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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, New Deal, National Industrial Recovery Act, zero interest rates, deflation

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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 "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 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 raise 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 (1).

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.

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 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 not new. The

[2]The closest argument is made in Tobin (1975) and De Long and Summers (1986). They show that policies that make a sticky price economy more “rigid" may stabilize output. I discuss this argument in section 5 and confirm

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.

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.

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

their result in the present model.

[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.

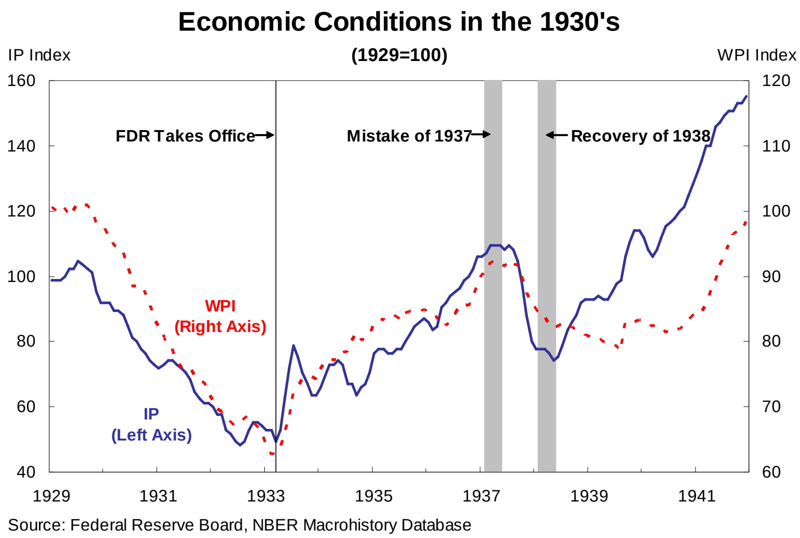

Figure 1: Both whole sale prices (WPI) and industrial output (IP) collapsed in 1929-1933 but abruptly started to recover in March 1933 when FDR took power and announced the New Deal.

consumption. The effect of these policies is analyzed in Eggertsson (2005) in a general equilibrium model. It remains an important research topic to estimate how much each of these policies contributed to the recovery. This paper takes a different focus by 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.

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 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

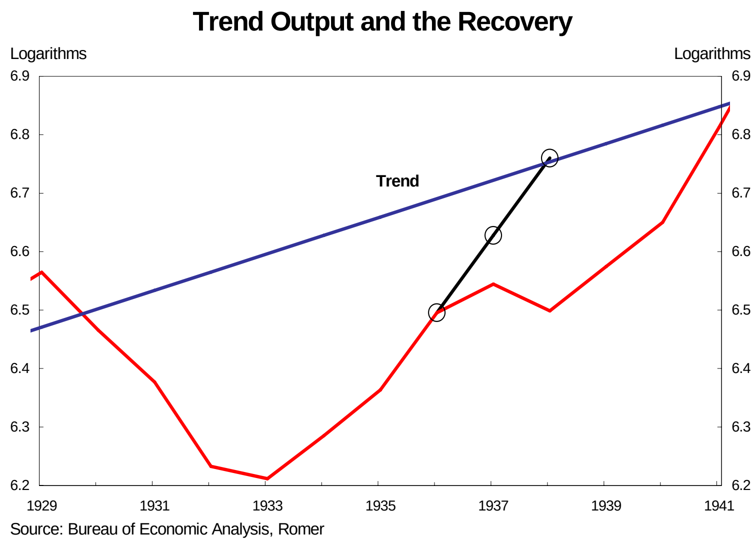

Figure 2: *The "slow recovery puzzle" is partially explained by the recession in 1937-38 which was triggered by abandonment of a commitment to reflation.*

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 (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]

[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.

[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

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) 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.

1 The Wedges and the Model

I extend a relatively standard general equilibrium model to allow for distortionary 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). I assume a representative household that seeks to maximize a utility function of the form

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

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,

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

and $H_t(j)$ is the quantity supplied of labor of type j. Each industry j employs an industry-specific type of labor, with its own wage $w_t(j)$.

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.

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.

For simplicity I assume complete financial markets and no limits on borrowing against future income. As a consequence, a household faces an intertemporal budget constraint of the form

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

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, $\Pi_t(i)$ represents the 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 represents the net nominal tax liabilities of each household in period t.

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

$$u_c(Y_t, \xi_t) = \beta E_t \left[u_c(Y_{t+1}, \xi_{t+1})(1 + i_t) \frac{P_t}{P_{t+1}} \right], \tag{2}$$

where i_t is the riskless nominal interest rate on one-period obligations purchased in period t. Household optimization similarly requires that the paths of aggregate real expenditure and the price index satisfy the conditions

$$\sum_{T=t}^{\infty} \beta^T E_t u_c(Y_T, \xi_T) Y_T < \infty, \tag{3}$$

$$\lim_{T \to \infty} \beta^T E_t [u_c(Y_T, \xi_T) W_T / P_T] = 0 \tag{4}$$

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 will be impossible for it to be negative,

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

as long as private sector parties 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 for the exposition 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

$$u_c(Y_t, \xi_t) = (1+r_t)\beta E_t u_c(Y_{t+1}, \xi_{t+1}) \tag{6}$$

Each differentiated good i is supplied by a single monopolistically competitive producer. As in Woodford (2003), I assume that 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 their prices at the same time. Each good is produced in accordance with a common production function[9]

$$y_t(i) = A_t h_t(i),$$

where A_t is an exogenous productivity factor common to all industries, and $h_t(i)$ 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 $H_t(j)$ so that every labor supply of type j satisfies

$$\frac{w_t(j)}{P_t} = (1+\omega_{1t}(j))\frac{v_h(\frac{y_t(j)}{A_t};\xi_t)}{u_c(Y_t;\xi_t)} \tag{7}$$

where I have substituted for hours using the production function and assumed market clearing. 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

[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.

