Was the New Deal Contractionary?

January, 2008

Gauti B. Eggertsson
Federal Reserve Bank of New York
Gauti.Eggertsson@ny.frb.org
http://www.ny.frb.org/research/economists/eggertsson/

Abstract

Can government policies that increase the monopoly power of firms and the militancy of unions increase output? This paper studies this question in a dynamic general equilibrium model with nominal frictions and shows that these policies are expansionary when certain "emergency" conditions apply. I argue that these emergency conditions—zero interest rates and deflation—were satisfied during the Great Depression in the United States. Therefore, the New Deal, which facilitated monopolies and union militancy, was expansionary, according to the model. This conclusion is contrary to the one reached by Cole and Ohanian (2004), who argue that the New Deal was contractionary. The main reason for this divergence is that the current model incorporates nominal frictions so that inflation expectations play a central role in the analysis. The New Deal has a strong effect on inflation expectations in the model, changing excessive deflation to modest inflation, thereby lowering real interest rates and stimulating spending.

Key words: Great Depression, the New Deal, zero interest rates, deflation.
JEL classification: E52, E62, E65, N12.

The views expressed do not reflect the opinions of the Federal Reserve Bank of New York or the Federal Reserve System. I thank Jordi Gali, Dale Hendersson, Jim Kahn, Filippo Occhino, Simon Potter, Ben Pugsley, Christina Romer, Eric T. Swanson and especially Michael Woodford, for useful comments. I especially wish to thank Ben Puglsey and Krishna Rao for outstanding research assistance.

Can government policies that reduce the *natural level* of output increase *actual* output? For example, can facilitating monopoly pricing of firms, increasing the bargaining power of workers' unions or, even more exotically, burning production such as pigs, corn or cattle, increase output? Most economists would find the mere question absurd. In this paper, however, I show that the answer is yes under the special "emergency" conditions that apply when the short-term nominal interest rate is zero and there is excessive deflation. Furthermore, I argue that these special "emergency" conditions were satisfied during the Great Depression in the United States.

This result indicates that the National Industrial Recovery Act (NIRA), a New Deal policy universally derided by economists ranging from Keynes (1933) to Friedman and Schwartz (1963), and more recently by Cole and Ohanian (2004), increased output in 1933 when Franklin Delano Roosevelt (FDR) became the President of the United States. The NIRA declared a temporary "emergency" that suspended antitrust laws and facilitated union militancy to increase prices and wages. Some other laws, such as the Agricultural Adjustment Act (AAA), mandated outright destruction of output. The goal of these emergency actions was to battle the downward spiral of wages and prices observed in 1929-1933.

This paper studies these policies in a dynamic general equilibrium model with sticky prices. In the model, the NIRA creates distortions that moves the natural level of output away from the efficient level by increasing the monopoly power of firms and workers.[1] Following a previous literature, I call the distortions policy "wedges" because they create a wedge between the marginal rate of substitution between hours and consumption on the one hand and the marginal rate of transformation on the other. My definition of the wedges is the same as in Mulligan's (2002) and Chari, Kehoe and McGrattan's (2006) analysis of the Great Depression. Their effect on output, however, is exactly the opposite. While these authors find that the policy wedges reduce output in a model with flexible prices, I find that they increase output once the model is extended to include nominal frictions and special "emergency" conditions apply.

The NIRA policies, i.e. the wedges, are expansionary due to an expectation channel. Demand depends on the path for current and expected short-term real interest rates and expected future income. The real interest rate, in turn, is the difference between the short-term nominal interest rate and expected inflation. The NIRA increases inflation expectations because it helps workers and firms increasing prices and wages. Higher inflation expectations decrease real interest rates and thereby stimulate demand. Expectations of similar policy in the future increases demand further by increasing expectations about future income.

Under regular circumstances these policies are counterproductive. A central bank that targets price stability, for example, will offset any inflationary pressure these policies create by increasing the short-term nominal interest rate. In this case the policy wedges will reduce output through

[1] The natural level of output is the output if prices are flexible and the efficient output is the equilibrium output in the absence of any distortions, nominal or real. These concepts are formally defined in the model in section (2).

traditional channels. The New Deal policies are expansionary in the model because they are a response to the "emergency" conditions created by deflationary shocks. Building on Eggertsson and Woodford (2003) and Eggertsson (2006), I show that excessive deflation will follow from persistent deflationary shocks that imply that a negative real interest rate is needed for the efficient equilibrium. In this case a central bank, having cut the interest rate to zero, cannot accommodate the shocks because that would require a negative nominal interest rate, and the nominal interest rate cannot be negative. The deflationary shocks, then, give rise to a vicious feedback effect between current demand and expectations about low demand and deflation in the future, resulting in what I term a *deflationary spiral*. The New Deal policies are helpful because they break the deflationary spiral, by helping firm and workers to prevent prices and wages from falling.

The theoretical results of the paper stand at odds with both modern undergraduate macroeconomic or microeconomic textbooks. The macroeconomic argument against the NIRA was first articulated by John Maynard Keynes in an open letter to Franklin Delano Roosevelt in the New York Times on the 31st of December 1933. Keynes argument was that demand policies, not supply restrictions, were the key to recovery and to think otherwise was "a technical fallacy" related to "the part played in the recovery by rising prices." Keynes logic will be recognized by a modern reader as a basic IS-LM argument: a demand stimulus shifts the "aggregate demand curve" and thus increases both output and prices, but restricting aggregate supply shifts the "aggregate supply curve" and while this increases prices as well, it contracts output at the same time. Keynes argument against the NIRA was later echoed in Friedman and Schwartz (1963) account of the Great Depression and by countless other authors.

The microeconomic argument against the NIRA is even more persuasive. Any undergraduate microeconomics textbook has a lengthy discussion of the inefficiencies created by the monopoly power of firms or workers. If firms gain monopoly power they increase prices to increase their profits. The higher prices lead to lower demand. Encouraging workers collusion has the same effect. The workers conspire to prop up their wages, reducing hours demanded by firms. These results can be derived in a wide variety of models and have been applied by several authors in the context of the Great Depression in the US. An elegant example is an important paper by Cole and Ohanian (2004) but this line of argument is also found in several other recent papers such as Bordo, Erceg and Evans (2000), Mulligan (2002), Christiano, Motto and Rostagno (2004) and Chari, Kehoe and McGrattan (2006).

Given this broad consensus it is not surprising that one of the authors of the NIRA, Regford Guy Tugwell, said of the legislation that "for the economic philosophy which it represents there are no defenders at all." To my knowledge this paper is the first to formalize an economic argument in favor of these New Deal policies.[2] The logic of the argument, however, is far from new. The

[2] The closest argument is made in Tobin (1975) and De Long and Summers (1986). They show that policies that

argument is that these policies were expansionary because they changed expectations from being deflationary to being inflationary, thus eliminating the deflationary spiral of 1929-33. This made lending cheaper and thus stimulated demand. This, also, was the reasoning of the architects of the NIRA. The New York Times, for example, reported on the 29th of April 1933, when discussing the preparation of that NIRA

> A higher price level which will be sanctioned by the act, it was said, will encourage banks to pour into industry the credit now frozen in their vaults because of the continuing downward spiral of commodity prices.

The Keynesian models miss this channel because expectations cannot influence policy. Cole and Ohanian (2004) and the papers cited above miss it because they assume (i) flexible prices, (ii) no shocks and/or (iii) abstract from the zero bound. All three elements are needed to for the New Deal policies to be expansionary.

Under certain conditions the standard neoclassical growth model predicts that output increases in response to policy distortions. Imagine, for example, a permanent labor tax levied on households and that the proceeds of the tax are thrown into the sea. To make up for lost income the households work more and hence aggregate output increases (under certain restrictions on utility and taxes). The role of the policy distortions in this paper is unrelated to this well known example. According to our analysis, the natural level of output (which corresponds to the equilibrium output in the neoclassical model) unambiguously *decreases* as a result of the policy distortions studied. It is therefore the interaction of *nominal frictions* and the policy wedges that cause the output expansion. Moreover, while increasing the policy wedges always *reduces* welfare in the neoclassical model, the interaction of the policy wedges and sticky prices *increase* welfare in this paper. The paper thus establishes a new foundation of the New Deal as the optimal second best policy, in the classic sense of Lipsey and Lancaster (1954).

The basic channel for the economic expansion in this paper is the same as is in many recent papers that deal with the problem of the zero bound such as for example Krugman (1998), Svensson (2001) and Eggertsson and Woodford (2003,4) and Eggertsson (2006,2008) to name only a few. In these papers there can be an inefficient collapse in output if there are large deflationary shocks so that the zero bound is binding. The solution is to commit to higher inflation once the deflationary shocks have subsided. The New Deal policies facilitate this commitment because they reduce deflation in states of the world in which the zero bound is binding, beyond what would be possible with monetary policy alone. While this is always true *analytically*, i.e. regardless of the equilibrium concept used to study government policy, it is especially important *quantitatively* if there are limits to the government's ability to manipulate expectations about future policy.

make a sticky price economy more "rigid" may stabilize output. I discuss this argument in section 6 and confirm their result in the present model.

Policy makers during the Great Depression claimed that the main purpose of NIRA was to increases prices and wages to break the deflationary spiral of 1929-33.[3] There were several other actions taken to increase prices and wages, however. The most important ones were the elimination of the gold standard and an aggressive fiscal expansion that made a permanent increase in the monetary base credible as well as stimulating aggregate demand through higher government consumption. The effect of these policies is analyzed in Eggertsson (2008) in a general equilibrium model. While it remains an important research topic to estimate how much each of these policies contributed to the recovery, the paper shows that the NIRA was expansionary even under the extreme circumstances when the government can fully commit to future monetary policy (section **??**). The main focus of the paper, however, is on studying the contribution of the NIRA at the margin by abstracting from fiscal policy or institutional constraints such as the gold standard. This is important because the conventional wisdom is that the NIRA worked in the opposite direction to these stimulative policies. I find, in contrast, that they worked in the same direction and facilitated the recovery rather than halting it.

1 A Brief Historical Narrative

Excessive deflation helps explain the output collapse during the Great Depression: double digit deflation raised real interest rates in 1929-33 as high as 10-15 percent while the short-term nominal interest rates collapsed to zero (the short-term rate as measured by 3 month treasury bonds, for example, was only 0.05 percent in January 1933). This depressed spending, especially investment. Nobody was interested in investing when the returns from stuffing money under the mattress were 10-15 percent in real terms. Output contracted by a third in 1929-1933 and monthly industrial production lost more than half of its value, as shown in figure (1) and (2).

In the model the NIRA – even in the absence of any other policy actions – transforms deflationary expectations into inflationary ones. Deflation turned into inflation in March 1933, when FDR took office and announced the New Deal. Output, industrial production and investment responded immediately. Annual GDP grew by 39 percent in 1933-37 and monthly industrial production more than doubled as shown in figure (1) and (2). This is the greatest expansion in output and industrial production in any 4 year period in US history outside of war.

The NIRA was struck down by the Supreme court in 1935. Many of the policies, however, were maintained in one form or another throughout the second half of the 1930's, a period in which

[3] The *Wall Street Journal*, for example, reports that Franklin Delano Roosevelt declared after a joint meeting with the Prime Minister of Canada on the 1st of May of 1933:

> 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.

The action in the "economic field" FDR referred to was the NIRA.

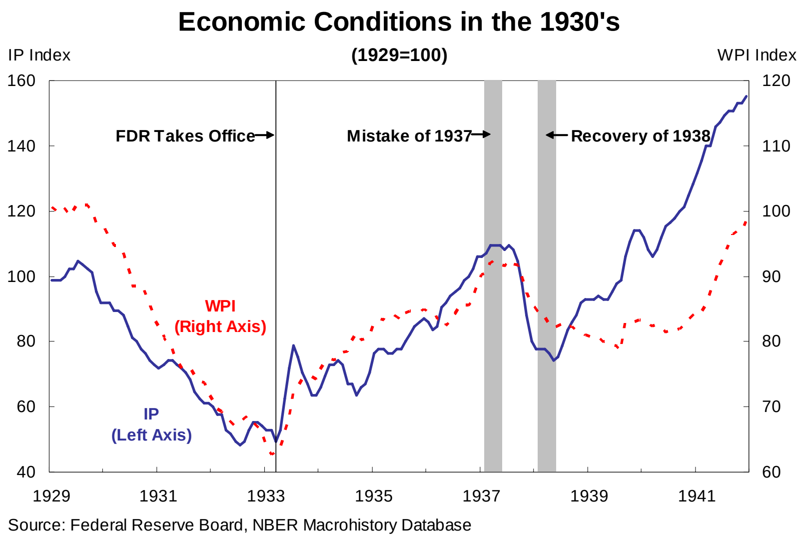

Figure 1: Both whole sale prices (WPI) and industrial output (IP) collapsed in 1929-1933 but abruptly started to recover in March 1933 when FDR took power and announced the New Deal.

interest rate remained close to zero. Some authors, such as Cole and Ohanian (2004), argue that other policies that replaced them, such as the National Labor Relation Act, had a similar effect.

While 1933-37 registers the strongest growth in US economic history outside of war, there is a common perception among economists that the recovery from the Great Depression was very slow (see e.g. Cole and Ohanian (2004)). One way to reconcile these two observations is to note that the economy was recovering from an extremely low level of output. Even if output grew fast in 1933-37, some may argue, it should have grown even faster, and registered more than 9 percent average growth in that period. Another explanation for the perception of "slow recovery" is that there was a serious recession in 1937-38 as can be seen in figure (1) and (2). Much of the discussion in Cole and Ohanian (2004), for example, focuses on comparing output in 1933 to output in 1939 when the economy was just starting to recover from the recession in 1937-38. If the economy had maintained the momentum of the recovery and avoided the recession of 1937-38, GDP would have reached trend in 1938. Figure 2 illustrates this point by plotting the natural logarithm of annual real output and an estimated linear trend for Romer's (1992) data on GDP.[4] By some other measures, such as monthly Industrial Production, the economy had already reached trend before the onset of the recession of 1937 (see Eggertsson and Pugsley

[4] Romer's data is from 1909-1982. The trend reported is estimated by least squares. This trend differs from the one reported in Cole and Ohanian's because the estimation suggest that the economy was 10 percent above trend in 1929 but Cole and Ohanian assume that the economy was at potential in 1929. The circled line shows the evolution of output if the economy would have escaped the recession of 1937-38 and maintained the growth rate of 1935-36. In this case output reaches trend in 1938.

