.

Fiscal Multipliers and Policy Coordination[1]

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– preliminary –

This paper analyzes the effectiveness of fiscal policy at zero nominal interest rates. I solve a stochastic general equilibrium model with sticky prices assuming the government cannot commit to future policy. Real government spending increases demand by increasing public consumption. Deficit spending increases demand by generating inflation expectations. I compute a multiplier of government spending that calculates by how much each dollar of spending increases output. Both multiplier can be large, but the multiplier of deficit spending depends critically on monetary and fiscal cooperation. The theory suggests one interesting interpretation of why recovery measures – such as fiscal spending, exchange interventions, and large increases in the money supply – had a smaller effect on nominal demand in Japan during the Great Recession (1992-2006) than during the US's Great Depression (1929-1941). In both episodes the short-term nominal interest rate was close to zero. The theory suggests that part of the difference can be explained by the fact that while monetary and fiscal policy were coordinated in the US during the Great Depression, they were not in Japan during the Great Recession. The overall conclusion of the paper is that the effect of given policy actions, depends crucially on the institutional setup in the economy.

JEL classification: E52, E63

Key words: policy coordination, zero interest rates, deflation, Great Depression, Great Recession

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[1] This paper presents preliminary findings and is being distributed to economists and other interested readers solely to stimulate discussion and elicit comments. The views expressed in the paper are those of the author and are not necessarily reflective of views at the Federal Reserve Bank of New York or the Federal Reserve System. Any errors or omissions are the responsibility of the author.

1 Introduction

1.1 General Overview

"It is important to recognize that the role of an independent central bank is different in inflationary and deflationary environments. In the face of inflation, which is often associated with excessive monetization of government debt, the virtue of an independent central bank is its ability to say "no" to the government. With protracted deflation, however, excessive monetary creation is unlikely to be the problem, and a more cooperative stance on the part of the central bank may be called for."

- Ben Bernanke, Chairman of the Board of Governors of the Federal Reserve, before the Japan Society of Monetary Economics, Tokyo, Japan, May 31, 2003.

> *"Coordinate, Coordinate*
>
> *If monetary policy lacks sufficient power on its own to end deflation, the solution is not to give up but to try a coordinated monetary and fiscal stimulus."*

– The Economist, June 2003, editorial on Japan's fiscal and monetary policy

This paper is about an economy in a liquidity trap, i.e. an environment with zero nominal interest rate, deflationary pressures and subpar growth. The paper shows two "fiscal policy multipliers" in a relatively standard New Keynesian liquidity trap economy with taxation costs. It computes the multiplier of real government spending, and the deficit spending multiplier. In line with recent literature (see e.g. Eggertsson (2010) and references therein), it shows that the real government spending multiplier can be quite big. The deficit spending multiplier, however, can either be big or zero, depending on the institutional arrangement. That is the main point of the paper.

It is perhaps a bit misleading to talk about deficit spending multiplier. But I do this to sharpen the distinction between this mechanism relative to "real government spending." The deficit spending multiplier in this paper refers to the effect that increasing nominal debt has on output. In a Ricardian environment, where the choice between debt and taxes is irrelevant, this multiplier is zero. If there are costs of taxation things change. In this case a high nominal debt can trigger expectation of higher inflation because the discretionary government optimally trades off between costly taxation and some inflation. Expectation of some inflation is exactly what is needed in a economy with zero interest rate and deflationary pressure, because with the interest rate stuck at zero then higher inflation expectation reduce the real rate of interest and thus stimulate demand. Hence higher debt leads to higher inflation expectations which in turn leads to an output expansion. One interesting aspect of this is that while standard "budget deficits" lead to higher debt, that is not the only way nominal debt can be increased. Any policy action that increases debt, such as printing money (or bonds) and buying privately held assets such as foreign exchange or stocks also does the trick. As does dropping money (or bonds) from helicopters. The deficit spending multiplier is therefore for a catchphrase for things that increase government debt and thus affect the inflation incentive of the government.