[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.

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

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

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 $\omega_{2t} = 0$.

1.1 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

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

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 in 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 $p_t(i) = P_t$. Combining (7) and (9) then gives an aggregate supply equation

$$\frac{\theta - 1}{\theta} = \frac{1 + \omega_{1t}}{1 - \omega_{2t}} \frac{v_h(Y_t/A_t; \xi_t)}{A_t u_c(Y_t; \xi_t)} \qquad (10)$$

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

I can now define an equilibrium in the flexible price economy, which I call the natural rate of output, and the efficient level of output which is the optimal flex price output. These two concepts will be convenient in our analysis of the model with sticky prices.

[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.

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* $\{A_t, \xi_t\}$*. 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:

$$E_0 \sum_{t=0}^{\infty} \beta^t \{u(Y_T;\xi_T) - v(Y_t/A_t;\xi_T) + \psi_{1t}\{\frac{\theta-1}{\theta} - \frac{1+\omega_{1t}}{1-\omega_{2t}} \frac{v_h(Y_t/A_t;\xi_t)}{A_t u_c(Y_t;\xi_t)}\}.$$

The first order condition with respect to Y_T is

$$u_c(Y_T;\xi_T) - \frac{v_h(Y_t/A_t;\xi_T)}{A_t} - \psi_{1t} \frac{\partial \frac{1+\omega_{1t}}{1-\omega_{2t}} \frac{v_h(Y_t/A_t;\xi_t)}{A_t u_c(Y_t;\xi_t)}}{\partial Y_t} \tag{11}$$

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

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

Substituting this into (11), we obtains that $\frac{v_h(Y_t/A_t;\xi_T)}{u_c(Y_T;\xi_T)A_t} = 1$. 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).

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

1.2 Equilibrium with Nominal Frictions

In this section I introduce 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 (1983) I 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. Then I can write the maximization problem that each firm faces at the time it revises its price as

$$E_t \left\{ \sum_{T=t}^{\infty} (\alpha\beta)^{T-t} Q_{t,T} \{\{1-\omega_{2T}\} p_t^* Y_T (p_t^*/P_T)^{-\theta} + \omega_{2T} p_t^j Y_T (p_t^j/P_T)^{-\theta} - w_T(j) Y_T (p_t^*/P_T)^{-\theta}/A_T\} \right\} = 0.$$

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

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

where I have used (7) to substitute out for wages and also substituted out the stochastic discount factor using

$$Q_{t,T} = \beta^{T-t} \frac{u_c(C_T;\xi_T)P_t}{u_c(C_t;\xi_t)P_T}.$$

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 $\{\xi_t, A_t\}$.*

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 $A_t = \bar{A}$ 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. ■

2 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 what I call the first best equilibrium in the approximated economy (the first and second best equilibrium are formally defined in section 6).

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

$$\hat{Y}_t^e = \frac{\sigma^{-1}}{\sigma^{-1} + \nu} g_t + \frac{\nu}{\sigma^{-1} + \nu} q_t + \frac{1 + \nu}{\sigma^{-1} + \nu} a_t \tag{15}$$

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 three shocks are $g_t \equiv -\frac{\bar{u}_{c\xi}}{\bar{Y}\bar{u}_{cc}} \xi_t$, $q_t \equiv -\frac{\bar{v}_{h\xi}}{\bar{H}\bar{v}_{hh}} \xi_t$, $a_t \equiv \log(A_t/\bar{A})$ where a bar denotes that the variables (or functions) are evaluated in steady state. I define the parameters $\sigma \equiv -\frac{\bar{u}_c}{\bar{u}_{cc}\bar{Y}}$ and $\nu \equiv \frac{\bar{v}_{hh}\bar{h}}{\bar{v}_h}$. Using equation (6) the efficient level of interest can be approximated by

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

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

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

[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 $\pi_t \equiv \log P_t/P_{t-1}$. 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

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

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

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

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

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

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*

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

where t.i.p. denotes terms independent of policy.

Proof. Follows from Proposition 6.1, 6.3 and 6.4 in Woodford (2003) with appropriate modifications of the proofs. For the proof of 6.1 we need the modification that $\Phi_y = 0$ because we

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 $\bar{r}$.

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 $\hat{Y}_t^e$ 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 6 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* $\hat{Y}_t = \hat{Y}_t^e$ *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 $\hat{Y}_t = \hat{Y}_t^e \Longrightarrow \hat{\omega}_t = 0$ ■

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 (2005) argues that this type of policy describes relatively well the policy of the Federal Reserve shortly before FDR rose to power.