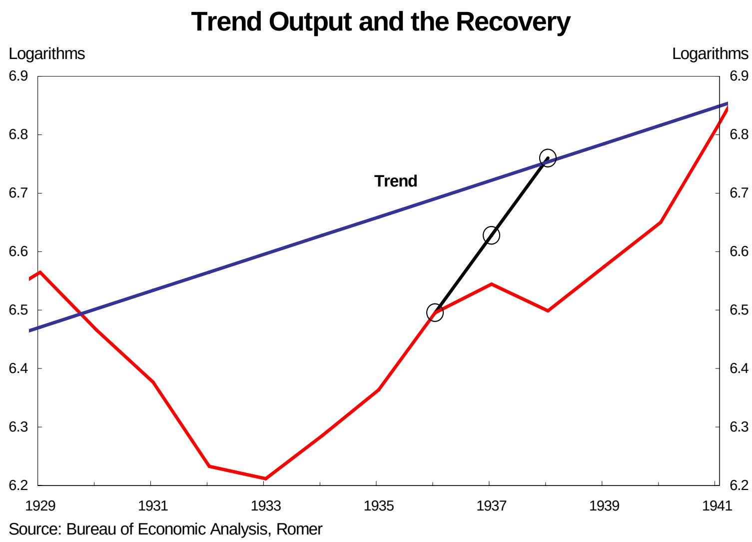

Figure 2: *The "slow recovery puzzle" is partially explained by the recession in 1937-38 which was triggered by abandonment of a commitment to reflation.*

(2006)).[5] To large extent, therefore, explaining the slow recovery is explaining the recession of 1937-38. This challenge is taken in Eggertsson and Pugsley's (2006) paper "the Mistake of 1937" which attributes the recession in 1937 to that the administration reneged on its commitment to increase the price level.[6]

[5] This is also consistent with what policymakers believed at the time. FDR said in his state of the Union address in Januare 1937, for example, "our task has not ended with the end of the depression." His view was mostly informed by the data on industrial production.

[6] They provide evidence for that the recession is explained by that in early 1937 the administration reneged on its commitment from 1933 to reflate the price level to pre-depression levels. This created pessimistic expectations of future prices and output and propagated into a steep recession. The NIRA does not feature directly in Eggertsson and Pugsley's story. It is worth pointing out, however, that in the spring of 1937 FDR lost one of the most important political battles of his life in the so called "court packing fiasco". This fiasco was brought about because FDR tried to use his reelection victory in 1936 to reorganize the Supreme Court by mandating several of the Judges to retire "due to age." FDR viewed the Supreme Court court as an obstacle to his recovery program because it had struck down several New Deal programs during his first term. The court packing failed due to adverse reactions by Congress and the public. To the extent that this fiasco signaled FDR's inability to legislate further reflationary policies such as NIRA, it could also have contributed to the deflationary expectation in 1937 and thereby help explain the recession of 1937-38. The recovery resumed in 1938 when the administration renewed its commitment to inflate the price level.

2 The Wedges and the Model

This section extends a standard general equilibrium model to allow for distortionary policy wedges. The source of the wedges are government policies that facilitate monopoly pricing of firms and union militancy. The model abstracts from endogenous variations in the capital stock, and assumes perfectly flexible wages, monopolistic competition in goods markets, and sticky prices that are adjusted at random intervals in the way assumed by Calvo (1983). A complementary appendix shows that the results are unchanged with endogenous capital or rigid wages. A representative maximizes a utility

$$E_t \sum_{T=t}^{\infty} \beta^{T-t} \left[u(C_T - H_t^c; \xi_T) - \int_0^1 v(L_T(j) - H_T^l(j); \xi_T) dj \right],$$

where β is a discount factor, C_t is a Dixit-Stiglitz aggregate of consumption of each of a continuum of differentiated goods,

$$C_t \equiv \left[\int_0^1 c_t(i)^{\frac{\theta}{\theta-1}} di \right]^{\frac{\theta-1}{\theta}},$$

with an elasticity of substitution equal to $\theta > 1$, P_t is the Dixit-Stiglitz price index,

$$P_t \equiv \left[\int_0^1 p_t(i)^{1-\theta} di \right]^{\frac{1}{1-\theta}} \tag{1}$$

and $L_t(j)$ is the quantity supplied of labor of type j. H_t^c and $H_t^l(j)$ are external consumption and labor habits. Each industry j employs an industry-specific type of labor, with its own wage $w_t(j)$.

For each value of the disturbances ξ_t, $u(\cdot; \xi_t)$ is concave function that is increasing in consumption. Similarly, for each value of ξ_t, $v(\cdot; \xi_t)$ is an increasing convex function. The vector of exogenous disturbances ξ_t may contain several elements, so that no assumption is made about correlation of the exogenous shifts in the functions u and v.

Financial markets are complete and there is no limit on borrowing against future income. As a consequence, a household faces an intertemporal budget constraint of the form

$$E_t \sum_{T=t}^{\infty} Q_{t,T} P_T C_T \leq W_t + E_t \sum_{T=t}^{\infty} Q_{t,T} \left[\int_0^1 \Pi_T(i) di + \int_0^1 w_T(j) L_T(j) dj - T_T \right]$$

looking forward from any period t. Here $Q_{t,T}$ is the stochastic discount factor by which the financial markets value random nominal income at date T in monetary units at date t, i_t is the riskless nominal interest rate on one-period obligations purchased in period t, W_t is the nominal value of the household's financial wealth at the beginning of period t, $\Pi_t(i)$ is nominal profits (revenues in excess of the wage bill) in period t of the supplier of good i, $w_t(j)$ is the nominal wage earned by labor of type j in period t, and T_t is net nominal tax liabilities in period t.

Optimizing household behavior implies the following necessary conditions for a rational-expectations equilibrium. Optimal timing of household expenditure requires that aggregate demand for the composite good[7] satisfy an Euler equation of the form

$$u_{c,t} = \beta E_t \left[u_{c,t+1}(1+i_t)\frac{P_t}{P_{t+1}} \right], \tag{2}$$

where i_t is the riskless nominal interest rate on one-period obligations purchased in period t and $u_{c,t}$ denotes marginal utility of consumption at time t. Household optimization similarly requires that the paths of aggregate real expenditure and the price index satisfy the conditions

$$\sum_{T=t}^{\infty} \beta^T E_t u_{c,T} Y_T < \infty, \tag{3}$$

$$\lim_{T\to\infty} \beta^T E_t [u_{c,T} W_T / P_T] = 0 \tag{4}$$

looking forward from any period t. W_t measures the total nominal value of government liabilities, which are held by the household. Condition (3) is required for the existence of a well-defined intertemporal budget constraint, under the assumption that there are no limitations on the household's ability to borrow against future income, while the transversality condition (4) must hold if the household exhausts its intertemporal budget constraint. For simplicity I assume throughout that the government issues no debt so that 4 is always satisfied.

Without entering into the details of how the central bank implements a desired path for the short-term interest rate, it is important to observe that it cannot be negative as long as people have the option of holding currency that earns a zero nominal return as a store of value.[8] Hence the zero lower bound

$$i_t \geq 0. \tag{5}$$

It is convenient to define the price for a one period real bond. This bond promises its buyer to pay one unit of a consumption good at date $t+1$, with certainty, for a price of $1+r_t$. This asset price is the short term real interest rate. It follows from the household maximization problem that the real interest rate satisfies the arbitrage equation

$$u_{c,t} = (1+r_t)\beta E_t u_{c,t+1} \tag{6}$$

Each differentiated good i is supplied by a single monopolistically competitive producer. As in Woodford (2003) there are many goods in each of an infinite number of "industries"; the goods in each industry j are produced using a type of labor that is specific to that industry and also change

[7] For simplicity, I abstract from government purchases of goods.

[8] While no currency is actually traded in the model, it is enough to assume that the government is commited to supply currency in an elastic supply to derive the zero bound. The zero bound is explicitly derived from money demand in Eggertsson and Woodford (2003) and Eggertsson (2006) but I abstract from these monetary frictions here for simplicity.

their prices at the same time. Each good is produced in accordance with a common production function[9]

$$y_t(i) = l_t(i),$$

where $l_t(i)$ is the industry-specific labor hired by firm i. The representative household supplies all types of labor as well as consuming all types of goods.[10] It decides on its labor supply by choice of $L_t(j)$ so that every labor supply of type j satisfies

$$\frac{w_t(j)}{P_t} = (1 + \omega_{1t}(j)) \frac{v_{L,t}}{u_{c,t}} \tag{7}$$

where $v_{L,t}$ denotes the marginal disutility of working at time t. The term $\omega_{1t}(j)$ is a distortionary wedge as in Chari, Kehoe and McGrattan (2006) or what Benigno and Woodford (2004) call labor market markup. The household takes this wedge as exogenous to its labor supply decisions. If the labor market is perfectly flexible then $\omega_{1t}(j) = 0$. Instead I assume that by varying this wedge the government can restrict labor supply and thus increase real wages relative to the case in which labor markets are perfectly competitive. The government can do this by facilitating union bargaining or by other anti competitive policies in the labor market. A marginal labor tax, rebated lump sum to the households, would have exactly the same effect.

The supplier of good i sets its price and then hires the labor inputs necessary to meet any demand that may be realized. Given the allocation of demand across goods by households in response to the firms pricing decisions, given by $y_t(i) = Y_t(\frac{p_t(i)}{P_t})^{-\theta}$, nominal profits (sales revenues in excess of labor costs) in period t of the supplier of good i are given by

$$\Pi_t(i) = \{1 - \omega_{2t}(j)\} p_t(i) Y_t(p_t(i)/P_t)^{-\theta} + \omega_{2t}(j) p_t^j Y_t(p_t^j/P_t)^{-\theta} - w_t(j) Y_t(p_t(i)/P_t)^{-\theta}/A_t \tag{8}$$

where p_t^j is the common price charged by the other firms in industry j and $p_t(i)$ is the price charged by each firm.[11] The wedge $\omega_{2t}(j)$ denotes a monopoly markup of firms - in excess of the one implied by monopolistic competition across firms – due to government induced regulations. A fraction $\omega_{2t}(j)$ of the sale revenues of the firm is determined by a common price in the industry, p_t^j, and a fraction $1 - \omega_{2t}(j)$ by the firms own price decision. (Observe that in equilibrium the two prices will be the same). A positive $\omega_{2t}(j)$ acts as a price collusion because a higher $\omega_{2t}(j)$, in equilibrium, increases prices and also industry j's wide profits (local to no government intervention). A consumption tax – rebated either to consumers or firms lump sum – would introduce exactly the same wedge. In the absence of any government intervention $\omega_{2t} = 0$

[9] There is no loss of generality in assuming a linear production function because I allow for arbitary curvature in the disutility of working.

[10] We might alternatively assume specialization across households in the type of labor supplied; in the presence of perfect sharing of labor income risk across households, household decisions regarding consumption and labor supply would all be as assumed here.

[11] In equilibrium, all firms in an industry charge the same price at any time. But we must define profits for an individual supplier i in the case of contemplated deviations from the equilibrium price.

To close the model we need to specify the evolution of the external habits. The consumption habit is proportional to aggregate consumption from the last period, while the labor habit is proportional to aggregate labor from last period (where aggregate labor is defined as a Dixit-Stiglitz index of each sector specific labor input, analogous the consumption habit). Since all output is consumed, and production is linear in labor, this implies that in equilibrium

$$H_t^c = H_t^l = \rho Y_{t-1}$$

and hence

$$u_{c,t} = u_c(Y_t - \rho Y_{t-1}; \xi_t)$$

$$v_{L,t} = v_L(L_t(j) - \rho Y_{t-1}; \xi_t)$$

2.1 Equilibrium with Flexible Prices

If prices are fully flexible, $p_t(i)$ is chosen each period to maximize (8). This leads to the first order condition for the firm maximization

$$p_t(i) = \frac{\theta}{\theta - 1} \frac{w_t(j)/A_t}{1 - \omega_{2t}(j)} \tag{9}$$

which says that the firm will charge a markup $\frac{\theta}{\theta-1}\frac{1}{1-\omega_{2t}(j)}$ over its labor costs due to its monopolistic power. As this equation makes clear the policy variable $\omega_{2t}(j)$ can create a distortion by increasing the markup industry j charges beyond what is socially optimal. Under flexible prices all firms face the same problem so that in equilibrium $y_t(i) = Y_t$ and $p_t(i) = P_t$ and $L_t = L_t(j) = Y_t$. Combining (7) and (9) then gives an aggregate supply equation

$$\frac{\theta - 1}{\theta} = \frac{1 + \omega_{1t}}{1 - \omega_{2t}} \frac{v_{L,t}}{u_{c,t}} \tag{10}$$

where I have assumed that the wedges are set symmetrically across sectors.

Equilibrium output in the flexible price economy is called the natural rate of output, and the efficient level of output is the optimal flex price output. These two concepts will be convenient in our analysis of the model with sticky prices.