Our main focus in this paper is on optimal policy when the government cannot commit to future policy (i.e. optimal policy under discretion). It can be said with some generality that the problem of the liquidity trap can be largely be eliminated in most general equilibrium models if the government can commit to higher future money supply (see e.g. Krugman (1998), Eggertsson and Woodford (2003), Eggertsson (2006), Auerbach and Obstfeld (2006)), or equivalently, a higher future price level. The optimal monetary policy commitment in Eggertsson and Woodford (2003), for example, makes the problem of the zero bound pretty trivial. One approach to understanding how bad things can happen in these models at zero interest rate, therefore, is to say that this commitment can't be achieved due to credibility problems (see Eggertsson (2006)). If we think of the monetary authorities as increasing the money supply today, the problem boils down to: How can it commit to not reducing the money supply back to its original level in the future? This puts a certain perspective on "monetary and fiscal cooperation." We can think of monetary fuelled fiscal expansion as a way of credibly committing the government to a higher future money supply.

While the mechanism of how deficits and debt can increase inflation is relatively obvious, its existence relies on a key assumption. I have already pointed out that it relies on some cost of taxation. But it will also only work to the extent that monetary authorities react to the inflation incentives this nominal debt creates. If the monetary authority does not react to this inflation incentive, then the multiplier of deficit spending is also zero. In some respect we can think of modern independent central banks as having been developed precisely to eliminate inflationary incentives. Hence under modern institutional arrangement, is not all that clear that this multiplier is all that big, if existent at all. That is one motivation for "monetary and fiscal policy coordination", and one goal of this paper is to put some structure on what that sort of thing means both in theory and practice.

In this paper an independent central bank is defined as a bank that has an objective other than optimizing social welfare and its policy choices are in not influenced the government budget constraint or borrowing limit. Coordinated monetary and fiscal policy, on the other hand, is when policy makers jointly set monetary and fiscal policy to maximize social welfare and are responsible for satisfying the government's budget constraint and debt limit. Under coordination, deficit spending increases output and the price level when the interest rate is zero because it credibly increases expectations about future money supply since this has fiscal benefits (as e.g. stressed by Calvo (1978), Barro and Gordon (1983), Stokey and Lucas (1983) and more recently by Eggertsson (2006,8) and Auerbach and Obstfeld (2005)). Without coordination this link is broken because the central bank does not internalize the fiscal consequences of its actions. Therefore, deficit spending and other actions that affect the government balance sheet (such as foreign exchange interventions and purchases of real assets) have no effect on nominal output and price level if the central bank is "goal independent".

This perspective on what coordinated monetary and fiscal policy means puts an interesting texture on several proposals that are common in the literature, which often implicitly (or explicitly) assume some form of coordination. Caballero (2010), for example, recommends a "helicopter drop" of money from the Fed aimed at the Treasury.[2] Our framework clarifies that this only has an effect if the Federal Reserve cares about the fiscal consequences of its action, or more precisely that its own budget constraint or that of the Treasury plays a role the Federal Reserves policy making. In the absence of fiscal considerations, there is nothing that prevents the Fed from undoing the helicopter drop as soon as the economy improves (i.e. the nominal interest rate rises), rendering the policy irrelevant.

While the main point of the paper is positive the normative implications are a topic in itself. The results indicates that some cooperation between the treasury and the central bank can be helpful to combat deflationary shock, an argument made by Ben Bernanke, then Governor of the Federal Reserve, in Japan in 2003, which is cited above. It seems important to work out the institutional details of how such a cooperation may take place. It is worth keeping in mind, however, that to the extent that the central bank can make credible commitments about future policy, there may be less need for such cooperation. One way of thinking about coordination, then, is as an escalation plan that is implemented if monetary policy reflation lacks credibility.

The importance of fiscal policy emphasized here relates to recent literature on fiscal theory of the price level (see e.g. Sargent and Wallace (1981), Leeper (1992), Sims (1994), Woodford (1996) and Benhabib, Schmitt-Grohe, Uribe (2003)). The key difference between my model and these contributions is that I model the government as a maximizing agent subject to certain constraints while the fiscal theory characterizes policy by exogenous “policy rules”. This alternative modelling strategy allows me to clarify the role of central bank independence and a richer interpretation of the role of coordination.