3 Excessive Deflation and an Output Collapse under a Baseline Policy

In this section I explore 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 consider a shock process for r_t^e as in Eggertsson and Woodford (2004):

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,* $\hat{Y}_t^e = 0 \ \forall \ t$. *The stochastic date the shock returns back to steady state is denoted* τ. *To ensure a bounded solution the probability* γ *is such that* $\gamma(1 - \beta(1-\gamma)) - \sigma\kappa(1-\gamma) > 0$

For simplicity I have assumed that $\hat{Y}_t^e$ is constant so that the dynamics of the model are driven by the exogenous component of the natural rate of interest r_t^e.[14]. Recall from section (2) that all the shocks in the sticky price economy can be summarized by r_t^e and $\hat{Y}_t^e$. 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 and Woodford (2004) for a detailed discussion of the kind of shocks that imply a constant $\hat{Y}_t^e$. A temporary collapse in some autonomous component of aggregate spending (that is separate from private consumption) can also be interpreted as a preference shock.[15]

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.[16] 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

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

[14] The same result would apply if Y_t^e is assumed to be stochastic but would then refer to the output gap, i.e. $Y_t - Y_t^e$, instead of output. The most simple example of a shock that implies that Y_t^e is constant while r_t^e varies is a purely intertemporal shock such that $E_t \sum_{T=t}^{\infty} \beta^{T-t} \left[u(C_T; \xi_T) - \int_0^1 v(H_T(j); \xi_T) dj \right] = E_t \sum_{T=t}^{\infty} \beta^{T-t} \xi_T \left[u(C_T) - \int_0^1 v(H_T(j)) dj \right]$

[15] More generally, the most plausible reason for a collapse in aggregate spending is a collapse in investment. A host of candidates could lead to an investment collapse, such as problems in financial intermediation, adverse shocks to the balance sheets of firms, or a productivity slowdown that may lead to a capital overhang (and thus excess capital, leading to a decline in the natural rate of interest). These shocks are not modelled in detail at this level of abstraction but could be studied in a model with capital and financial intermediation frictions.

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

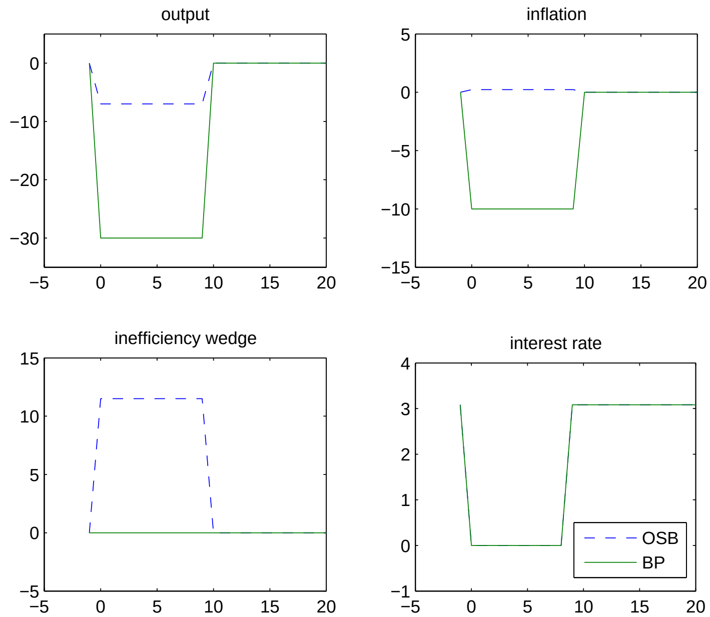

Figure 3: The benchmark policy (BP) compared to the Optimal Second Best (OSB) under the contingency that the shock reverts to steady state in period 10.

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

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

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:*

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

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

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.

While the results are analytical, it is useful to put some numbers on them for illustration purposes. To solve the model I need to determine the parameters $(\beta, \sigma, \theta, \nu, \kappa)$ and take a stance on the shock process governed by (r_L^e, γ). Each period is a quarter. I follow Cole and Ohanian

(2004) in setting the parameters $(\beta, \sigma, \theta, \nu)$ (see Table 1 and further discussion in the Appendix). The difference in the calibration comes from the choice of the parameter κ, which is a function of these parameters and the frequency of price change α. Cole and Ohanian's model can be thought of a limiting case of a sticky price model as $\alpha \to 0$ and $\kappa \to \infty$. Instead of assuming this I choose this parameter to match the extent of the deflation in 1932 – the year prior to FDR's rise to power and prior to the implementation of NIRA – and the associated collapse in output (assume that NIRA was unexpected). Using equation (27) I choose κ to match inflation and the output collapse in 1932

$$\kappa = (1 - \beta(1 - \gamma))\frac{\pi_t}{Y_t} = 0.0089$$

In choosing this parameter I have assumed that output is 30 percent from steady state and there is 10 percent deflation. Furthermore I choose the parameter of the shock $\gamma = 0.1$ so that the expected duration of the shock is 10 quarters. Finally I assume that the shock r_L^e is -3 percent (i.e. $-0.03/4$) to match the 30 percent contraction in output using equation (28).

Table 1

parameters	calibrated values
σ	1
β	0.9923
κ	0.0089
γ	0.1
shock	calibrated values
γ	1/10
r_L^e	-0.03/4

Figure 3 shows the output contraction and deflation under A1 this calibration. The figure shows the case in which the natural rate of interest returns to steady state in period $\tau = 10$ (which is the expected duration of the shock).Recall from equations (28) and (29) that these lines would look the same for any other contingency but with a different breaking point corresponding to $t = \tau$ (i.e. the lines would jump up at different time). Because of the choice of r_L^e the model generates a 30 percent collapse in output and 10 percent deflation and the contraction lasts as long as the duration of the shock (which is stochastic). The contraction at any time t is created by a combination of the deflationary shock in period $t < \tau$ – but more importantly – the *expectation* that there will be deflation and output contraction in future periods periods $t + j < \tau$ 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*.

4 Was the New Deal expansionary?

Can the government break the deflationary spiral 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

$$\hat{\omega}_L = \phi r_L^e > 0 \text{ when } 0 < t < \tau \tag{30}$$

and

$$\hat{\omega}_t = 0 \text{ when } t > \tau \tag{31}$$

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 (30) and (31).

