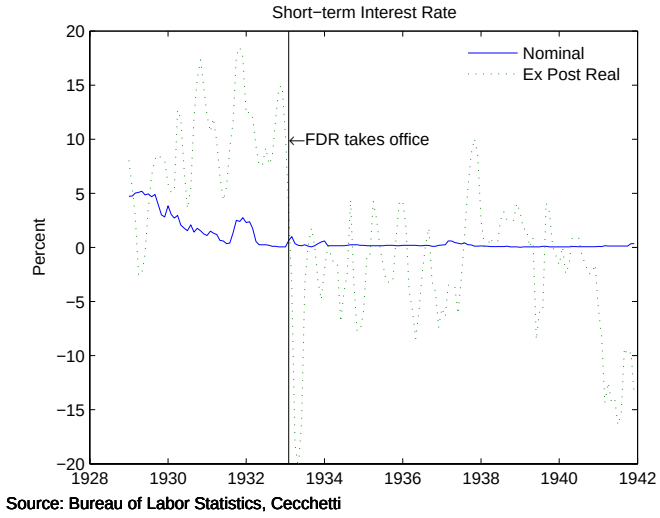

Figure 7: Real Rates collapsed with FDR rise to power thus stimulating demand.

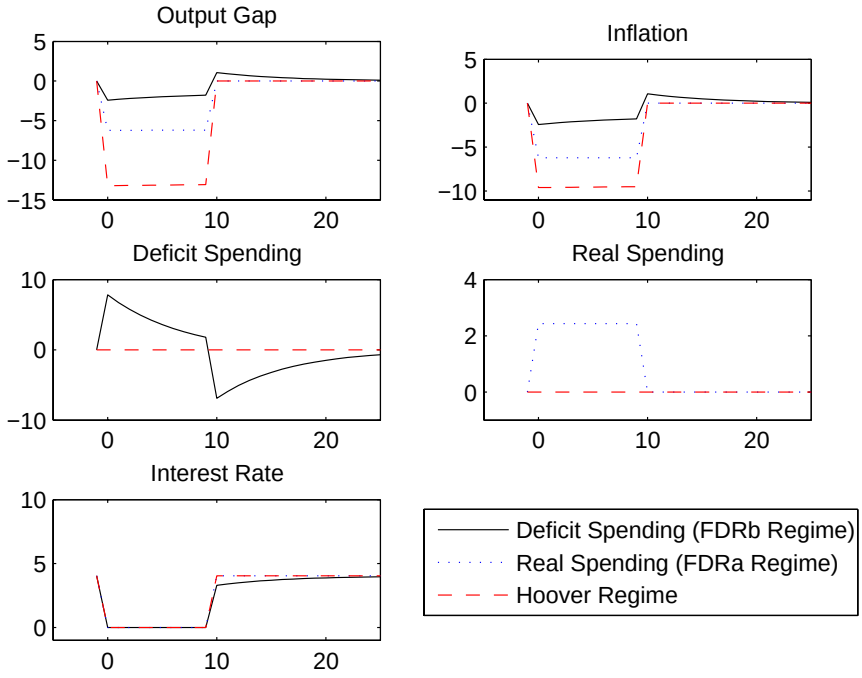

Figure 8: The model predicts an output collapse and double digit deflation under the Hoover policy regime but a very modest contraction under the FDR regime.

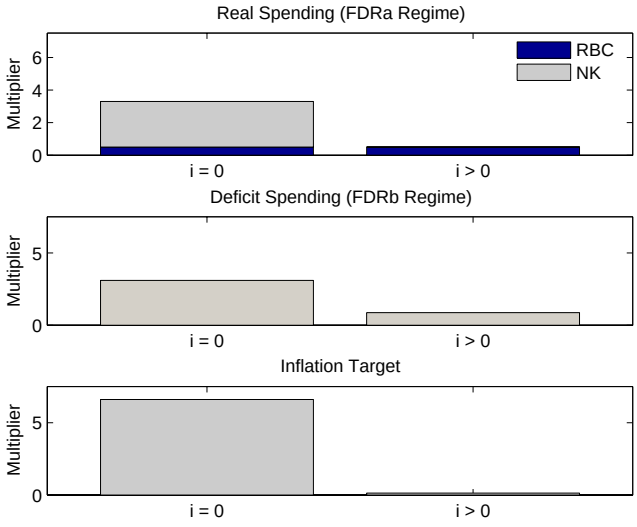

Figure 9: Fiscal policy is much more important to increase demand at zero interest rate than under normal circumstances when interest rate are positive.