1.2 A tale of two countries

The way in which I specify the institutional setup, i.e. the interaction between the treasury and the central bank, is guided by a certain objective, because the paper also has a complementary goal. That goal, which is somewhat lofty, is to use the theory sketched out to think about the very different results observed during the Great Depression in the US and the Great Recession in

[2] Proposals with similar flavor include Bernanke (2003) and Auerbach and Obstfeld (2006).

Japan in response to relatively similar policy actions. This part of the paper is quite speculative, and is only based on the simple theoretical structure proposed and some broad pattern in the data. I think, however, that the thought experiments are quite helpful to cast some light on these episodes, and the largely speculative component of the exercise is in my view justified given how high the stakes are for understanding these events.

More specifically the episodes I have in mind is US during Great Depression (GD) in 1929-41 and Japan during the Great Recession (GR) in 1992-2006.[3] Both countries saw unusually large policy actions as measured by interest rate cuts, increases in the money supply, expansion in fiscal variables and exchange market interventions. Yet, the outcomes were very different: while demand responded strongly during the Great Depression in the US during the recovery phase (1933-37 and 1938-41) it responded little – if at all – during the Great Recession in Japan. I suggest that the different outcomes are explained by the independence of the Bank of Japan relative to the Federal Reserve's during the 1930's. Illustrating how economic outcomes, as a function of policy actions, depend on the institutional framework gives a novel interpretation of the GD relative to the GR. More generally, I think one takeaway from this paper is that you can't understand the consequences of certain policy actions, independently from the institutional framework. The modeling exercise gives one way of thinking about this, but I think the narrative accounts in the paper do as well.

While the Great Depression in the US and the Great Recession in Japan were very different along several dimensions, there are some important similarities. Both events started with a big decline in the stock market. In the aftermath of these large shocks both central banks cut the interest rate down to zero, albeit somewhat gradually, to counteract an economic slowdown. Table 1 shows that by 1996 the overnight interest rate had declined close to zero in Japan. While there is no comparable data for the US during the Great Depression the closest proxy is the interest paid on 3 month Treasuries. Table 2 shows that according to this measure, by the end of 1932, the short-term interest rate had also declined close to zero in the US. Another similarity is that both countries experienced deflation and contraction in nominal GDP. During the entire Great Recession in Japan nominal GDP stagnated and there was mild deflation, while the US experienced sharp and violent declines in prices and nominal GDP during the first and second phase of the Great Depression in 1929-33 and 1937-38.

Another striking similarity is the response of the policy makers in Japan and the US. After the nominal interest rate reached zero in both countries the central banks expanded the monetary base much beyond what was required to keep the interest rate at zero. The Federal Reserve almost

[3] I am coining the period 1992-2006 as the Great Recession in Japan, since in 2006 the BoJ raised interest rate based on the expectation that the growth observed at the time and modest inflation would signal the end of the long contractionary phase. In 2008, however, as the world economy entered financial crisis, Japan once againt found itself in a similar situation as during 1992-2006.

doubled the nominal monetary base in 1933-37 (the initial phase of the recovery). Similarly in 1996, when the interest rate first approached zero, to 2006 the BoJ more than doubled the base. The BoJ was especially aggressive in the period of "quantitative easing" that started in May 2001 and ended in the spring of 2006 when it expanded the base by 70 percent in nominal terms. On the fiscal front a similar picture emerges. In the US, the government spent 70 percent more dollars in 1937 than in 1933. The expansion of government expenditures was of the magnitude of 6% of GDP in 1933. The growth rate of government spending in Japan was smaller. The Japanese government spent 20 percent more yen in 2005 than in 1992. However, if the increase is measured as a fraction of 1992 GDP it is about the same as in the US, or 6 percent (table 1).[4] Neither country financed these spending increases with tax hikes. Instead, both governments ran large deficits. The annual deficits were 4-9 percent of GDP in the US from 1933-37 and they have been of similar order throughout the Great Recession in Japan. In fact, net government debt, as a fraction of GDP, was 94.7 percent in Japan as of 2006 up from 14.3 percent in 1992 before the onset of the Great Recession. Finally, both countries intervened in the foreign exchange markets. The Ministry of Finance in Japan has bought foreign exchange on several occasions. In 2003, for example, the interventions corresponded to about 5.7 percent of GDP and 37 percent of the monetary base (Lipscomb and Tille (2005)). One can to some extent interpret US purchases of gold as corresponding to foreign exchange interventions. The scope of these interventions were of similar order, for example, in 1933-34 (Eggertsson (2008)).[5]