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

$$Y_t = (1-\gamma)Y_t + \sigma(1-\gamma)\pi_t + \sigma r_L^e$$

$$\pi_t = \kappa Y_t + \beta(1-\gamma)\pi_t + \frac{\kappa}{\sigma^{-1}+\nu}\hat{\omega}_L$$

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 ω_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, that is the key propositions 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 (30) and (31). Then output and inflation are increasing in $\hat{\omega}_L$ and given by*

$$\hat{Y}_t^{ND} = \frac{1-\beta(1-\gamma)}{\gamma(1-\beta(1-\gamma))-\sigma\kappa(1-\gamma)}[\sigma r_L^e + \frac{(1-\gamma)\kappa}{[1-\beta(1-\gamma)](\nu+\sigma^{-1})}\sigma\hat{\omega}_L] > \hat{Y}_t^D \text{ if } t < \tau$$

$$\text{and } \hat{Y}_t^{ND} = 0 \text{ if } t \geq \tau$$

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

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

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

so that the NIRA policy will have a contractionary effect. To offset the inflationary effect of an increase in ω_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 ω_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, a policy formally derived in section 6, and compares it to the benchmark policy. As shown, the increase in the wedge $\hat{\omega}_t$ leads to a dramatic recovery in output and prices relative to the benchmark. The reason for this is as follows: The increase in $\hat{\omega}_t$ increases expected inflation by increasing the markup of firms and/or workers unions. Higher expected inflation stimulates demand because it lowers the real rate of interest. The quantitative effect of this is large in the model.

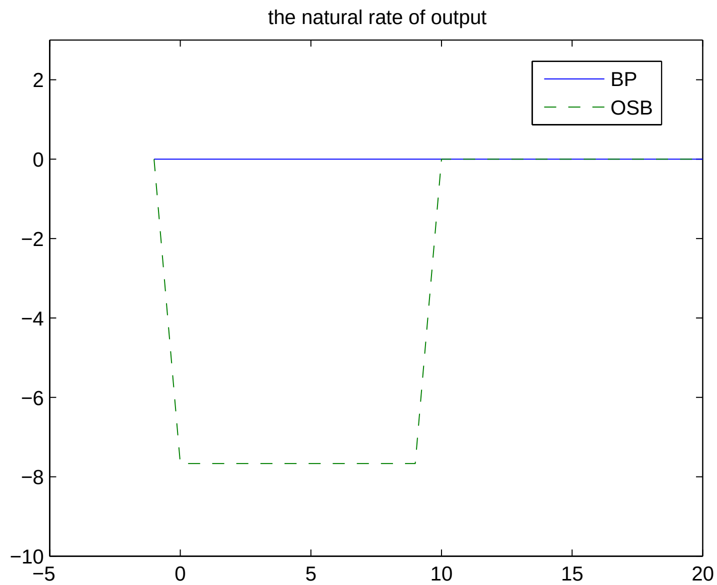

Figure 4: The optimal second best policy reduces the natural rate of output.

In the figure the benchmark policy (solid line) represents the equilibrium in the absence of New Deal policies, $\hat{\omega}_t$, which is interpreted as the equilibrium before FDR rose to power in 1933. This interpretation is logical because we showed that the benchmark can be justified on the "naive" ground that it satisfies the necessary conditions for the first best "as closely as possible". I will also show in section (6) that it is the optimal forward looking policy if the government does not use $\hat{\omega}_t$ as an instrument for policy. The dashed line is interpreted as the solution after FDR rose to power and implemented the NIRA which implied an increase in $\hat{\omega}_t$.

In the calibrated example the wedge increases by about 12 percent. This is equivalent to a government introduced policy that increased monopoly markups of firms or workers unions by 12 percent. Figure 4 shows the implied change in the natural rate of output due to the change in the wedges. The New Deal policies lead to a decline in the natural rate of output by 8 percent. 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 of 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, i.e. moving from the dashed line to the solid line in the figure. This leads to an increase in output of about 25 percent. As can be seen from the data from the Great Depression in figures 1, similar movements occurred in the US after the introduction of the New Deal policies in the spring of 1933. Furthermore, the real interest rate fell from double digits to slightly negative levels. As a result output grew by about a 39 percent from 1933-37, registering the strongest economic expansion in US economic history outside of war. Several other policies were implemented during this period that also played an important role. For discussion of other policy actions of FDR see Eggertsson (2005) and for a discussion of the depression in 1937-38, see Eggertsson and Pugsley (2006). 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.[17]

While the results are analytical some readers may be interested in how sensitive the numerical examples are to different parameter values. The results were obtained using the vales for $(\sigma, \nu, \beta, \theta)$ assumed by Cole and Ohanian. Table 2 in the Appendix shows sensitivity of the results to variations in these parameters, choosing the value of κ and the shock in the same way as described in section 3 (i.e. the shock is calibrated so that output contracts by -30 percent in the absence of New Deal Policies and κ is picked so that the output collapse corresponds to 10 percent deflation). Since output and deflation are constant in the absence of New Deal policies, the table only reports the value for output and inflation in the 'depression state' when the New Deal policies are applied. The numerical results are relatively insensitive to variations in the parameters. This suggests that the fundamental assumption driving the results is not the particular parameters taken from Cole and Ohanian's study but instead the presumption of nominal frictions (captured by the calibration of κ to match the extent of deflation corresponding to the output contraction) and the *assumption* that there are intertemporal shock that give these frictions enough leverage to generate an output contraction (captured by the calibration of r_L to match the output contraction). The next section discusses these two assumptions.