Definition 1 *A flexible price equilibrium is a collection of stochastic processes for* $\{P_t, Y_t, i_t, r_t, \omega_{1t}, \omega_{2t}\}$ *that satisfy (2), (5), (6) and (10) for a given sequence of the exogenous processes* $\{\xi_t\}$ and an initial condition (Y_{-1}, P_{-1}). *The output in this equilibrium is called the natural rate of output and is denoted* Y_t^n.

Definition 2 *An efficient allocation is the flexible price equilibrium that maximizes social welfare. The equilibrium output in this equilibrium is called the efficient output and is denoted* Y_t^e *and the real interest rate is the efficient level of interest and denoted* r_t^e.

The next proposition shows how the government should set the wedges to achieve the efficient allocation.

Proposition 1 *In the efficient equilibrium the government sets* $\frac{1+\omega_{1t}}{1-\omega_{2t}} = \frac{\theta-1}{\theta}$ *and output,* Y_t^e*, is determined by (10).*

Proof. The constraints (2), (5) and (6) play no role apart from in determining the nominal prices and real and nominal interest rate are thus redundant in writing the social planners problem.[12] The Lagrangian for optimal policy can thus be written as:

$$E_0 \sum_{t=0}^{\infty} \beta^t \{u(Y_T - \rho Y_{T-1}; \xi_T) - v(Y_t - \rho Y_{T-1}; \xi_T) + \psi_{1t}\{\frac{\theta-1}{\theta} - \frac{1+\omega_{1t}}{1-\omega_{2t}} \frac{v_{L,t}}{u_{c,t}}\}.$$

The first order condition with respect to Y_T can be written as

$$u_{c,t} - v_{L,t} + \beta\rho E_t(u_{c,t+1} - v_{L,t+1}) - \psi_{1t} \frac{\partial \frac{1+\omega_{1t}}{1-\omega_{2t}} \frac{v_{L,t}}{u_{c,t}}}{\partial Y_t} + \rho\beta\psi_{1t+1} \frac{\partial \frac{1+\omega_{1t+1}}{1-\omega_{2t+1}} \frac{v_{L,t+1}}{u_{c,t+1}}}{\partial Y_{t+1}}$$

where I have used the form of the utility function to substitute out for the derivative of ∂Y_t in terms of ∂Y_{t+1} so that I can forward this equation. Forwarding and using $\beta\gamma < 0$ and assuming a bounded solution we obtain

$$u_{c,t} - v_{L,t} - \psi_{1t} \frac{\partial \frac{1+\omega_{1t}}{1-\omega_{2t}} \frac{v_{L,t}}{u_{c,t}}}{\partial Y_t} = 0 \tag{11}$$

The first order conditions with respect to ω_{1t} and ω_{2t} say that

$$\psi_{1t} = 0 \tag{12}$$

Substituting this into (11), we obtain that $\frac{v_{L,t}}{u_{c,t}} = 1$. Substitute this into (10) to obtain the result.
■

The efficient policy only pins down the ratio $\frac{1+\omega_{1t}}{1-\omega_{2t}}$ but says nothing about how each of the variables are determined. The condition in Proposition (1) says that the wedges should be set to eliminate the distortions created by the monopolistic power of the firms.

There are many paths for prices and nominal interest rate that are consistent with the efficient allocation when prices are flexible. The implication is that the zero bound constraint (5) plays no role in determining the efficient output or the real interest rate (i.e. Y_t^e and r_t^e).

2.2 Equilibrium with Nominal Frictions

This section introduces nominal rigidities which play a key role in the analysis. Instead of being flexible prices remain fixed in monetary terms for a random period of time. Following Calvo

[12] This can be shown formally by adding them to the Lagrangian problem and show that the Lagrance multipliers of these constraints are zero.

(1983) suppose that each industry has an equal probability of reconsidering its price each period. Let $0 < \alpha < 1$ be the fraction of industries with prices that remain unchanged each period. In any industry that revises its prices in period t, the new price p_t^* will be the same. The maximization problem that each firm faces at the time it revises its price is

$$\max_{p_t^*} E_t \left\{ \sum_{T=t}^{\infty} (\alpha\beta)^{T-t} Q_{t,T} \{ \{1-\omega_{2T}\} p_t^* Y_T (p_t^*/P_T)^{-\theta} + \omega_{2T} p_t^j Y_T (p_t^j/P_T)^{-\theta} - w_T(j) Y_T (p_t^*/P_T)^{-\theta} \} \right\}$$

The price p_t^* is defined by the first-order condition

$$E_t \left\{ \sum_{T=t}^{\infty} (\alpha\beta)^{T-t} u_c(Y_T - \rho Y_{T-1}; \xi_T) (\frac{p_t^*}{P_T})^{-\theta} Y_T \{ (1-\omega_{2T}) \frac{p_t^*}{P_T} - \frac{\theta}{\theta-1} (1+\omega_{1T}) \frac{v_L(Y_T(p_t^*/P_T)^{-\theta} - \rho Y_{T-1}; \xi_T)}{u_c(Y_T - \rho Y_{T-1}; \xi_T)} \} \right\} = 0 \tag{13}$$

where (7) is used to substitute out for wages and the stochastic discount factor has been substituted out using

$$Q_{t,T} = \beta^{T-t} \frac{u_{c,T} P_t}{u_{c,t} P_T}.$$

The first order condition (13) says that the firm will set its price to equate expected discounted sum of its nominal price to a expected discounted sum of its markup times nominal labor costs. Finally, the definition (1) implies a law of motion for the aggregate price index of the form

$$P_t = \left[(1-\alpha) p_t^{*1-\theta} + \alpha P_{t-1}^{1-\theta} \right]^{\frac{1}{1-\theta}}. \tag{14}$$

Equilibrium can now be defined as follows.

Definition 3 *A sticky price equilibrium is a collection of stochastic processes* $\{Y_t, P_t, p_t^*, i_t, r_t, \omega_{1t}, \omega_{2t}\}$ *that satisfies (2), (5), (6),(13), (14) for a given sequence of the exogenous shocks* $\{\xi_t\}$ and an initial condition (Y_{-1}, P_{-1}).

A steady state of the model is defined as a constant solution to the model when there are no shocks. The following propositions shows how a social planner can implement the efficient equilibrium in the steady state of the sticky price model.

Proposition 2 *If there are no shocks so that* $\xi_t = \bar{\xi}$ *and then in a sticky price equilibrium (i) a social planner can achieve the efficient equilibrium by selecting* $i_t = 1/\beta - 1$ *and* $\frac{1+\omega_{1t}}{1-\omega_{2t}} = \frac{\theta-1}{\theta}$ *and ensure that* $P_{t+1} = P_t = \bar{P}$, $Y_t = Y_t^n = Y_t^e$ *and (ii) the efficient equilibrium is the optimal allocation.*

Proof. To prove the first part observe that if $P_t = \bar{P}$ for all t then $p_t^* = P_t$. This implies conditions (13) is identical to (10) so that the sticky price allocation solves the same set of equations as the flexible price allocation. Then the first part of the Proposition follows from Proposition 1. The second part of this proposition can be proved by following the same steps as Benigno and Woodford (2003) (see Appendix A.3 of their paper). They show a deterministic solution of a social planners problem that is almost identical to this one, apart from that in their case the wedge is set to collect tax revenues. ■

3 Approximate Sticky Price Equilibrium and Necessary Conditions for the First Best Allocation

Our main concern will be about the behavior of the model when perturbed by temporary shocks because this is what gives rise to the deflationary spiral. To characterize the equilibrium in this case we approximate the sticky price model in terms of log-deviations from the steady state defined in the last section. A convenient feature of this model is that the shocks in the sticky price model can be summarized in terms of the efficiency rates of output and interest. Hence we can think of the model as being determined by two blocks. On the one hand the shocks determine the efficient rate of interest and output completely independently of the policy setting. On the other hand the sticky price model, taking the efficient rate of interest and output as inputs, determines equilibrium output and prices as a function of the policy choices of the government. In this section, I show what conditions about policy are needed so that the sticky price equilibrium perfectly tracks the efficient rate of output and interest. This is the first best equilibrium in the approximated economy (the first and second best equilibrium are formally defined in section 7).

In the steady state $1+\bar{\omega} \equiv \frac{1+\omega_1}{1-\omega_2} = \frac{\theta-1}{\theta}$, $\Pi = 1$, $\bar{Y} = \bar{Y}^e = \bar{Y}^n$. By equation (10) and Proposition 1 the efficient level of output can be approximated by

$$\tilde{Y}_t^e = \hat{Y}_t^e - \rho\hat{Y}_{t-1}^e = \frac{\delta_c^{-1}\sigma^{-1}}{\delta_c^{-1}\sigma^{-1} + \delta_l\nu} g_t + \frac{\nu}{\sigma^{-1}+\nu} q_t \tag{15}$$

where the hat denotes log deviation from steady state, i.e. $\hat{Y}_t^e \equiv \log Y_t^e/\bar{Y}^e$ and the quasi growth rate is denoted by tilda, i.e. $\tilde{Y}_t^e \equiv \hat{Y}_t^e - \rho\hat{Y}_{t-1}^e$. They key advantage of the habit formation assumed here is that we can express all the variables (output, the natural rate of output and the efficient level of output) in terms of this quasi-growth rate variable. The model without habit is identical to the model derived here since $\rho = 0$ in that case and $\tilde{Y}_t^e = \hat{Y}_t^e$. The shocks are $g_t \equiv -\frac{\bar{u}_{c\xi}}{\bar{Y}\bar{u}_{cc}}\xi_t$, $q_t \equiv -\frac{\bar{v}_{L\xi}}{\bar{L}\bar{v}_{LL}}\xi_t$, where a bar denotes that the variables (or functions) are evaluated in steady state. I define the parameters $\sigma \equiv -\frac{\bar{u}_c}{\bar{u}_{cc}(\bar{C}-\bar{H}^c)}$ and $\nu \equiv \frac{\bar{v}_{LL}(\bar{L}-\bar{H}^l)}{\bar{v}_L}$ and $\delta_c \equiv \frac{\bar{C}-\bar{H}^c}{\bar{Y}}$ and $\delta_l \equiv \frac{\bar{L}-\bar{H}^l}{\bar{L}}$. Using equation (6) the efficient level of interest can be approximated by

$$r_t^e = \bar{r} + \delta_c^{-1}\sigma^{-1}[(g_t - \tilde{Y}_t^e) - E_t(g_{t+1} - \tilde{Y}_{t+1}^e)] \tag{16}$$

where $\bar{r} \equiv \log\beta^{-1}$. I can now express the consumption Euler equation (2) as[13]

$$\tilde{Y}_t - \tilde{Y}_t^e = E_t\tilde{Y}_{t+1} - E_t\tilde{Y}_{t+1}^e - \delta_c\sigma(i_t - E_t\pi_{t+1} - r_t^e) \tag{17}$$

[13] The i_t in this equation actually refers to $\log(1+i_t)$ in the notation of previous section, i.e. the natural logaritm of the gross nominal interest yield on a one-period riskless investment, rather than the net one-period yield. Also

where $\pi_t \equiv \log P_t/P_{t-1}$ and $\tilde{Y}_t \equiv \hat{Y}_t - \rho\hat{Y}_{t-1}$. This equation says that current demand depends on expectation of future demand and the difference between the real interest rate and the efficient rate of interest.

Using equations (10) and (15) the relation between the natural level of output and the efficient level can be approximated by

$$\tilde{Y}_t^n = \tilde{Y}_t^e - \frac{1}{\delta_c^{-1}\sigma^{-1} + \delta_l \upsilon}\hat{\omega}_t \tag{18}$$

where $\hat{\omega}_t \equiv \log((1+\omega_t)/(1+\bar{\omega}))$. This equation illustrates that while the efficient level of output in (15) is only a function of the exogenous shocks, policy induced distortionary wedges can change the natural level of output.

The Euler equation (13) of the firm maximization problem, together with the price dynamics (14), can be approximated to yield

$$\pi_t = \kappa(\tilde{Y}_t - \tilde{Y}_t^n) + \beta E_t \pi_{t+1} \tag{19}$$

where $\kappa \equiv \frac{(1-\alpha)(1-\alpha\beta)}{\alpha}\frac{\delta_c^{-1}\sigma^{-1}+\delta_l\upsilon}{1+\delta_l\nu\theta}$. The shocks in the model are now completely summarized by the stochastic processes for r_t^e and $\tilde{Y}_t^e$ so that an equilibrium of the model can be characterized by equations (17), (18) and (19) for a given sequence of $\{\tilde{Y}_t^e, r_t^e\}$.

Definition 4 *An approximate sticky price equilibrium is a collection of stochastic processes for the endogenous variables $\{\tilde{Y}_t, \pi_t, \tilde{Y}_t^n, i_t, \hat{\omega}_t\}$ that satisfy (5), (17),(18), (19) for a given sequence of the exogenous shocks $\{\tilde{Y}_t^e, r_t^e\}$.*

To evaluate the welfare consequences of policy in the approximate economy one needs to determine the welfare function of the government. The next proposition characterizes the objective of the government to a second order. As shown by Woodford (2003), given that I only characterize fluctuations in the variables to the first order, I only need to keep track of welfare changes to the second order.

Proposition 3 *Utility of the representative household in an approximate sticky price equilibrium can be approximated to a second order by*

$$U_t \approx -\frac{1}{2}\sum_{t=0}^{\infty}\beta^t\{\pi_t^2 + \lambda(\tilde{Y}_t - \tilde{Y}_t^e)^2\} + t.i.p \tag{20}$$

where t.i.p. denotes terms independent of policy and $\lambda = \kappa/\theta$.

---

note that this variable, unlike the others appearing in the log-linear approximate relations, is not defined as a deviation from steady-state value. I do this to simplify notation, i.e. so that I can express the zero bound as the constraint that i_t cannot be less than zero. Also note that I have also defined r_t^n to be the log level of the gross level of the natural rate of interest rather than a deviation from the steady state value $\bar{r}$.