Despite the similarities in policy *actions,* the *outcomes* were radically different. A sensible measure of outcomes is nominal GDP. A real business cycle theorist expects a nominal demand stimulus to mainly increase the price level whereas a Keynesian or a monetarist would expect some combination of real output and price increases. All theories that I am aware of, however, suggest that *nominal* GDP increases. Consider the reaction of nominal GDP in the US 1933-37 after FDR started expansionary policies in earnest. In 1933-37 nominal GDP expanded by 52 percent, of which about 80 percent is explained by growth in real GDP and 20 percent by inflation (table 2). In contrast, nominal GDP contracted or stagnated throughout the Great Recession in Japan due to ongoing mild deflation and modest or no real growth (table 1). The nominal GDP in 2005 was only 5 percent higher than it was in 1992 and 2 percent lower than in 1997. What is the reason for these radically different outcomes?

[4] This is explained by that the government in Japan was much bigger in 1992 in relative terms than the US government in 1933. It is worth stressing that although deficits and government expenditures have increased in Japan, government consumption of final goods and services has by various measures not been increased substantially since 1996 (Broda and Weinstein (2005)). Similar points, however, have been made about the government expansion in the US during the Great Depression, see Brown (1956), so this fact hardly explains the difference in outcomes.

[5] The US went of the gold standard in 1933. The dollar value of gold was again fixed in 1934 only to be changed in the 1970's but it is generally argued that the US was off the gold standard for all practical purposes from 1933 onwards.

The reigning hypothesis for the US growth in 1933-37 attributes it to the monetary expansion. Leading proponents include Friedman and Schwartz (1963), Romer (1992) and more recently Bordo, Erceg and Evans (2000). All authors point towards the increase of the monetary base (or usually M1). But if 70 percent increase in the nominal stock of money increased nominal GDP by 52 percent in the US, why did the larger increase in Japan not lead to a robust recovery in nominal GDP? The leading alternative hypothesis relates to fiscal expansion. But if increasing government spending by 6 percent of GDP and running deficits of 4-9 percent increased nominal GDP by 52 percent in the US, why did the larger and more sustained increase in Japan not lead to a robust recovery in nominal GDP?

The hypothesis of the US recovery in this paper relies on a recent paper, Eggertsson (2008), which argues that the recovery was driven by a shift in expectations. This shift was triggered by the policy choices of FDR. In particular FDR announced an explicit target to raise prices. A large body of recent literature on the liquidity trap (e.g. Krugman (1998), Auerbach and Obstfeld (2005), Eggertsson (2006,8), Eggertsson and Woodford (2003), Svensson (2001,3) and Jeanne and Svensson (2006), Adam and Billi (2006a,b) and Jung et al (2006)) has shown that when the short-term interest rate is zero, as in 1933 when FDR took power, it is crucial to raise expectations about future money supply in order to stimulate demand. The problem is how to generate these expectations. Eggertsson (2008) argues that beyond making an explicit verbal commitment to inflate, FDR achieved this objective with fiscal expansion and other actions that affected the government's balance sheet (such as foreign exchange interventions) thereby making the commitment to inflate "credible." Printing money in the future became crucial to finance the fiscal actions and prevent future balance sheet losses. This paper adds to the story in Eggertsson (2008) by emphasizing that for this channel to work monetary and fiscal policy need to be coordinated and uses this insight to contrast the response of the economy to policy in the GR relative to the GD.