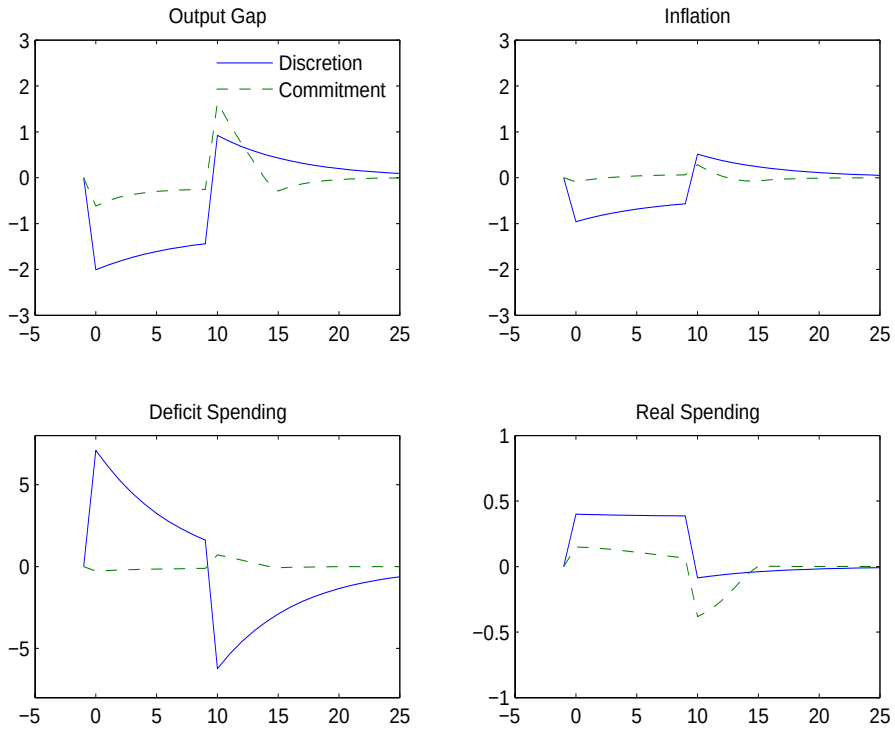

Figure 10: The FDR policy regime is relatively close to the optimal equilibrium if the government can commit to future policy.

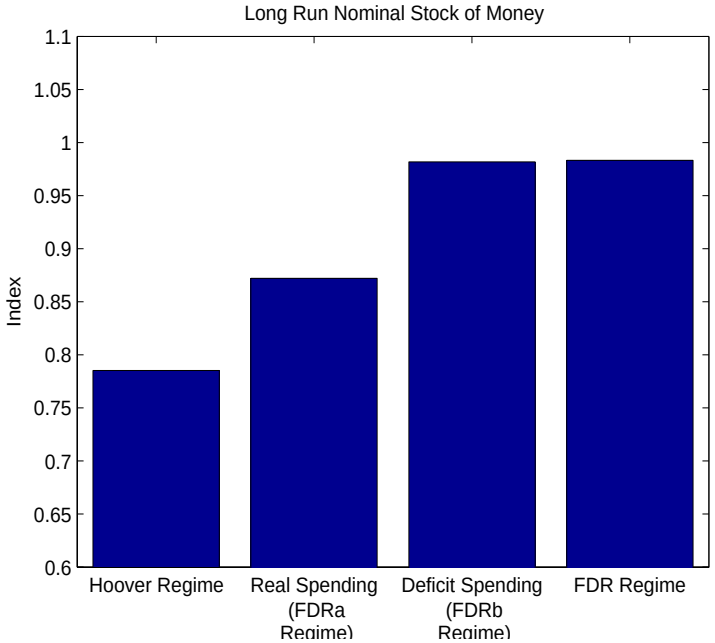

Figure 11: The long run nominal money stock = 1 in the absence of shocks.