Proof. Follows from Proposition 6.1, 6.3 and 6.4 in Woodford (2003) with appropriate modifications of the proofs, taking into account the wedges and the habit persistence parameters. For the proof of 6.1 we need the modification that $\Phi_y = 0$ because we expand around the fully efficient steady and replace equation E.6 on p. 694 with equation (15). The rest follows unchanged. ■

This proposition indicates that in a model in which there are shocks so that $\tilde{Y}_t^e$ varies over time then, at least to a second order, social welfare is maximized when inflation is stable at zero and the equilibrium output tracks the efficient level of output. This is what I define as the first best solution. I defer to section 7 to formally distinguish between first and second best social planner problems. Without going into the details of the social planner's problem, however, it is straight forward to derive the necessary conditions for the first best equilibrium as shown in the next proposition.

Proposition 4 *Necessary conditions for implementing the first best solution in which* $\tilde{Y}_t = \tilde{Y}_t^e$ *and* $\pi_t = 0$ *are that*

$$i_t = r_t^e \tag{21}$$

$$\hat{\omega}_t = 0 \tag{22}$$

Proof. Substitute $\pi_t = 0$ and $\hat{Y}_t = \hat{Y}_t^e$ into equation 17 $\Longrightarrow i_t = r_t^e$. Substitute equation 18 into equation 19 and use $\pi_t = 0$ and $\tilde{Y}_t = \tilde{Y}_t^e \Longrightarrow \hat{\omega}_t = 0$ ■

Condition (21) says that the nominal interest rate should be set equal to the efficient level of interest. There is no guarantee, however, that this number is positive in which case this necessary condition has to be violated due to the zero bound on the short-term interest rate. Given the two necessary conditions derived in Proposition (4) a tempting policy recommendation is to direct the government to try to achieve these conditions "whenever possible" and when not possible then to satisfy them "as closely as possible", taking future conditions as given. I will now explore consequences of this policy which serves as a baseline policy.

Observe that this policy is equivalent to a policy in which the government targets zero inflation at all times "if possible". Eggertsson (2008) argues that this type of policy describes relatively well the policy of the Federal Reserve shortly before FDR rose to power.

4 Excessive Deflation and an Output Collapse under a Baseline Policy

This section explores the equilibrium outcome when r_t^e is temporarily negative and the government tries to satisfy the necessary conditions for the first best "as closely as possible". In this case, one of the necessary conditions for the first best solution cannot be satisfied due the zero bound on the short-term nominal interest rate. I assume the following shock process for r_t^e.

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

This assumption is the same as in Eggertsson (2008) who argues that this disturbance is necessary to explain a simultaneous decline in interest rates, output and inflation. For simplicity I have assumed that $\tilde{Y}_t^e$ is constant so that the dynamics of the model are driven by the exogenous component of the natural rate of interest r_t^e. Recall from section (3) that all the shocks in the sticky price economy can be summarized by r_t^e and $\tilde{Y}_t^e$. We observe from the equation (16) for r_t^e that there are several forces that can create a temporary 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), see Eggertsson (2008) for a detailed discussion.

A policy which aims at satisfying (21) and (22) "whenever possible" (and if that is not feasible then "as closely as feasible") takes the form

$$i_t = 0 \text{ for } 0 < t < \tau \tag{23}$$

$$i_t = r_H^e + \phi_\pi \pi_t \text{ for } t \geq \tau \tag{24}$$

$$\hat{\omega}_t = 0 \text{ for all } t \tag{25}$$

This is the benchmark policy. In equation (24) we assume that $\phi_\pi > 1$. The term $\phi_\pi \pi_t$ is redundant because $\pi_t = 0$ in periods $t \geq \tau$ but I include this term to ensure local determinacy of equilibria.[14] We show in section 7 that in the absence of $\hat{\omega}_t$ as a viable policy instrument (23) (24) corresponds to optimal monetary policy from a forward looking perspective, and furthermore, is the Markov Perfect Equilibrium of the model.

Consider the solution under this policy. In the periods $t > \tau$ the solution is that $\pi_t = \hat{Y}_t = 0$. In periods $t < \tau$ the simple assumption made on the natural rate of interest implies that inflation in the next period is either zero (with probability γ) or the same as at time t i.e. π_t (with probability $(1 - \gamma)$). Hence the solution in $t < \tau$ satisfies the IS and the AS equations

$$\tilde{Y}_t = (1 - \gamma)\tilde{Y}_t + \sigma(1 - \gamma)\pi_t + \sigma r_L^e \tag{26}$$

$$\pi_t = \kappa \tilde{Y}_t + \beta(1 - \gamma)\pi_t \tag{27}$$

where we have taken account of the fact that $E_t\pi_{t+1} = (1 - \gamma)\pi_t$, $E_t\tilde{Y}_{t+1} = (1 - \gamma)\tilde{Y}_t$ and that (23) says that $i_t = 0$ when $t < \tau$. Solving these two equations with respect to π_t and $\tilde{Y}_t$ one obtains the next proposition.

[14] see e.g. discussion in Woodford (2003).

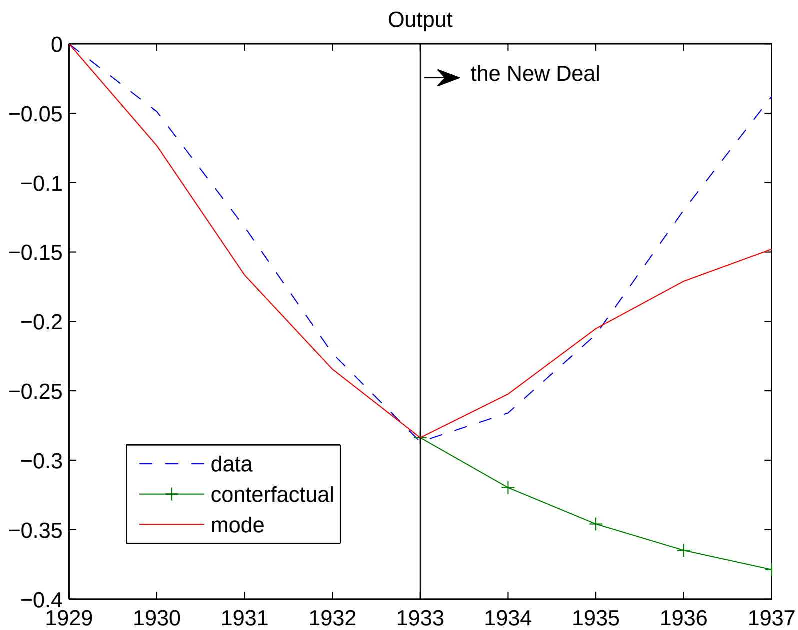

Figure 3: Data on output and simulated output from the model with and without the New Deal (NIRA).

Proposition 5 ***Output Collapse and Deflationary Spiral under the Benchmark Policy.*** *If A1 then the evolution of output and inflation under the benchmark policy is:*

$$\tilde{Y}_t^D = \frac{1-\beta(1-\gamma)}{\gamma(1-\beta(1-\gamma))-\sigma\kappa(1-\gamma)}\sigma r_L^e < 0 \text{ if } t < \tau \text{ and } \tilde{Y}_t^D = 0 \text{ if } t \geq \tau \tag{28}$$

$$\pi_t^D = \frac{1}{\gamma(1-\beta(1-\gamma))-\sigma\kappa(1-\gamma)}\kappa\sigma r_L^e < 0 \text{ if } t < \tau \text{ and } \pi_t^D = 0 \text{ if } t \geq \tau \tag{29}$$

The restriction on γ 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.

4.1 Bayesian Evaluation of the model

While all the results in this paper are based on closed form analytical solutions it is useful to put some numbers on them for illustration purposes, and get some sense of if the model can replicate the data under configurations which can be counted as "reasonable". Similarly it is of some interest to understand how sensitive the conclusion presented in later sections are to perturbation to the parameters. To solve the model numerically we need to determine the parameters $(\beta, \sigma, \theta, \nu, \alpha, \rho)$ (which in turn determine δ_c, δ_l and κ) and take a stance on the shock process governed by (r_L^e, γ). I use Bayesian methods to do this. Let us denote the parameters and the shocks by

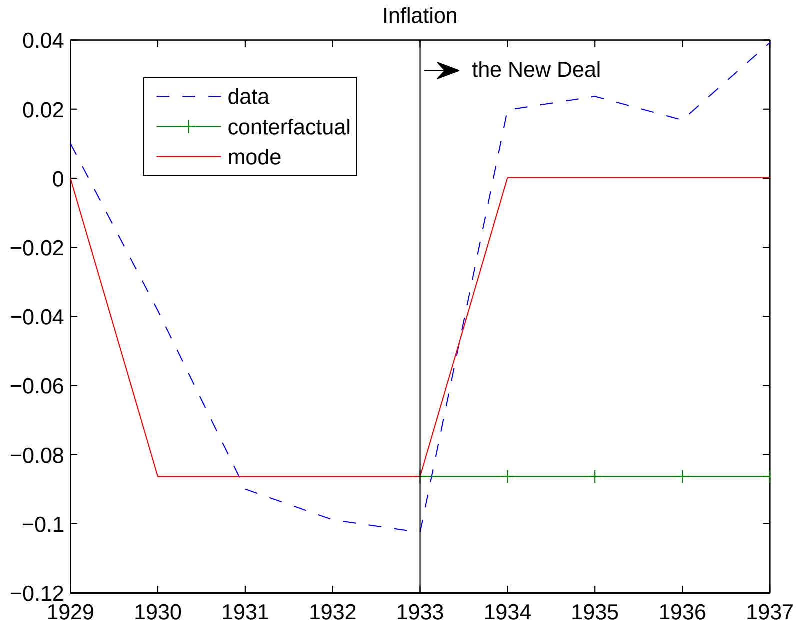

Figure 4: Data on inflation and simulated inflation from the model with and without the New Deal (NIRA).

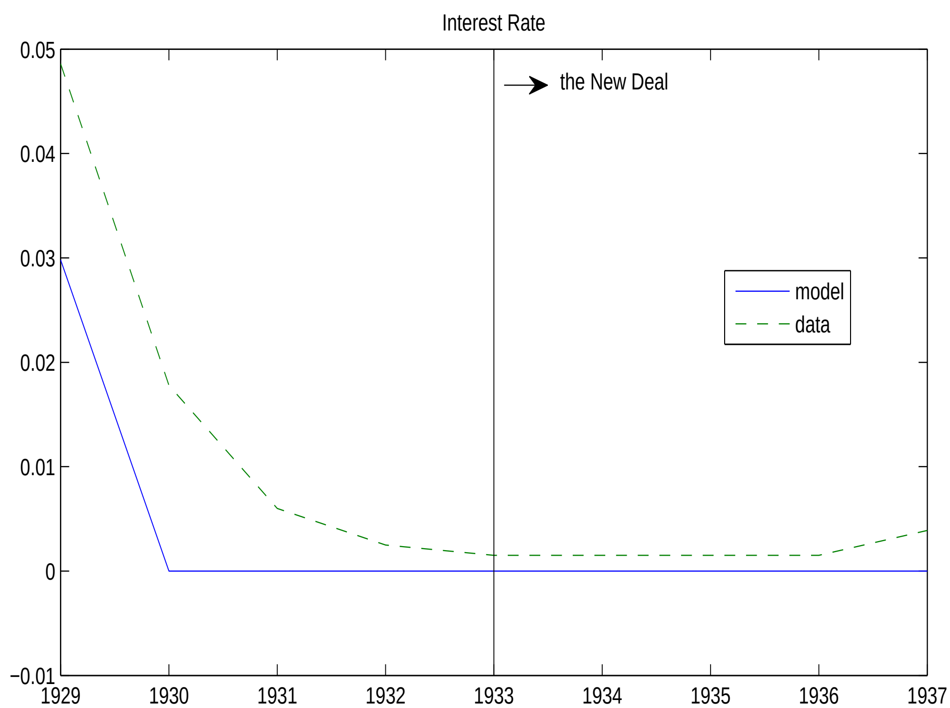

Figure 5: Short term interest rates from the data and the simulated model.

the set Ω, which is the object of choice in the model evaluation. The set Ω is chosen to match the collapse in output and inflation in the data in 1929-33 shown in figures (3)-(4) as closely as possible. This choice is made subject to prior distributions about the parameters and the shocks which are meant to capture prior outside information. It is assumed that Ω satisfies condition A1 (since the inequality in that condition is required for a bounded solution and as discussed in Eggertsson (2008) a negative r_L^e is needed to match the key features of the data). I assume that there is a random discrepancy between the data and the model so that $\pi_t^{model} = \pi_t^{data} + \epsilon_t^{\pi}$ and $Y_t^{model} = Y_t^{data} + \epsilon_t^{\pi}$ where ϵ are iid and normally distributed shocks with variances $\sigma_{\pi,t}^2$ and $\sigma_{Y,t}^2$. Under this assumption the log of the posterior likelihood of the model is

$$\log L = -\sum_{t=1929}^{1933} \frac{(\pi_t^{model} - \pi_t^{data})^2}{2\sigma_{\pi,t}^2} - \frac{(Y_t^{model} - Y_t^{data})^2}{2\sigma_{Y,t}^2} + \sum_{\psi_s \in \Omega} f(\psi_s) \qquad (30)$$

where Y_t^{model} and π_t^{model} are given by (28) and (29) and I write the likelihood conditional on the hypothesis that the shock r_L is in the "low state". Observe that the data is in annual frequencies, while the model is parameterized in quarterly frequencies. The mapping between the quarterly observation of the model and the annual data is a straight forward summation (e.g. π_t^{model} is the sum of inflation over four quarters in the model). The functions $f(\psi_s)$ measure the distance of the variables in Ω from the priors imposed where the parameters and shocks are denoted $\psi_s \in \Omega$. The distance functions $f(\psi_s)$ are given by the statistical distribution of the priors listed in table 1. I use gamma distribution for parameters that are constrained to be positive and beta distribution for parameters that have to be between 0 and 1. The distributions, shown in Table 1, are chosen so that θ has a mean of 10 (consistent with markup of 10 percent), price rigidities are consistent with prices being adjusted on average once every three quarters, β is consistent with 4 percent average annual interest rate, the mean of the preference parameters σ and ν are consistent with that utility that is logarithmic in consumption and quadratic in disutility of working (as in Christiano, Eichenbaum and Evans (2005)). Since there is no agreement about what value to assign to the habit persistence parameter ρ I impose a uniform prior on it between 0 and 1. The rational for the priors is described further in the footnote.[15]

[15] The prior for the shocks are choosen as follows. It is assumed that the mean of the shock r_L^e in the low state is equivalent to is 2 standard deviation shock to a process fitted to ex ante real interest rates in post war data. While ex ante real rates would only be an accurate measure of the efficient rate of interest in the event output was at its efficient rate at all times, this gives at least some sense of a reasonably "large" shock as a source of the Great Depression. The prior on the persistence of the shock is that it is expected to reach steady state in 10 quarters, which is consistent with the stochastic process of estimated ex ante real rates. It also seems reasonable to suppose that in the midst of the Great Depression people expected it to last for several years. All these priors are specified as distributions and table 1 gives information on this. Observe that the value of $\sigma_{\pi,t}^2$ and $\sigma_{Y,t}^2$ measure how much we want to match the data vs the priors. I choose it to be $\sigma_\pi = \sigma_Y = 0.1$, so that the one one standard deviation in the epsilon leads to a 10 percent discrepancy between the model and the data.