Why did the public's expectations about the future money supply not increase as dramatically in Japan in the GR as they did during 1933-37 in the US, when the fiscal and monetary policy actions taken by the Japanese government were just as dramatic? The most obvious difference is that in addition to his various expansionary actions, FDR announced an explicit objective to inflate the price level to pre-Depression level (Eggertsson (2008)). In Japan, by contrast, despite various expansionary actions, policymakers never made an explicit commitment to future inflation. Yet, if this explanation is the silver bullet, it should leave economists a bit unsettled. Is the lesson that policy *actions* are irrelevant, and all that matters is what policy makers *say*? And why did FDR's words have such tremendous power in 1933? We have several records of President Hoover's pronouncement's in 1929-33 that a recovery in prices and output was just around the corner – even if he did not specify exactly pre-depression levels for prices. Similarly, Japanese policy makers have on occasion made similar predictions. Why did these words not carry the same weight?

In this paper I explain the strong reaction of nominal demand in the US vs. the weak response in Japan with differences in the monetary and fiscal institutions in the two countries. In particular I assume that the Bank of Japan is independent, while in the US monetary and fiscal policy were coordinated. I document how this coordination was achieved through legislation in the US Congress in section (8). This explanation does not rely on policy makers' "words". In fact, I assume words have no power in this paper.[6] While extreme, and arguably unrealistic, the assumption that words carry no weight is useful for isolating the importance of different institutions, and to distinguish between why some actions had a big effect in the US in the 1930's, while little or no effect in Japan, even if we abstract from differences in "announced" policy commitments. This approach also highlights what types of actions are likely to be helpful to make various communication strategies *credible* and which institutional reforms may facilitate this objective. This is why I consider an equilibrium in which the government is purely discretionary so that it cannot commit to any future actions (as e.g. in Kydland and Prescott (1977) and Barro and Gordon (1983)) apart from that it will repay any debt issued (as in Stokey and Lucas (1983)).

While coordination of monetary and fiscal policy can explain the recovery in the US in 1933-37 – and the lack thereof the prolonged recession in Japan – there are some alternative explanations. One alternative is that the US recovery was due to the resolution of the banking crisis in the spring of 1933, an explanation that has been emphasized by many authors. Given the difficulties in the Japanese banking system, one could speculate that what was missing in Japan was not coordination of monetary and fiscal policy but a cleanup of the banking system. While solving the banking crisis was certainly a contributing factor in the recovery in 1933-37, this hypothesis does not explain the second contractionary phase of the Great Depression in 1937-38 and the recovery starting from 1938. During the second phase there were no banking crisis. As I argue in section 8, however, the recession in 1937 can be interpreted through the lens of the *same theory* we apply here, namely that the Federal Reserve was re-asserting its independence (mainly through raising reserve requirements) and the private sector *expected* it to renege on the administration commitment to re-inflate prices to pre-Depression levels. Hence FDR's commitment to permanently increase the money supply was no longer credible in 1937. Similarly, as I argue in section 8, the recovery in 1938 can be interpreted as a renewed commitment to inflating the price level by a coordination of monetary and fiscal policy.[7]

[6] This is surely an extreme assumption that does not hold exactly. There is some evidence, for example, that BoJ's announcements, e.g. in the fall of 2003, were helpful to stimulate demand. At that time, and on a few other occasions, the bank announced that the short-term interest rates would be zero until the CPI changes moved back into postitive territory, which helped lowering real rates and stimulate spending. Similar announcements by the Federal Reserve in 2003 most likely also stimulated demand (but Fed funds rate were then at 1% and there were concerns over deflation).

[7] A similar comment applies to an alternative hypothesis that abolishing the gold standard explains the recovery in 1933, in exclusion of the channel proposed. While I argue in Eggertsson (2008) that going off gold was a necessary

2 The Model

Here I outline a simplified version of relatively standard New Keynesian model, assuming reduced form money demand and special functional forms.[8] I assume there is a representative household that maximizes expected utility over the infinite horizon:

$$E_t \left\{ \sum_{T=t}^{\infty} \beta^{T-t} b_T [\log C_T + \chi \log G_T - \psi \frac{h_T^{1+\omega}}{1+\omega}] \right\} \tag{1}$$

where b_t is an intertemporal shock, C_t is a Dixit-Stiglitz aggregate of consumption of each of a continuum of differentiated goods