5 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 reason for the different conclusions reached. This also clarifies the role of the two fundamental assumptions driving my results. 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

[17] 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.

paths of the economy for given initial conditions. They show that the recovery, given this initial condition, is slower than implied by a standard growth model and give possible explanations for the slow recovery. The slow recovery in Cole and Ohanian's model is due to that they calibrate the size of a "cartelized sector" to match data that show that real wages were 20 percent above trend in the manufacturing sector in 1939. Because this sector, in their calibration, corresponds to 32 percent of the economy, this indicates that real wages, on average, were 6 percent higher than they otherwise would have been. The high real wages, due to cartelization policy, create a distortionary wedge and thus suppress employment and aggregate output.

The two most important differences between the assumptions and calibration parameters in this paper and Cole and Ohanian's are: 1) prices are sticky and 2) there are deflationary shocks that make the market clearing interest rate negative throughout the period 1933-39 (i.e. the negative value of r_L^e which I *choose* in the calibration to drive output down to -30% of steady state). Below I discuss each of these assumptions. Before detailing whether or not they were likely to be satisfied it is useful to ask the following question: Given 1) and 2), what is the response of the economy if the wedges in the current model are calibrated to match the same data as Cole and Ohanian match, i.e. that real wages were above trend? Just as in their model, the high real wages in the recovery phase *imply* a particular wedge in the model of this paper. To see this one can approximate equation (7) and use the assumption A1 that $\hat{Y}_t^e = 0$ (and assuming no productivity shocks) to yield

$$\hat{w}_t^p = \hat{\omega}_t + (\sigma^{-1} + \nu)\hat{Y}_t$$

where $\hat{w}_t^p$ is the deviation of the average real wage from steady state. Because the model abstract from productivity growth, I interpret this variable as deviation of real wages from trend. I now assume that policy takes the same form as in the last section, i.e. that the wedge is temporarily increased during the periods in which there are deflationary shocks. This implies that $\hat{\omega}_H = 0$ where H denotes that the shock r_t^e has reverted to steady state. Using the equation above along with the IS and the AS equation the implied wedge $\hat{\omega}_L$ solves the three equations

$$\hat{w}_L^p = \hat{\omega}_L + (\sigma^{-1} + \nu)\hat{Y}_L$$

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

$$\gamma Y_L = \sigma(1 - \gamma)\pi_L + \sigma r_L^n$$

If we calibrate $\hat{w}_L^p$ to match that real wages were on average 6 percent above trend during the recovery phase we can solve for $\omega_L, \hat{Y}_L$ and $\hat{\pi}_L$. Under our baseline calibration this value for the real wages imply that the inefficiency wedge is 12.8 percent, output -4.5 percent and inflation 1.3

percent. Compare these values to the equilibrium in which the inefficiency wedge is zero. Then there is an output contraction of 30 percent and deflation of 10 percent. Thus the New Deal policies, if we match the same real wage data as Cole and Ohanian, increased output by about 25.5 percent in this model, and thus supported a recovery rather than prolonging the depression. Incidentally this value of the inefficiency wedge is very close to the optimal second best policy.

This conclusion relies on the assumed degree of price stickiness. If prices were perfectly flexible then the output would be equal to the natural rate of output. Using equation (18), a wedge of 12.8 percent implies that the natural rate of output is -8.5 percent below steady state but at steady state when the wedge is zero. Thus when prices are perfectly flexible the model delivers the same qualitative result as Cole and Ohanian's analysis, i.e. the New Deal policies reduced output by 8.5 percent. Hence the difference in result derived in this paper is driven by the assumed value of κ. How sensitive are the results to the assumed degree of price rigidity? A well known weakness of the Calvo model is that it assumes that the frequency of price adjustment is constant – and thus independent of policy – and one may wonder to what extent the result changes if – for given value of the shocks and the other structural parameters – this frequency increases. Somewhat surprisingly the quantitative result is becomes even *stronger* as prices become *more flexible*. The formulas in (28) and (29) reveal the puzzling conclusion that the higher the price flexibility (i.e. the higher the parameter κ) the stronger the output collapse in the absence of the New Deal policies. This is paradoxical because, when prices are perfectly flexible as in Cole and Ohanian (2005), output is constant.

The forces at work here were first recognized by Tobin (1975) and De Long and Summers (1986). These authors show that more flexible prices can lead to the expectation of further deflation in a recession. If demand depends on expected deflation, as in equation (17), higher price flexibility can lead to ever lower demand in recession, thus increasing output volatility. This dynamic effect, the so called "Mundell effect", must be weighted against the reduction in the static output inflation trade-off in the AS curve due to higher price flexibility. In some cases the Mundell effect can dominate, depending on the parameters of the model. Formula (28) in Proposition 5 indicates that the Mundell effect will always dominate at zero interest rates.

This result indicates that higher price flexibility will make the New Deal policies even more beneficial in the model, since it attenuates the output collapse in their absence. It is only in the very extreme case when prices are perfectly flexible that the result of the paper collapses because in that case, by definition, the equilibrium output has to be equal to the natural rate of output.