Figure (3)-(4) plot the mode of the posterior (30) of the model and compares to the data. The figures show that the model captures the collapse in output and inflation relatively well. Figure (5) shows the path for interest rates as well, which is assumed to have remained at zero in the model throughout the period. Observe that the interest rates did not decline to zero immediately in the data, suggesting that actual policy was even more contractionary than suggested by the model. As shown in Eggertsson (2008), however, this discrepancy does not change the solution four output and inflation quantitatively much.

The contraction at any time t observed in figure (3)-(4) in 1929-1933 is created by a combination of the deflationary shock r_L^e in period $t < \tau$ – but more importantly – the *expectation* that there will be deflation and output contraction in future periods periods $t + j < \tau$ for $j > 0$. The deflation in period $t + j$ in turn depends on expectations of 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 γ in A1 is satisfied. The overall effect is an output collapse as shown in figure (3) or what I term *deflationary spiral*.

Observe that we only pick the parameters and shocks so as to match the contraction phase 1929-1933. The key question, then, is what is the consequence of the New Deal policies, keeping the shocks as given. The crossed lines in figures (3)-(4) show the evolution of output and inflation predicted by the model in the absence of the New Deal (or any other policy actions), conditional on the shock r_t^e remaining in the low state. Assuming that r_t^e remained in the low state in 1933-37 is a reasonable assumption, since the nominal interest stayed at zero throughout this time (a reversal in the shock would have lead to an associated increase in nominal interest rates, see Eggertsson (2008)). We see that in the absence of any policy actions output and prices would continue to fall and the question we ask is to what extent the New Deal can help explaining the recovery in the data.

Parameters	**Distributions**	**Priors**			**Posteriors**			**mode**
		10%	50%	90%	10%	50%	90%	
Alpha	Beta	0.527	0.665	0.786	0.557	0.661	0.756	0.6634
Beta	Beta	0.983	0.991	0.996	0.983	0.990	0.995	0.9925
Gamma	Beta	0.042	0.092	0.168	0.042	0.066	0.097	0.0599
Nu	Gamma	0.436	0.918	1.670	0.541	1.006	1.701	0.7279
ReL	Beta	-2.527	-1.974	-1.507	-2.737	-2.156	-1.664	-1.926
Rho	Uniform[0,1]	0.100	0.500	0.900	0.821	0.890	0.938	0.9238
Sigma	Gamma	0.874	0.997	1.130	0.895	1.015	1.149	0.9931
Theta	Gamma	6.399	9.702	13.986	6.791	9.992	14.032	8.9626

Table 1: Priors and Posteriors. The shock r_L^e is reported on annual basis.

Table 1 shows the priors for the distribution of the parameters and shocks I choose in the exercise and compares these priors with the posterior distributions. The posterior is computed using a Metropolis algorithm to approximate (30) (see e.g. Gelman et al (2004)). The point of the exercise is *not* to use the data (which only covers 4 datapoints 1929-33) to "estimate" the parameters and attempt to tilt the priors significantly. Instead, the idea is to understand the extent to which the results we present in the next section are sensitive to the parameters assumed, and by specifying the parameters as probability distributions, we can construct confidence intervals to get an idea of the sensitivity of the results. Nevertheless, it is interesting to observe that while all the priors and posteriors for the parameters are relatively similar in table 1, there is one important exception. The prior on the habit persistence parameter is a uniform distribution from 0 to 1 since there is no consensus on this parameter in the literature. According to the posterior distribution, however, this parameter is estimated to be very high, with relatively tight confidence bands as can be seen in table 1. This is because the model is completely forward looking with the exception of the habit persistence parameter and it is the habit persistence that generates inertial output movements in the figures. Hence this parameter is doing all the work in making the output decline in 1929-33 gradual rather than immediately (without habits output would have dropped right away in 1929 due to the assumption about a two state Markov process for the shock).

5 Was the New Deal expansionary?

Can the government break the deflationary spiral observed in figure 1 by increasing the distortionary wedges? To analyze this question I assume that interest rates are again given by (23) and (24) but that the government implements the NIRA according to the policy

$$\omega_t = \phi(r_t^e - \bar{r}).$$

where $\phi < 0$. This policy says that when the efficient level of interest is negative ('depression') the government will increase the inefficiency wedges. Under our assumption A1 this policy rule takes the form

$$\hat{\omega}_L = \phi r_L^e > 0 \text{ when } 0 < t < \tau \tag{31}$$

and

$$\hat{\omega}_t = 0 \text{ when } t > \tau \tag{32}$$

There are two reasons to consider this class of policies for the wedge. The first is theoretical. As I will show in the next section the optimal forward looking policy and the optimal policy under discretion are members of this class of policies. The second reason is empirical. As discussed in the introduction the NIRA was an "emergency" legislation that was installed to reflate the price level. The NIRA stated that

> A national emergency productive of widespread unemployment and disorganization of industry [...] is hereby declared to exist.

It then went on to specify when the emergency would cease to exist

> This title shall cease to be in effect and any agencies established hereunder shall cease to exist at the expiration of two years after the date of enactment of this Act, or sooner if the President shall by proclamation or the Congress shall by joint resolution declare that the emergency recognized by section 1 has ended.

Hence a reasonable assumption is that the increase in inefficiency wedges were expected to be temporary, or as long as the shock lasts (which creates the deflationary "emergency" in the model) which is captured by the policy in (31) and (32).

Consider now the solution in the periods when the zero bound is binding but the government follows this policy. Output and inflation now solve the IS and the AS equations

$$\tilde{Y}_t = (1-\gamma)\tilde{Y}_t + \delta_c\sigma(1-\gamma)\pi_t + \delta_c\sigma r_L^e$$

$$\pi_t = \kappa\tilde{Y}_t + \beta(1-\gamma)\pi_t + \frac{\kappa}{\delta_c^{-1}\sigma^{-1} + \delta_l\nu}\hat{\omega}_L$$

Observe that according to the IS equation, output is completely demand determined, i.e. it only depend on the real shock r_L^e and the expectation of future inflation $E_t\pi_{t+1} = (1-\gamma)\pi_t$. Inflation expectations, however, can be increased by increasing the $\hat{\omega}_L$ in the second equation. This is what makes the NIRA policy expansionary: The expectation of inflationary policy in the "emergency state" will curb deflationary expectation, breaking the deflationary spiral, and thus stimulate demand. Solving these two equations together proves the next proposition, which is the key proposition of the paper.

Proposition 6 *The expansionary consequences of NIRA. Suppose A1, that monetary policy is given by (23) and (24) and that the government adopts the NIRA given by (31) and (32). Then output and inflation are increasing in $\hat{\omega}_L$ and given by*

$$\begin{aligned} \tilde{Y}_t^{ND} &= \frac{1-\beta(1-\gamma)}{\gamma(1-\beta(1-\gamma)) - \delta_c\sigma\kappa(1-\gamma)}[\delta_c\sigma r_L^e + \frac{(1-\gamma)\kappa}{[1-\beta(1-\gamma)](\delta_l\nu + \delta_c^{-1}\sigma^{-1})}\delta_c\sigma\hat{\omega}_L] > \tilde{Y}_t^D \ \textit{if } t < \tau \\ \textit{and } \tilde{Y}_t^{ND} &= 0 \ \textit{if } t \geq \tau \end{aligned}$$

$$\pi_t^{ND} = \frac{\kappa}{1-\beta(1-\gamma)}(\hat{Y}_t^{ND} + \frac{\kappa}{\delta_c^{-1}\sigma^{-1} + \delta_l\nu}\hat{\omega}_L) > \pi_t^D \ \textit{if } t < \tau \ \textit{and } \hat{Y}_t^{NIRA} = 0 \ \textit{if } t \geq \tau$$

The proposition above does not, however, indicate that the NIRA policy is always expansionary. To clarify this point, assume that $r_L^e > 0$. In this case the zero bound is not binding in the low state. Consider now a central bank that aims at setting the interest rate to achieve zero inflation. In this case the (18) and (19) indicate that

$$\tilde{Y}_t = -\frac{\kappa}{\delta_c^{-1}\sigma^{-1} + \delta_l\nu}\hat{\omega}_L$$

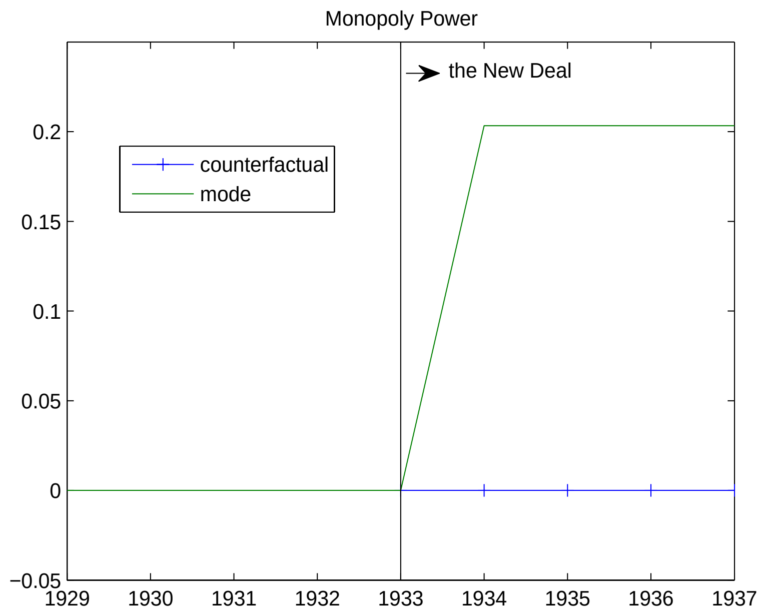

Figure 6: Simulated rise in monopoly power from the model with and without the New Deal (NIRA).

so that the NIRA policy will have a contractionary effect. To offset the inflationary effect of an increase in $\hat{\omega}_L$ the central bank will increase the nominal interest rate to achieve price stability. The equilibrium is then going to replicate a conventional RBC solution and output contracts in response to higher $\hat{\omega}_L$. The reason is completely conventional: an increase in the distortionary wedge will increase the monopoly power of either workers or firms and this will lead to an output contraction in the aggregate. When the central bank targets price stability the special "emergency" conditions of the deflationary spiral are needed for the New Deal policies to be expansionary.

Consider now the solution under assumption A1 so that the zero bound is binding and there is a deflationary spiral under the benchmark policy. Figure 3 shows the evolution of output and inflation under the assumption that ω_L is chosen optimally from 1933 onwards, a policy formally derived in section 7, and compares it to the counterfactual policy in which case no actions are taken, and the data. As shown, the increase in the wedge $\hat{\omega}_t$ leads to a dramatic recovery in output and prices from 1933 onwards. The reason for this is as follows: The increase in $\hat{\omega}_t$ prevents the large fall in the prices observed in 1929-33 by increasing the markup of firms and/or workers unions. It even implies a slight inflation, thus shifting expected deflation of several percentage to mild inflation. This large change in inflation expectations stimulates demand because it lowers the real rate of interest. The quantitative effect of this is large in the model.

In the calibrated example the wedge increases by about 20 percent. This is equivalent to a

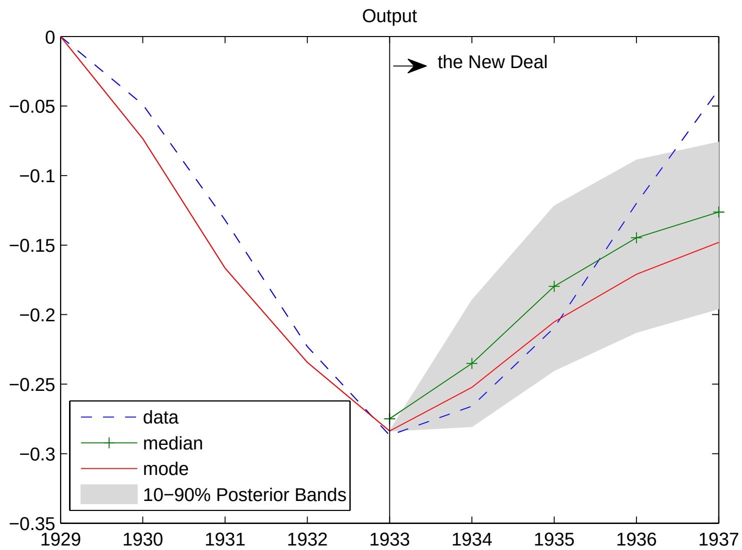

Figure 7: Predicted effect of the New Deal taking into account uncertaintly of the underlying shocks and parameters.

government introduced policy that increased monopoly markups of firms or workers unions by 20 percent. The implied change in the natural rate of output due to the change in the wedges is considerable. Despite this large *decline* in the natural rate of output there is a large *increase* in equilibrium output as figure 3 shows.