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

with elasticity of substitution equal to $\theta > 1$, G_t is is a Dixit-Stiglitz aggregate of government consumption defined in a similar way, P_t is the Dixit-Stiglitz price index,

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

and h_t is hours worked. E_t denotes mathematical expectation conditional on information available in period t. For simplicity I assume that only one period riskless government bonds and money are traded so the household faces the budget constraint

$$C_t + B_t + M_t = (1 + i_{t-1})B_{t-1} + M_{t-1} + Z_t + n_t h_t - T_t$$

where Z_t is a representative firm profit, T_t taxes, M_t money, B_t one period riskless bonds, i_t one period nominal risk-free interest rate and n_t wages . The household maximizes its utility subject to the budget constraint by choice of its asset holdings, labor and consumption. There is a continuum of firms on the unit interval that maximize expected discounted profits. Firms produce using a production function that is linear in labor and I abstract from capital dynamics. As Rotemberg (1983), I assume that firms face a resource cost of price changes $\frac{\delta}{2}(\frac{p_t(i)}{p_{t-1}(i)} - 1)^2$[9]. For algebraic simplicity I follow Rotemberg and Woodford (1997) by assuming a subsidy $(1+s) = \frac{\theta}{1-\theta}$

condition for the recovery, it was not a sufficient condition. Some countries that abolished the gold standard (such as Britain) did not experience fast growth during the Great Depression. Furthermore, the price of gold was fixed from 1934 until to the 1970's so focusing on the government mandated price of gold in dollar terms cannot explain the recession in 1937-38 and the recovery in 1938.

[8] A more detailed version is in Eggertsson (2006) with a money-in-utility function and general functional forms.

[9] I use this functional form for simplicity. In the results, which are only accurate to the first order, all that is assumed is that there is a function $d(\frac{p_t(i)}{p_{t-1}(i)} - 1)$ with first derivative equal to zero in steady state and a second derivative that is greater than zero. If one analyses the fully non-linar model one would need to take a stance on what is a realistic functional form, and a quadratic one is probably not the most natural canditate. Similar comment applies to function assumed for the cost of taxation.

for each unit produced so that production is at its efficient level in steady state and there is no inflation bias (see Eggertsson (2006) for the general case).

The first order conditions of the household and firm maximization problems can be summarized by two Euler equations. The household consumption decisions satisfy the Euler equation often referred to as the "IS equation"

$$C_t = (1 + i_t) f_t^e \tag{2}$$

where $f_t^e = E_t C_{t+1}^{-1} \Pi_{t+1}^{-1} \beta \frac{b_{t+1}}{b_t}$ is an expectation variable and $\Pi_t \equiv \frac{P_t}{P_{t-1}}$. This equation says that consumption demand depends on expected future consumption, the nominal interest rate, expected inflation and the intertemporal shocks. The firm optimal pricing decisions on the one hand, and the household optimal labor supply decisions on the other, also satisfy an Euler equation, often referred to as the "AS equation"

$$\Pi_t(\Pi_t - 1) = \frac{\theta}{\delta}(\psi C_t Y_t^{\omega} - 1) Y_t + \beta C_t S_t^e \tag{3}$$

where $S_t^e = E_t \Pi_{t+1}(\Pi_{t+1} - 1) C_{t+1}^{-1} \beta \frac{b_{t+1}}{b_t}$ is an expectation variable. This equation is a standard New Keynesian Phillips curve that says that inflation depends on the marginal cost of production and expected inflation deflated by the stochastic discount factor.