The second key assumption in the paper is that there are shocks such that the efficient rate of interest is temporarily negative, i.e .$r_L^e < 0$. In the absence of this shock there are no deflationary pressures. For a given inflation target, therefore, output will be equal to the natural level and inefficiency wedges will thus only reduce output as long as the government tries to maintain a given inflation target. Thus, in the absence of these shocks, the results of the model will coincide

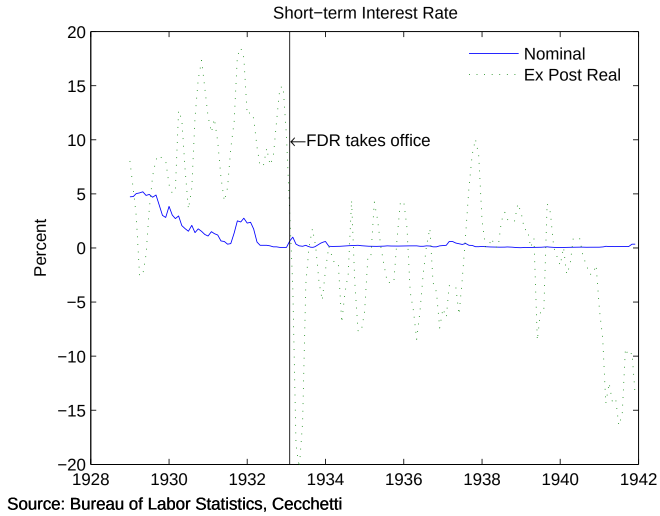

Figure 5: *Real Rates collapsed with FDR rise to power.*

with those derived by Cole and Ohanian. Is it plausible to assume that the market clearing interest rate was negative throughout the recovery period? Figure 5 shows the ex post real interest rate in the US in the 1930's.[18] The real rate of interest does not need to be equal to the efficient level. Indeed equation (17) shows that if the (current and expected) real rate of interest is higher that then efficient level of interest there will be a recession. In contrast if the real rate of interest is lower than the efficient level of interest there is a boom. During 1929-1933 the short term real rate of interest was extremely high relative to the assumed efficient real interest rate in the calibration, consistent with the collapse in output. In 1933-1937, however, the short-term real interest rate was slightly negative. If there were no shocks during this period, the model would imply that output had to be above its efficient level during this period. This does not, however, appear consistent with the data since output was mostly recovering to its pre-depression level and is generally considered to have been below potential during this period. This indicates that the efficient level of interest was even more negative than the real interest rate during this period, consistent with the assumed path of the shocks in this paper. While this evidence is suggestive, I leave it to future research to fully estimate the model to match the shocks and the parameters to the data (this could for example be done using the Bayesian methods as in Primiceri, Tambalotti and Schaumburg (2006)). That enterprise will no doubt benefit from a more complex model that includes several frictions and additional dynamics. The key advantage of the current setup, in addition to the closed form solutions already derived, is that I can derive explicit closed form

[18] See e.g. Hamilton (1992), who uses commodity futures, and Cechetti (1992), who uses CPI data, for estimates of the ex ante real interest rate. Their estimates correspond quite closely to a smooth version of the ex post real rate reported here and thus the discussion would be unchanged if I used either measure of the ex ante real rate.

solutions for the optimal policy under different assumptions about the government's ability to commit to future policy. This is what I now turn to.

6 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 $\{r_t^e, \hat{Y}_t^e\}$ 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.

6.1 The optimal forward looking solution

In the approximate sticky price equilibrium there are two physical state variables $\hat{Y}_t^e$ 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* $\pi(\hat{Y}^e, r^e), Y(\hat{Y}^e, r^e), \omega(\hat{Y}^e, r^e), i(\hat{Y}^e, r^e)$ *that maximize social welfare.*

The social planner problem at date t is then

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

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

$$\begin{aligned} L_0 &= E_0 \sum_{t=0}^{\infty} \beta^t \{\frac{1}{2}\pi(r_t^e)^2 + \frac{1}{2}\lambda\hat{Y}(r_t^e) + \psi_1(r_t^e)[\pi(r_t^e) - \kappa\hat{Y}(r_t^e) - \frac{\kappa}{\sigma^{-1}+\upsilon}\hat{\omega}(r_t^e) - \beta\pi(r_{t+1}^e)] \\ &\quad \psi_2(r_t^e)[\hat{Y}(r_t^e) - \hat{Y}(r_{t+1}^e) + \sigma i(r_t^e) - \sigma\pi(r_t^e) - \sigma r_t^e] + \psi_3(r_t^e) i(r_t^e)\} \end{aligned} \quad (32)$$

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, $\pi_L, \hat{Y}_L, i_L, \omega_L$ or $\pi_H, \hat{Y}_H, i_H, \omega_H$ 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 $\pi_H, \hat{Y}_H, i_H, \hat{\omega}_H$ (i.e. the Lagrangian conditional on being in the H state) can be simplified to yield[19]

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

[19] 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.

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

$$\pi_H = \hat{Y}_H = \hat{\omega}_H = 0 \tag{33}$$

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

$$i_H = r_H \tag{34}$$

$$\hat{\omega}_H = 0. \tag{35}$$

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

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

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

$$i_L \geq 0$$

Consider the Lagrangian (32) given the solution (33)-(35). There is a part of this Lagrangian that is weighted by the arbitrarily small probability that the low state happens (which was ignored in our previous calculation). Conditional on being in that state and substituting for (33)-(35) the Lagrangian at a date t in which the economy is in the low state can be written as:

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

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

$$\pi_L + (1-\beta(1-\gamma))\psi_{1L} - \sigma(1-\gamma)\psi_{2L} = 0 \tag{36}$$

$$\lambda\hat{Y}_L - \kappa\psi_{1L} + \alpha\psi_{2L} = 0 \tag{37}$$

$$-\frac{\kappa}{\sigma^{-1}+\upsilon}\psi_{1L} = 0 \tag{38}$$

$$\sigma\psi_{2L} + \psi_{3L} = 0 \tag{39}$$

$$i_L \geq 0,\ \psi_{3L} \geq 0,\ i_L\psi_{3L} = 0 \tag{40}$$

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 (38) cannot be satisfied). The solution of the conditions above (replacing (38) 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 ($\pi_L, \hat{Y}_L, \omega_{L,}\psi_{1L,}\psi_{2L,}\psi_{3L}$ and equations (36)-(39) together with IS and AS equations) that can be solved to yield:

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

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

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

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.