As can be seen from the path for inflation in figure 3 the real interest rate in the model goes from +10 percent prior to the NIRA to being slightly negative under the New Deal. This leads to relatively robust recovery, although one that is still below what is observed in the data. This paper, however, is concerned with NIRA at the margin, abstracting from other policy options. The result, therefore, indicates that these policies may have contributed to the expansion.[16]

[16] The benchmark policy is too simplistic to account for the Federal Reserve's policy in 1929-33. The policy indicates that if the natural rate of interest is negative (and inflation below zero) the interest rate will immediately be cut down to zero. Instead the Federal Reserve reduced the interest rate more gradually moving down to zero in 1932. By failing to move faster the model indicates that the Federal Reserve exaggerated the output decline and propagated the deflationary shocks even further than suggested by the benchmark policy. To see this observe that moving the interest rate down to zero more slowly than implied by the benchmark policy will imply higher real rates and thus suppress demand. Since the interest rates were close to zero at the time FDR took office and implemented the NIRA this does not change the analysis of the NIRA which is the focus of this paper. For our purposes all that is needed is that the benchmark policy describes the policy stance in the spring on 1933 when FDR took office and implemented NIRA.

While the results are analytical, and the plot of the mode of the posterior of the model is mostly for illustration, some readers may be interested in how sensitive the numerical examples are to different parameter values. Figure 7 gives one way of thinking about sensitivity in this context, by showing 10-90 percent bands for the posterior distribution for output growth in the period 1934-37 using the simulated posterior of the model. The 10 to 90 the percentiles of the posterior distribution of the parameters in table 1 give an idea of the range of parameters that generate the different paths underlying the figure. Overall the figure suggest that the model is consistent with a relatively strong effect of the New Deal policies for the parameter distributions considered. The quality of the data, and the relatively weak priors we impose on the model, however, do not allow us to conclude that the National Industrial Recovery Act was entirely responsible for the recovery (although this is close to being possible with some probability according to the simulation). Evidently more was needed. This is in line with a recent finding by Eggertsson (2008) which concludes that monetary and fiscal policy alone can account for about 70-80 percent of the recovery in prices during this period, in a similar framework. Taken together these policies can explain the turnaround in 1933-37. An additional level of uncertainty not accounted for in the figure is that we assume that the wedge ω_L is set at the optimal level, to be formally defined in section 7. In this respect, the figure above represents a best case scenario for the policy and provides an upper bound on how effective this part of the New Deal may have been.

The parameters in table 1 are almost entirely conventional in the literature with one exception. The habit persistence parameter is higher than in most studies, although there are some examples in the literature that estimate such high degree of habit persistence (see e.g. Giannoni and Woodford (2004). If we assume a point prior on the habit parameter of 0 then the output collapse is immediate, and the recovery is also much faster than seen in the data. None of the qualitative conclusions, however, rely on assuming habit persistence. Choosing a point prior for any of the other parameters has relatively little effect on any of the results.

6 A comparison to Cole and Ohanian's result

In this section I compare the results to the ones obtained in Cole and Ohanian (2004) and clarify the reasons for the different conclusions reached, but they find that the New Deal was contractionary. Cole and Ohanian assume that the shocks that caused the Great Depression in 1929-33 were largely over in 1933 (completely so in 1936) and compute the transition paths of the economy for given initial conditions. They show that the recovery, given these initial condition, is slower than implied by a standard growth model and explain the slow recovery by the NIRA part of the New Deal.

Figure (8) shows the evolution of output under the assumption that the shocks perturbing the economy have subsided in 1933 as assumed by Cole and Ohanian, using their parameterization

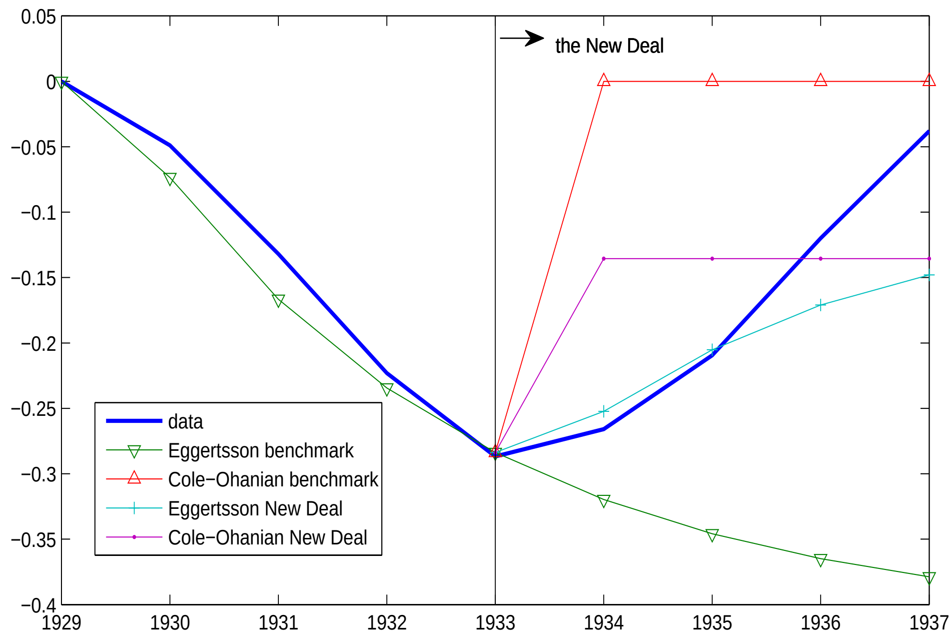

Figure 8: Comparison to Cole and Ohanian's (2004) results.

of the model (i.e. $\sigma = \nu = 1$ with no habit persistence).[17] The line denoted "Cole-Ohanian benchmark" shows that in this case the recovery is much faster than in the data. As has already been stressed, the prediction of the current model is consistent with Cole and Ohanian's result that increasing monopoly power of firms and workers under these conditions reduces output. The line denoted "Cole and Ohanian New Deal" uses formula (18) to compute by how much output contracts in the model if the New Deal was implemented assuming no shocks. In this simulation, we use the same value for ω_L as in the simulations for our earlier figures, i.e. the monopoly power of firms is increased by 20 percent.

Figure (8) compares Cole and Ohanian's benchmark scenario with the benchmark from this paper with the line denoted "Eggertsson benchmark" using the parameter configurations described in past sections. We see that in this case the output continue to decline in the absence of the New Deal so question to answer is the opposite from the one in Cole and Ohanian's paper. The question is not why the recovery was not faster, but instead, why the economy recovered at all. As the line "Eggertsson New Deal" shows, we observe that the New Deal contributed to the recovery, while not completely explaining it.

[17] If the central bank targets prices stability the assumed degree of price rigidities is irrelevant since there are no shocks and the sticky price model replicates the corresponding flex price meodel. One may alternatively think of thus alternatively think of the simulation denoted "Cole-Ohanian" as comming from a aflexible price model.

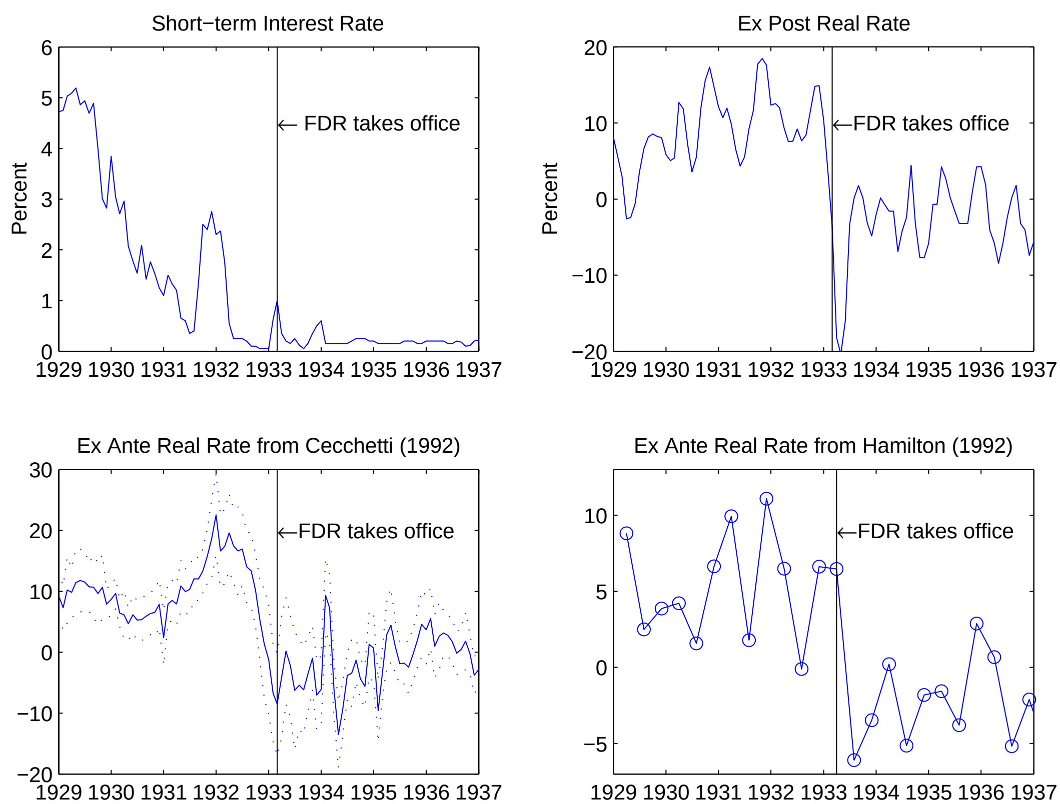

Figure 9: Real interest rate collapsed around the implementation of the New Deal, even if the short term nominal interest rate did not change much. This suggest a large change in inflation expectations.

The figure illustrates that the path for output is similar across the two models, the difference lies in the counterfactual. Which counterfactual is the relevant one? The answer to that question, in the context of the model, boils down to: Where there intertemporal disturbances during this period that needed to be accommodated by inflationary policy? If the recovery in 1933-37 was due to that negative shocks had subsided the model has a clear prediction: Interest rate should have risen as can be seen by equation (24) (see Eggertsson (2008) for further discussion of this alternative hypothesis of the recovery). Instead, interest rates stayed at zero throughout 1933-37, without significant inflationary pressures, which is evidence of continuing negative intertemporal disturbances during this period.

The hypothesis that this paper relies on is the presence of negative intertemporal disturbances that remained negative throughout the period. According to this theory, the output collapse is explained by that real rate failed to follow the "efficient level of interest" in 1929-33, and hence too high real interest rates are the main culprit for the output collapse. The recovery is explained by that real rates went significantly down due to policy changes in 1933. Figure (9) shows three estimates of short-term real rates that are consistent with this story. The first shows simple ex post rates, the second real rates as measured by Checchetti (1992) using term structure data and the third estimated by Hamilton (1992) using futures data.

All the estimates tell the same story which is consistent with the current theory, but contradicts the one suggested in Cole and Ohanian. Observe that while our theory requires real rates to go significantly down in 1933 to explain the recovery (and stay modestly negative) the theory by Cole and Ohanian's suggests that interest rate should have gone *up* around the turning point and then stayed high (at steady state). It should be stressed, however, that the failure of RBC models to match data on prices (e.g. factor prices, equity prices and so on) is widely known in the literature and is not special to the data from the Great Depression. In this respect the failure of Cole and Ohanian's model to match real interest rate data is certainly no surprise. It would therefore be premature to draw too strong conclusion from the observation about real rates alone, and future studies need to look at additional testable implication of the two theories to determine wether or not the New Deal was expansionary.

7 The New Deal as a Theory of the Optimal Second Best

So far we have studied the consequences of the NIRA policies assuming they take a particular form. The paper, however, has been silent on whether this policy is optimal. In this section I show that the NIRA was optimal, and is an interesting example of the "optimal second best" as defined by Lipsey and Lancester (1954).

A first best equilibrium is usually defined as a solution to a social planners problem that does not impose some particular constraint of interest. The second best equilibrium is the solution to the social planners problem when the particular constraint of interest is imposed. There are many examples of restrictions imposed on social planner's problems that give rise to second best analysis, such as legal, institutional, fiscal, or informational constraints (see e.g. Mas-Colell, Winston and Green (1995)). The distinction between a first and a second best planner's problem is not always sharp because it is not always obvious if a constraint makes a social planner's problem "second best" rather than a "first best." In this paper it is the zero bound constraint that gives rise to the second best planning problem. This distinction is natural because in the absence of the zero bound the social planner can always achieve the social maximum (that corresponds to the efficient flexible price allocation) as we saw in proposition (4). The first best equilibrium defined in this fashion also has the intuitive property that it is the equilibrium associated with price stability so that second best considerations arise only when the government cannot achieve price stability.

Definition 5 *The first best policy is a solution of a social planner's problem that does not take account of the zero bound on the short-term interest rate. The second best policy is a solution to a social planner's problem that takes the zero bound into account.*

The first best social planner's problem is then to maximizes (20) subject to the IS equation (17) and AS equation (19) taking the process for $\{r_t^e, \tilde{Y}_t^e\}$ as given. The second best social planners problem takes into account the zero bound constraint (5) in addition to the IS an AS equations.