There is an output cost of taxation (e.g. due to tax collection costs as in Barro (1979)) captured by the function $\frac{\gamma}{2} T_t^2$. For every dollar collected in taxes, $\frac{\gamma}{2} T_t^2$ units of output are wasted without contributing anything to utility. Total government real spending, F_t, is then given by

$$F_t = G_t + \frac{\gamma}{2} T_t^2.$$

In the remainder of the paper all expressions are written in terms of F_t instead of G_t using the equation above. Abstracting from seigniorage revenues[10], the government budget constraint can be written as

$$w_t = (1 + i_t)[w_{t-1} \Pi_t^{-1} + F_t - T_t] \tag{4}$$

where I have defined the variable $w_t \equiv \frac{B_t(1+i_t)+M_t}{P_t}$ as the real value of the end-of-period government debt inclusive of interest payments. To ensure solvency I assume that the government needs to satisfy a debt limit

$$w_t \leq \bar{w} \tag{5}$$

which excludes Ponzi schemes. Market clearing implies that

$$Y_t = C_t + F_t + \frac{\delta}{2}(\Pi_t - 1)^2. \tag{6}$$

Without entering into the details of the means by which the central bank controls the nominal interest rate, it is important to observe that as long as the government is committed to supply a

[10] For simplicity I drop the term $\frac{i_t}{1+i_t} M_t / P_t$ in the budget constraint. See Eggertsson (2006) for the extension.

nominal claim ('money') with zero return there is a zero bound on the short term nominal interest rate

$$i_t \geq 0 \tag{7}$$

An equilibrium is a collection of stochastic processes for $\{T_t, F_t, i_t, C_t, Y_t, \pi_t\}$ that satisfy equations (2)-(7) for a given path for the exogenous shock$\{b_t\}$.

An equilibrium can be defined without any reference to the money supply. A money demand equation can be appended to the model for example by having money supply entering additively separately in utility (Eggertsson (2006)). The money demand equation only has a role in determining money demand given the interest rate and consumption. It is useful, however, to keep track of a money supply since much of the earlier literature is cast in terms of money. I assume, as for example Krugman (1998) and King and Wolman (2004), that a certain fraction of production needs to be held in money balances so the following inequality has to be satisfied

$$\frac{M_t}{P_t} \geq vY_t. \tag{8}$$

I abstract from any effect money balances have on utility or welfare. At zero interest rate this inequality can be slack because the households can be indifferent between holding money instead of bonds.

3 Institutions

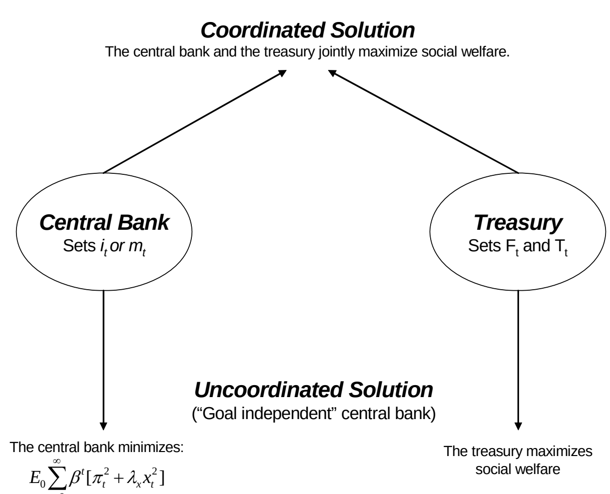

Diagram 1: The central bank and the treasury can act together or separately when setting their policy instruments.

I assume that monetary and fiscal policy were coordinated in the US in 1933-37 and 1938-1941 during the first and second recovery phase of the Great Depression while they were uncoordiated in Japan during the Great Recession. What does coordination mean in this paper? This is illustrated in diagram 1. There are two government agencies, the central bank and the treasury. The central bank sets the interest rate, i_t, (or alternatively the money supply M_t). The treasury decides spending F_t and taxes T_t. Policy is coordinated when the treasury and the central bank join forces to maximize social welfare. Policy is uncoordinated when each agency pursues its own objectives. The example I consider for uncoordinated policy is when the treasury maximizes social welfare but the central bank pursues a narrower objective. I refer to this institutional arrangement as a case in which the central bank is "independent". I assume that the independent central bank minimizes the quadratic deviation of inflation and output from a target, a relatively standard objective in the literature, but one could consider other specifications for the preferences of the bank without changing the central results. An important additional assumption I make is the independent central bank is not responsible for satisfying the treasury's budget constraint or borrowing limit. If this assumption is not made the treasury can force the central bank's hands by accumulating debt up to the limit and then cutting taxes further (in which case the central bank has to inflate in order to make the budget constraint and borrowing limit hold). The key difference between coordinated and uncoordinated solution is that in the uncoordinated case the independent central bank does not take into account the fiscal consequences of its actions. This institutional arrangement is somewhat special and my definition of "coordination" does not encompass all different cases various authors have in mind when discussing "coordiation" of monetary and fiscal policy (although it correspond quite closely to some of the previous literature).[11] This is not a major weakness in my view. What is important for my purposes is that the two cases (coordination vs. the uncoordinated solution) capture a basic difference between monetary and fiscal policy arrangement in Great Depression vs. the Great Recession. This may be even more clear in section 7 where I discuss explicitly how this particular institutional arrangement can be used to interpret these two events in the light of the narrative record. Hence the focus of the paper is mostly a positive analysis, a normative analysis may require a more detailed and flexible institutional description.