6.2 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).[20] 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 the government's objective and the system of equations that determine equilibrium are completely forward looking so that they only depend on the exogenous state $(r_t^e, \hat{Y}_t^e)$. It follows that the expectations $E_t\pi_{t+1}$and $E_t\hat{Y}_{t+1}$ 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 $\bar{\pi}(r_t^e, \hat{Y}_t^e)$ and $\bar{Y}(r_t^e, \hat{Y}_t^e)$ below). To solve the government's

[20] 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.

period maximization problem one can then write the Lagrangian

$$L_t = -E_t \begin{bmatrix} \frac{1}{2}\{\pi_t^2 + \lambda_y(\hat{Y}_t - \hat{Y}_t^e)^2\} \\ +\phi_{1t}\{\pi_t - \kappa\hat{Y}_t + \kappa\hat{Y}_t^e - \frac{\kappa}{\sigma^{-1}+\upsilon}\hat{\omega}_t - \beta\bar{\pi}(r_t^e, \hat{Y}_t^e)\} \\ +\phi_{2t}\{\hat{Y}_t - \bar{Y}(r_t^e, \hat{Y}_t^e) + \sigma(i_t - \bar{\pi}(r_t^e, \hat{Y}_t^e) - r_t^e)\} + \phi_{3t} i_t \end{bmatrix} \tag{41}$$

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

$$\pi_t + \phi_{1t} = 0 \tag{42}$$

$$\lambda_y(\hat{Y}_t - \hat{Y}_t^e) - \kappa\phi_{1t} + \phi_{2t} = 0 \tag{43}$$

$$-\frac{\kappa}{\sigma^{-1}+\upsilon}\phi_{2t} = 0 \tag{44}$$

$$\sigma\phi_{2t} + \beta^{-1}\phi_{3t} = 0 \tag{45}$$

$$\phi_{3t} \geq 0, \ \phi_{3t} i_t = 0 \tag{46}$$

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 (44). 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 (42)-(46) and the IS and AS equations is:

$$\hat{Y}_t = \frac{\sigma}{\gamma} r_L^e \text{ if } t < \tau \text{ and } \hat{Y}_t = 0 \text{ if } t \geq \tau \tag{47}$$

$$\pi_t = 0 \ \forall t \tag{48}$$

$$\hat{Y}_t^n = \frac{\sigma}{\gamma} r_L^e \text{ if } t < \tau \text{ and } \hat{Y}_t^n = 0 \text{ if } t \geq \tau \tag{49}$$

$$\hat{\omega}_t = -\frac{\sigma}{\gamma}(\sigma^{-1} + \upsilon) r_L^e > 0 \text{ if } t < \tau \ \hat{\omega}_t = 0 \text{ if } t \geq \tau \tag{50}$$

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. Figure (6) compares the OFP and the MPE in our baseline calibration. The figure shows the quantitative difference is trivial in our baseline calibration.

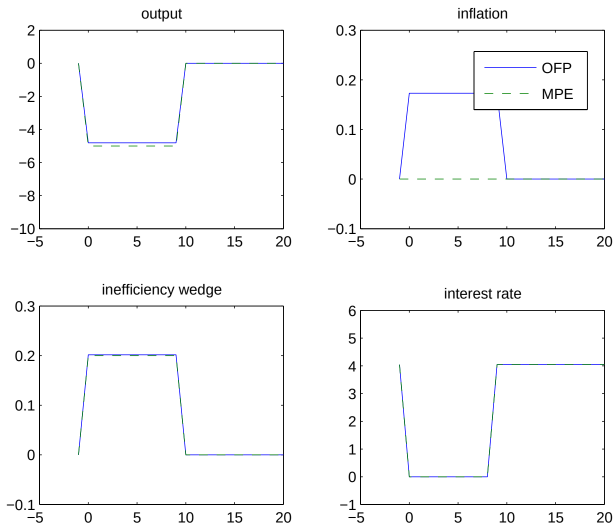

Figure 6: The optimal policy under discretion (Markov Perfect Equilibrium) and the optimal forward looking policy are almost identical.

6.3 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:

$$L_t = E_t \left[\begin{array}{c} \frac{1}{2}\{\pi_t^2 + \lambda \hat{Y}_t^2\} + \phi_{1t}(\pi_t - \kappa \hat{Y}_t - \frac{\kappa}{\sigma^{-1}+\upsilon}\hat{\omega}_t - \beta\pi_{t+1}) \\ +\phi_{2t}(\hat{Y}_t - \hat{Y}_{t+1} + \sigma i_t - \sigma\pi_{t+1} - \sigma\hat{r}_t^e) + \phi_{3t} i_t \end{array} \right] \tag{51}$$

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 7 shows the solution of the endogenous variables, using the solution method suggested in Eggertsson and Woodford (2004). 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