To study optimal policy one needs to take a stance on whether there are any additional restrictions on government policy beyond those prescribed by the private sector equilibrium conditions. The central result of this section will be cast assuming that government conducts optimal policy from a forward looking perspective (OFP) as in Woodford (2002) and Eggertsson and Woodford (2003,4). The optimal policy from a forward looking perspective is the optimal commitment under the restriction that the policy can only be set as a function of the physical state of the economy. It can be interpreted as the "optimal policy rule" assuming a particular restrictions on the form of the policy rule. After analyzing OFP rule the result is extended to a Ramsey equilibrium, in which the government can fully commit to future policy and, at the other extreme, a Markov Perfect Equilibrium (MPE) in which case the government cannot commit to any future policy. Quantitatively the OFP and MPE are almost identical under A1. In all these cases I show that the NIRA can be thought of as the optimal second best policy, where the second best analysis arises due to the zero bound constraint on the short-term nominal interest rate.

7.1 The optimal forward looking solution

In the approximate sticky price equilibrium there are two physical state variables $\tilde{Y}_t^e$ and r_t^e. The definition of an optimal forward looking policy is that it is the optimal policy commitment subject to the constraint that policy can only be a function of the physical state. I can therefore define the optimal policy from a forward looking policy as follows:

Definition 6 *The optimal policy from a forward looking perspective is a solution of a social planner's problem in which policy in each period only depends on the relevant physical state variables. In the approximated sticky price equilibrium the policy is a collection of functions* $\pi(\tilde{Y}^e, r^e), Y(\tilde{Y}^e, r^e), \omega(\tilde{Y}^e, r^e), i(\tilde{Y}^e, r^e)$ *that maximize social welfare.*

The social planner problem at date t is then

$$\min_{\pi(\tilde{Y}^e,r^e),\hat{Y}(\tilde{Y}^e,r^e),\hat{\omega}(\tilde{Y}^e,r^e),i(\tilde{Y}^e,r^e)} E_t \sum_{T=t} \beta^{T-t}\{\pi_T^2 + \lambda(\tilde{Y}_T - \tilde{Y}_T^e)^2\}$$
$$\text{s.t. } (5),\ (17),\ (19)$$

Under $A1$ the only state variable is r_t^e so I suppress $\hat{Y}^e$ from the policy functions. The minimization problem can be solved by forming the Lagrangian

$$L_0 = E_0 \sum_{t=0}^{\infty} \beta^t \{ \frac{1}{2}\pi(r_t^e)^2 + \frac{1}{2}\lambda \tilde{Y}(r_t^e) + \psi_1(r_t^e)[\pi(r_t^e) - \kappa \tilde{Y}(r_t^e) - \frac{\kappa}{\sigma^{-1}+\upsilon}\hat{\omega}(r_t^e) - \beta\pi(r_{t+1}^e)] \quad (33)$$
$$\psi_2(r_t^e)[\tilde{Y}(r_t^e) - \tilde{Y}(r_{t+1}^e) + \sigma i(r_t^e) - \sigma\pi(r_t^e) - \sigma r_t^e] + \psi_3(r_t^e) i(r_t^e)\}$$

where the functions $\psi_i(r^e)$, $i = 1, 2, 3$, are Lagrangian multipliers. Under $A1$ r_t^e can only take two values. Hence each of the variables can only take on one of two values, $\pi_L, \tilde{Y}_L, i_L, \omega_L$ or $\pi_H, \tilde{Y}_H, i_H, \omega_H$ and I find the first order conditions by setting the partial derivative of the Lagrangian with respect to these variables equal to zero. In A1 it is assumed that the probability of the switching from r_H to r_L is "remote" i.e. arbitrarily close to zero, so in the Lagrangian used to find the optimal value for $\pi_H, \tilde{Y}_H, i_H, \hat{\omega}_H$ (i.e. the Lagrangian conditional on being in the H state) can be simplified to yield[18]

$$L_0 = \frac{1}{1-\beta}\{\frac{1}{2}\pi_H^2 + \frac{1}{2}\lambda\tilde{Y}_H + \psi_{1H}((1-\beta)\pi_H - \kappa\tilde{Y}_H - \frac{\kappa}{\sigma^{-1}+\upsilon}\hat{\omega}_H) + \psi_{2H}(i_H - \pi_H - r_H) + \psi_{3H} i_H\}$$

It is easy to see that the solution to this minimization problem is:

$$\pi_H = \tilde{Y}_H = \hat{\omega}_H = 0 \quad (34)$$

and that the necessary conditions for achieving this equilibrium (in terms of the policy instruments) are that

$$i_H = r_H \quad (35)$$

$$\hat{\omega}_H = 0. \quad (36)$$

Taking this solution as given and substituting it into equations *(17)* and *(19),* the social planner's feasibility constraint in the states in which $r_t^n = r_L$ are

$$(1 - \beta(1-\gamma))\pi_L = \kappa\tilde{Y}_L + \frac{\kappa}{\sigma^{-1}+\upsilon}\hat{\omega}_L$$

$$\gamma\tilde{Y}_L = -\sigma i_L + \sigma(1-\gamma)\pi_L + \sigma r_L^e)$$

$$i_L \geq 0$$

Consider the Lagrangian (33) given the solution (34)-(36). There is a part of this Lagrangian that is weighted by the arbitrarily small probability that the low state happens (which was ignored

[18] In the Lagrangian we drop the terms involving the L state because these terms are weighted by a probability that is assumed to be arbitrarily small.

in our previous calculation). Conditional on being in that state and substituting for (34)-(36) the Lagrangian at a date t in which the economy is in the low state can be written as:

$$\begin{aligned} L_t &= E_t \sum_{T=t}^{\infty} \beta^{T-t} \{ \frac{1}{2}\pi(r_T^e)^2 + \frac{1}{2}\lambda\tilde{Y}(r_T^e) + \psi_1(r_T^e)[\pi(r_T^e) - \kappa\tilde{Y}(r_T^e) - \frac{\kappa}{\sigma^{-1}+\upsilon}\hat{\omega}(r_T^e) - \beta\pi(r_{T+1}^e)] \\ & +\psi_2(r_T^e)[\tilde{Y}(r_T^e) - \tilde{Y}(r_{T+1}^e) + \sigma i(r_T^e) - \sigma\pi(r_T^e) - \sigma r_T^e] + \psi_3(r_T^e)i(r_T^e)\} \\ &= \frac{1}{1-\beta(1-\gamma)}\{\frac{1}{2}\pi_L^2 + \frac{1}{2}\lambda\tilde{Y}_L^2 \\ & +\psi_{1L}((1-\beta(1-\gamma))\pi_L - \kappa\tilde{Y}_L - \frac{\kappa}{\sigma^{-1}+\upsilon}\hat{\omega}_L) \\ & +\psi_{2L}(\gamma\tilde{Y}_L + \sigma i_L - \sigma(1-\gamma)\pi_L - \sigma r_L^n) + \psi_{3L} i_L\} \end{aligned}$$

The first order conditions with respect to π_L, $\hat{Y}_L, \omega_L$ and i_L respectively are

$$\pi_L + (1-\beta(1-\gamma))\psi_{1L} - \sigma(1-\gamma)\psi_{2L} = 0 \tag{37}$$

$$\lambda\tilde{Y}_L - \kappa\psi_{1L} + \alpha\psi_{2L} = 0 \tag{38}$$

$$-\frac{\kappa}{\sigma^{-1}+\upsilon}\psi_{1L} = 0 \tag{39}$$

$$\sigma\psi_{2L} + \psi_{3L} = 0 \tag{40}$$

$$i_L \geq 0, \ \psi_{3L} \geq 0, \ i_L\psi_{3L} = 0 \tag{41}$$

Consider first the optimal forward looking policy under the constraint that the $\hat{\omega}_t$ is constrained at $\hat{\omega}_t = 0$ which is one of the conditions for the benchmark policy (so that (39) cannot be satisfied). The solution of the conditions above (replacing (39) with $\hat{\omega}_t = 0$) then takes exactly the same form as shown for the benchmark policy in (23) and (24). This means that the benchmark policy can be interpreted as the *optimal forward looking policy under the constraint the government cannot use* $\hat{\omega}_t$ *to stabilize output and prices.*

Consider now the optimal second best solution in which the government can use both policy instruments. Observe first that $i_L = 0$. This leaves 6 equations with 6 unknowns $(\pi_L, \tilde{Y}_L, \omega_{L,}\psi_{1L,}\psi_{2L,}\psi_{3L})$ and equations (37)-(40) together with IS and AS equations) that can be solved to yield:

$$\tilde{Y}_L = \frac{\sigma\delta_c}{[\gamma + \lambda\delta_c^2\sigma^2\frac{(1-\gamma)^2}{\gamma}]} r_L^e$$

$$\pi_L = -\frac{\delta_c^2\sigma^2\lambda\frac{1-\gamma}{\gamma}}{[\gamma + \lambda\delta_c^2\sigma^2\frac{(1-\gamma)^2}{\gamma}]} r_L^e > 0$$

$$\hat{\omega}_L = -(\delta_c^{-1}\sigma^{-1} + \delta_l\upsilon)\frac{\delta_c\sigma + \delta_c^2\sigma^2\lambda\frac{1-\gamma}{\gamma}[1-\beta(1-\gamma)]\kappa^{-1}}{[\gamma + \lambda\delta_c^2\sigma^2\frac{(1-\gamma)^2}{\gamma}]} r_L^e > 0$$

The central proposition of this section follows directly.

Proposition 7 *The New Deal as a Theory of Second Best. Suppose the government is a purely forward looking social planner and A1. If the necessary conditions for the first best* $i_t = r_t^e$ *is violated due to the zero bound so that* $i_t > r_t^e$*, then the optimal second best policy is that the other necessary condition* $\hat{\omega}_t = 0$ *is also violated so that* $\hat{\omega}_t > 0$*.*

This proposition is a classic second best result. To cite Lipsey and Lancaster (1956): "The general theorem of the second best states that if one of the Paretian optimum condition cannot be fulfilled a second best optimum is achieved only by departing from all other conditions."

What is perhaps surprising about Proposition 7 is not so much that both of the necessary conditions for the first best are violated by the way in which they are departed from. The proposition indicates that to increase output the government should *facilitate monopoly power of workers and firms to stimulate output and inflation.* This goes against the classic microeconomic logic that facilitating monopoly power of either firms and workers reduces output. Another noteworthy feature of the proposition is its unequivocal force. *The result holds for any parameter configuration of the model.* Some fundamental assumptions of the model need to be changed for the result to be overturned.

There are good reasons to start our analysis of the OFP over the Ramsey solution or the MPE that we study in the next two sections. The appeal of the Ramsey solution is that it is the best possible outcome the planner can achieve. The main weakness for my purposes is that it requires a very sophisticated commitment that is subject to a serious dynamic inconsistency problem, especially in the example I consider. This casts doubt on how realistic it is as a description of policy making in the 1930's. The MPE, in contrast, is dynamically consistent by construct, and may thus capture actual policy making a little bit better. Its main weakness, however, is that it is not a well defined social planner's problem because each government is playing a game with future governments. The optimal MPE government strategy is therefore not a proper second best policy, as defined in Definition 5, because showing that the government at time t chooses to use a particular policy instrument (e.g. ω_t) is no guarantee that this is optimal. Indeed in certain class of games it is optimal to restrict the government strategies to exclude certain policy instruments or conform to some fixed "rules" (see e.g. Kydland and Prescott (1977)).

The optimal policy from a forward looking perspective strikes a good middle ground between Ramsey equilibrium and the MPE. It is a well defined planner's problem and thus appropriate to illustrate the main point. Yet it is very close to the MPE in the example I consider and thus not subject to the same dynamic inconsistency problem as the Ramsey equilibrium (as further discussed below). Furthermore it requires a relatively simple policy commitment by the government, which makes it a more plausible description of actual policy during the Great Depression, and it accords relatively well with narrative accounts of the policy.

7.2 The optimal solution under discretion (MPE)

Optimal policy under discretion is standard equilibrium concept in macroeconomics and is for example illustrated in Kydland and Prescott (1977). It is also sometimes referred to as Markov Perfect Equilibrium (MPE).[19] The idea is that the government cannot make any commitments about future policy but instead reoptimizes every period, taking *future government actions* and the physical state as given. Observe that we have rewritten the model in terms of quasi growth rates of output and the growth rate of prices (inflation) so that the government's objective and the system of equations that determine equilibrium are completely forward looking. They only depend on the exogenous state $(r_t^e, \tilde{Y}_t^e)$. It follows that the expectations $E_t\pi_{t+1}$and $E_t\tilde{Y}_{t+1}$ are taken by the government as exogenous since they refer to expectations of variables that will be determined by future governments (I denote them by $\bar{\pi}(r_t^e, \tilde{Y}_t^e)$ and $\bar{Y}(r_t^e, \tilde{Y}_t^e)$ below). To solve the government's period maximization problem one can then write the Lagrangian

$$L_t = -E_t \begin{bmatrix} \frac{1}{2}\{\pi_t^2 + \lambda_y(\tilde{Y}_t - \tilde{Y}_t^e)^2\} \\ +\phi_{1t}\{\pi_t - \kappa\tilde{Y}_t + \kappa\tilde{Y}_t^e - \frac{\kappa}{\sigma^{-1}+\upsilon}\hat{\omega}_t - \beta\bar{\pi}(r_t^e, \tilde{Y}_t^e)\} \\ +\phi_{2t}\{\tilde{Y}_t - \bar{Y}(r_t^e, \tilde{Y}_t^e) + \sigma(i_t - \bar{\pi}(r_t^e, \tilde{Y}_t^e) - r_t^e)\} + \phi_{3t}i_t \end{bmatrix} \tag{42}$$

and obtain four first order conditions that are necessary for optimum and one complementary slackness condition

$$\pi_t + \phi_{1t} = 0 \tag{43}$$

$$\lambda_y(\tilde{Y}_t - \tilde{Y}_t^e) - \kappa\phi_{1t} + \phi_{2t} = 0 \tag{44}$$

$$-\frac{\kappa}{\sigma^{-1}+\upsilon}\phi_{2t} = 0 \tag{45}$$

$$\sigma\phi_{2t} + \beta^{-1}\phi_{3t} = 0 \tag{46}$$

$$\phi_{3t} \geq 0,\ \phi_{3t}i_t = 0 \tag{47}$$

Consider first the equilibrium in which the government does not use $\hat{\omega}_t$ to stabilize prices and output (i.e. $\hat{\omega}_t = 0$) in which case the equilibrium solves the first order conditions above apart from (45). In this case the solution is the same as the optimal forward looking policy subject to $\hat{\omega}_t = 0$ and thus also equivalent to the benchmark policy in Proposition 5.

Next consider the optimal policy when the government can use $\hat{\omega}_t$. In this case the solution that solves (43)-(47) and the IS and AS equations is:

$$\tilde{Y}_t = \frac{\sigma}{\gamma}r_L^e \text{ if } t < \tau \text{ and } \tilde{Y}_t = 0 \text{ if } t \geq \tau \tag{48}$$

[19] Although it is common in the literature that uses the term MPE to assume that the government moves before the private sector. Here, instead, the government and the private sector move simultaneously.

$$\pi_t = 0 \ \forall t \tag{49}$$

$$\tilde{Y}_t^n = \frac{\sigma}{\gamma} r_L^e \text{ if } t < \tau \text{ and } \tilde{Y}_t^n = 0 \text{ if } t \geq \tau \tag{50}$$

$$\hat{\omega}_t = -\frac{\sigma}{\gamma}(\sigma^{-1} + \upsilon) r_L^e > 0 \text{ if } t < \tau \ \hat{\omega}_t = 0 \text{ if } t \geq \tau \tag{51}$$

The analytical solution above confirms the key insight of the paper, that the government will increase $\hat{\omega}_t$ to increase inflation and output when the efficient real interest rate is negative. There is however some qualitative difference between the MPE and the OFP. Under the optimal forward looking policy the social planner increases the wedge beyond the MPE to generate inflation in the low state. The reason for this is that under OFP the policy maker uses the wedge to generate expected inflation to lower the real rate of interest. In the MPE, however, this commitment is not credible and the wedge is set so that inflation is zero. The quantitative significance of the difference between MPE and OFP, however, is trivial and almost to visible if graphed up.

7.3 Ramsey Equilibrium

I now turn to the Ramsey equilibrium. In this case the government can commit to any future policy. The policy problem can then be characterized by forming the Lagrangian:

$$L_t = E_t \begin{bmatrix} \frac{1}{2}\{\pi_t^2 + \lambda \hat{Y}_t^2\} + \phi_{1t}(\pi_t - \kappa \tilde{Y}_t - \frac{\kappa}{\sigma^{-1}+\upsilon}\hat{\omega}_t - \beta \pi_{t+1}) \\ +\phi_{2t}(\tilde{Y}_t - \tilde{Y}_{t+1} + \sigma i_t - \sigma \pi_{t+1} - \sigma \hat{r}_t^e) + \phi_{3t} i_t \end{bmatrix} \tag{52}$$

which leads to the first order conditions:

$$\pi_t + \phi_{1t} - \phi_{1t-1} - \sigma \beta^{-1} \phi_{2t-1} = 0$$

$$\lambda \hat{Y}_t - \kappa \phi_{1t} + \phi_{2t} - \beta^{-1} \phi_{2t-1} = 0$$

$$\sigma \phi_{2t} + \phi_{3t} = 0$$

$$\phi_{1t} = 0$$

$$\phi_{3t} i_t = 0 \ i_t \geq 0 \text{ and } \phi_{3t} \geq 0$$

Figure 10 shows the solution of the endogenous variables, using the solution method suggested in Eggertsson and Woodford (2004). The calibration here is from their paper, and there is no habit persistence in the model. Again the solution implies an increase in the wedge in the periods in which the zero bound is binding. The wedge is about 5 percent initially. In the Ramsey solution, however, there is a commitment to reduce the wedge temporarily once the deflationary shocks have reverted back to steady state. There is a similar commitment on the monetary policy side. The government commits to zero interest rates for a considerable time after the shock has reverted back to steady state.

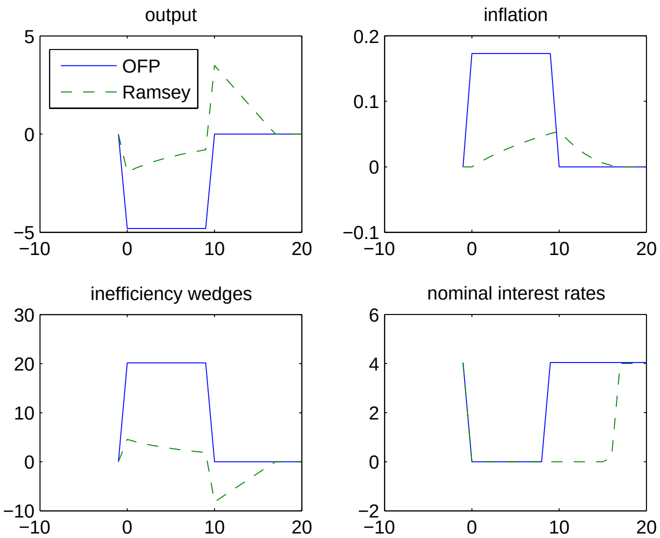

Figure 10: The qualitative features of the optimal forward looking and Ramsey policy are the same. The key difference is that the Ramsey policy achieves a better outcome by manipulating expectations about policy at the time at which the deflationary shocks have subsided.

The optimal commitment thus also deviates from the first best in the periods $t \geq \tau$ both by keeping the interest rate at zero beyond what would be required to keep inflation at zero at that time and by keeping the wedge below its efficient level. This additional second best leverage – which the government is capable of using because it can fully commit to future policy – lessens the need to increase the wedge in period $t < \tau$. This is the main difference between the Ramsey equilibrium and the MPE and OFP. The central conclusion of the paper, however, is confirmed, the government increases the wedge ω_t to reduce deflation during the period of the deflationary shocks.

The key weakness of this policy, as a descriptive tool, is illustrated by comparing it to the MPE. The optimal commitment is subject to a serious dynamic inconsistency problem. To see this consider the Ramsey solution in periods $t \geq \tau$ when shocks have subsided. The government can then obtain higher utility by reneging on its previous promise and achieve zero inflation and output equal to the efficient level. This incentive to renege is severe in our example, because the deflationary shocks are rare and are assumed not to reoccur. Thus the government has strong incentive to go back on its announcements. This incentive is not, however, present to the same extent under optimal forward looking policy. Under the optimal forward looking policy the commitment in periods $t \geq \tau$ is identical to the MPE.

8 Conclusion

This paper shows that an increase in the monopoly power of firms or workers unions can increase output. This theoretical result, if interpreted literally, may change the conventional wisdom about the general equilibrium effect of the National Industrial Recovery Act during the Great Depression in the US. It goes without saying that this does not indicate that these policies are good under normal circumstances. Indeed, the model indicates that facilitating monopoly power of unions and firms is suboptimal in the absence of shocks leading to inefficient deflation. It is only under the condition of excessive deflation and an output collapse that these policies pay off. The historical record suggests that there was some understanding of this among policy makers during the Great Depression. The NIRA was always considered as a temporary recovery measure due to the emergency created by the deflationary spiral observed in 1929-1933.

This paper can be also interpreted as an application of the General Theory of Second Best proposed by Lipsey and Lancaster (1956). These authors analyze what happens to the other optimal equilibrium conditions of a social planner problem when one of the conditions cannot be satisfied for some reason. Lipsey and Lancaster show that, generally, when one optimal equilibrium condition is not satisfied, for whatever reason, all of the other equilibrium conditions will change. The previous literature of the National Recovery Act is usually explicitly or implicitly cast in the context of an economy that is at a first best equilibrium. Cole and Ohanian (2004), for example, study an economy without shocks and fully flexible prices and show that in that environment facilitating monopoly powers of firms or workers reduces output. Their result is built on standard economic logic that has been applied by various authors.

The Theory of the Second Best, however, teaches us that if one of the social planners optimality conditions fails, then all the other conditions change as well. In this paper the social planner's optimality condition that holds under regular circumstances fails due to a combination of sticky prices, shocks that make the natural rate of interest negative, and the zero bound on the short term interest rate (that prevents the government from accommodating the shocks by interest rate cuts). This combination changes the optimality conditions of the social planner so that, somewhat surprisingly, it becomes optimal to facilitate the monopoly pricing of firms and workers alike. This result provides a new and surprising policy prescription that has been frowned upon by economists for the past several hundred years, dating at least back to Adam Smith who famously claimed that the collusion of monopolies to prop up prices was a conspiracy against the public.

9 References

1. Benigno, Pierpaolo and Michael Woodford (2003), "Optimal Monetary and Fiscal Policy: A Linear Quadratic Approach," NBER Macroeconomics Annual 2003.

2. Bils, M., and P. J. Klenow (2004): "Some Evidence on the Importance of Sticky Prices," Journal of Political Economics, 112(5), 947–985.

3. Bordo, Erceg, Evans (2000), "Money, Sticky Wages, and the Great Depression," American Economic Review, Vol. 90, No. 5, p. 1447-1463.

4. Calvo, Guillermo. (1983) "Staggered Prices in a Utility-Maximizing Framework," Journal of Monetary Economics, 12: 383-98.

5. Chari, V. Kehoe, P., and McGrattan, E., (2006), "Business Cycle Accounting," Econometrica, forthcoming.

6. Christiano, L., Motto, R. and M. Rostagno (2004), "The Great Depression and the Friedman-Schwartz Hypothesis," Journal of Money, Credit and Banking.

7. Cecchetti, S. (1992), "Prices during the Great Depression," American Economic Review, Vol 82, No. 1, March, p. 141-156.

8. Cole, H, and L. Ohanian (2004), "New Deal Policies and the Persistence of the Great Depression: A General Equilibrium Analysis," Journal of Political Economy, Volume 112, Number 4.

9. De Long, J.B., and Summers, (1986), "Is Increased Price Flexibility Stabilizing?" American Economic Review 76, 1031-1044.

10. Eggertsson, Gauti (2008), "Great Expectations and the End of the Depression," American Economic Review, forthcoming.

11. Eggertsson, Gauti. (2006), "The Deflation Bias and Committing to Being Irresponsible," Journal of Money, Credit, and Banking.

12. Eggertsson, Gauti and Woodford, Michael (2003), "The Zero Bound on Interest Rates and Optimal Monetary Policy," Brookings Papers on Economic Activity 1, 212-219.

13. Eggertsson, Gauti and Michael Woodford. (2004), "Optimal Monetary and Fiscal Policy in a Liquidity Trap," ISOM conference volume 2004.

14. Friedman, Milton and Anna Schwartz. (1963), "A Monetary History of the United States," Princeton University Press.

15. Gelman, Andrew, John B. Carlin, Hal S. Stern and Donald B. Rubin (2004), "Bayesian Data Analysis". Chapman & Hall/CRC.

16. Hall, Robert E. "Macroeconomic Fluctuations and the Allocation of Time."' Journal of Labor Economics, January 1997, 15(1), pp. 223—50.

17. Hamilton, James D. (1992), "Was the Deflation During the Great Depression Anticipated? Evidence from the Commodity Futures Market," American Economic Review, March, 82, p.157-82.

18. Keynes, John Maynard. (1933) "Open Letter to Franklin D. Roosevelt", New York Times, 31st of December 1933.

19. Krugman, Paul (1998), "It's Baaack! Japan's Slump and the return of the Liquidity Trap," Brookings Papers on Economic Activity 2:1998.

20. Kydland, Finn E. and Edward C. Prescott (1977): "Rules Rather than Discretion: The Inconsistency of Optimal Plans." Journal of Political Economy (85): 473-91.

21. Lipsey and Lancaster (1956), "The General Theory of Second Best," Review of Economic Studies, p. 11-32.

22. Maskin, Eric. and Jean Tirole. (2001) "Markov Perfect Equilibrium: Observable Actions," Journal of Economic Theory.

23. Mulligan, Casey B. "A Dual Method of Empirically Evaluating Dynamic Competitive Equilibrium Models with Market Distortions, Applied to the Great Depression and World War II." NBER Working Paper 8775, 2002.

24. Nakamura, Emi and Jon Steinsson, "Five Facts About Prices: A Reevaluation of Menu Cost Models," Harvard University, mimeo.

25. Primiceri, G., Schaumburg, E., and Tambalotti, A. (2006), "Intratemporal Shocks," Federal Reserve Bank of New York, mimeo.

26. Rotemberg, Julio J., and Michael Woodford (1997) "An Optimization-Based Econometric Framework for the Evaluation of Monetary Policy," NBER Macroeconomics Annual, p. 297-346.

27. Summers, Lawrence (1991), "Panel Discussion: Price Stability. how Should Long-Term Monetary Policy Be Determined?" Journal of Money, Credit and Banking, 23(3), 625-631.

28. Svensson, Lars (2001), "The Zero Bound in an Open-Economy: A Foolproof Way of Escaping from a Liquidity Trap," Monetary and Economic Studies 19(S-1), 277-312.

29. Tobin, James (1975), “Keynesian Models of Recession and Depression," American Economic Review Papers and Proceedings, May, 65, pg. 195-202.

30. Woodford, Michael. (2003), “Interest and Prices: Foundations of a Theory of Monetary Policy," Princeton University.