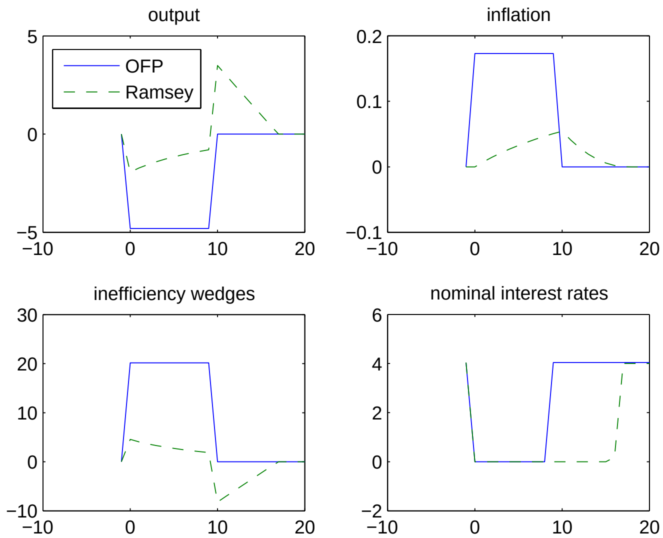

Figure 7: The qualitative features of the optimal forward looking and Ramsey policy are the same. The key difference is that the Ramsey policy achieves a better outcome by manipulating expectations about policy at the time at which the deflationary shocks have subsided.

side. The government commits to zero interest rates for a considerable time after the shock has reverted back to steady state.

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.

7 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.

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9 Appendix: Calibration and Sensitivity

I start with discussing how I use Cole and Ohanian work to calibrate the parameters and then discuss the sensitivity with respect to this parameterization. They assume the period utility function

$$\log C_t + A \log(1 - n_t).$$

where n_t is household market time and $A > 0$ is a parameter. The log utility in consumption implies that $\sigma = 1$ in the current model. Cole and Ohanian assume that that the household devotes one third of its time to work. This implies a Frisch elasticity of $\frac{1-\bar{n}}{\bar{n}} = 2$ that in our model corresponds to $\nu = 0.5$. Cole and Ohanian assume that the elasticity of substitution across goods is $\theta = 10$ which is a relatively standard value. Finally they assume that the real return on capital is 5 percent and the average output growth rate per capita is 1.9. Together these assumption imply a value $\beta = 0.97$. Since I calibrate my model to quarterly data I choose $\beta = 0.97^{1/4} = 0.992$.

Table 2 reports the implication for deviating from the baseline calibration parameters $(\nu, \theta, \sigma, \beta)$. The table shows the sensitivity of the results to variations in these parameters, choosing the value of κ and the shock in the same way as described in section 3 (i.e. the shock is calibrated so that output contracts by -30 percent in the absence of New Deal Policies and κ is picked so that this corresponds to 10 percent deflation). Since output and deflation are constant in the absence of New Deal policies, the table only reports the value for output and inflation in the 'depression state' when the New Deal policies are applied. Inflation and interest rates are reported in terms of percentages per year, output in terms of percentage deviation from steady state.

The parameter ν is the inverse of the Frisch elasticity. The Frisch elasticity is often assumed to be much lower (based on micro evidence) than assumed in the Cole and Ohanian study. The effect of the New Deal policy, measured in terms of output and inflation, is relatively insensitive to this variation in this parameter. I also allow for β and θ to take on different values and again the results do not change much (observe that the model is calibrated in quarterly frequencies so that steady state real interest rate is $(1+r)^4 = \beta^{-4}$). It is sometimes argued that the coefficient of relative risk aversions should be higher than 1 and the results are more sensitive to this parameter. In the extreme case when $\sigma^{-1} = 20$ the output effect of the New Deal is only 2.3 percent of GDP compared to 25 percent under the baseline calibration.

The different parameters imply a different frequency of price adjustment and this number can be computed by the formula for κ. The last column of the table shows that the average duration of price adjustment is in the range 4-7 quarters for most of the calibrations considered. The last lines shows that this value is 3 quarters for a particular parameter combinations to illustrate that one can match a lower value for this parameter by varying more than one parameter from the baseline. It can be brought down further – holding all the parameters constant – if one assumes that monetary policy is not responsible for as large a fraction of the output drop (i.e. if Y_L^D used to calibrate κ is smaller).[21]

Table 2

baseline (see figures in paper)
θ=10,ν=0.5, β=0.9923, σ=1

variations to baseline
Under all variations r_L^e is choosen so that

$$\pi_L^D=-10 \quad Y_L^D=-30$$

The effect of the New Deal policies is sensitive to the parameter var

	π_L^{ND}	Y_L^{ND}	$(Y_L^N)^{ND}$	r_L^e	1/(1-α)
ν=20	0.2243	-6.9953	-7.6682	-3	3.9998
ν=10	0.2243	-6.9953	-7.6682	-3	4.0728
ν=2	0.2243	-6.9953	-7.6682	-3	4.5901
θ=20	0.1161	-7.2389	-7.587	-3	4.4961
θ=7	0.3115	-6.7992	-7.7336	-3	6.771
θ=5	0.4203	-6.5542	-7.8153	-3	7.6278
β=0.9973	0.2156	-7.0149	-7.6617	-3	5.9706
β=0.9948	0.22	-7.005	-7.665	-3	5.9448
β=0.9899	0.2286	-6.9856	-7.6715	-3	5.8954
σ=1/2	0.2953	-18.4178	-19.3037	-15	7.526
σ=1/5	0.1631	-25.4266	-25.9158	-51	11.0389
σ=1/20	0.0889	-27.73	-27.9968	-111	15.2708
θ=20,ν=20	0.1161	-7.2389	-7.587	-3	2.9938

[21] There are various empirical estimation of the value for α for US postwar data, most of which centers around one year. A notable exception is Bills and Klenow (2004) who report that BLS data imply an average duration of price adjustment of only 2 quarters which is below the lower range of what I report. Nakamura and Steinsson (2006) show, however, using a more complete dataset that enables them to better adjustment for sales that the median duration is about 3 quarters, which is better consistent with the lower range of the value of α that is reported in the table.