[11] Observe that this definition, i.e. the goal independent central bank, is consistent with Rogoff's (1985) conservative central banker and is identical to Dixit and Lambertini's (2003) institutional framework.

4 Discretionary Equilibrium under Coordinated Policy

4.1 Definition

This section defines optimal policy under discretion when monetary and fiscal policy are coordinated. Under discretion the government cannot commit to future policy. Optimal policy under discretion is sometimes referred to as a Markov perfect equilibrium. The timing of events in the game is as follows: at the beginning of each period t, w_{t-1} is a predetermined state variable. At the beginning of the period, the shock b_t is realized and observed by the private sector and the government. The monetary and fiscal authorities choose policy for period t given the current state (b_t, w_{t-1}) and the private sector forms expectations f_t^e and S_t^e. I assume that the private sector may condition its expectation at time t on the policy actions of the government. In other words, it observes the policy actions of the government in that period so that expectations are determined jointly with the other endogenous variables. The only endogenous state variable in the model at time $t+1$ is w_t. This implies that the expectation variables f_t^e and S_t^e are a function of w_t and b_t

$$f_t^e = \bar{f}^e(w_t, b_t) \tag{9}$$

$$S_t^e = \bar{S}^e(w_t, b_t) \tag{10}$$

so that the IS and AS equations can be written as

$$C_t = (1 + i_t)\bar{f}^e(w_t, b_t) \tag{11}$$

$$\Pi_t(\Pi_t - 1)^2 = \frac{\theta}{\delta}(\psi C_t Y_t^{\omega} - 1)Y_t + C_t \bar{S}^e(w_t, b_t) \tag{12}$$

Under discretion the government maximizes the value function $J(w_{t-1}, b_t)$ by its choice of the policy instruments taking the expectation functions $\bar{f}^e(w_t, b_t)$, $\bar{S}^e(w_t, b_t)$ as given because it cannot commit to future policy. Thus it solves

$$J(w_{t-1}, b_t) = \max_{F_t, T_t, i_t} \{[\log C_t + \chi \log(F_t - \frac{\gamma}{2}T_t^2) - \psi \frac{h_t^{\omega}}{1+\omega}]b_t + \beta E_t J(w_t, b_{t+1})\} \tag{13}$$

s.t. (4), (5), (6), (7), (11), (12). The first order conditions for the maximization problem are derived by writing the right hand side as a Lagrangian problem and setting the partial derivatives with respect to each of the variables $(\Pi_t, C_t, Y_t, w_t, i_t, F_t, T_t)$ to zero. Because the government is a large strategic player and moves simultaneously with the private sector it can choose a value for all these variables as long as they satisfy the private sector optimality conditions and the resource constraint.[12] The model has a well defined steady state with zero inflation and debt. The model is approximated around this steady state so that the solution is only accurate to the first order. In the next section we characterize this approximate solution.

[12] There are some recent examples in the literature that assume that the government moves before the private sector within each period (see e.g. King and Wolman (2004), Albanesi, Chari, Christiano (2003)). In those cases there are some examples in which there can be multiple point-in-time equilibria. I do not prove the global uniqueness

4.2 Results

Below I show the linear approximation of the equilibrium. To express this solution it is useful to first define two concepts: the natural level of output and the natural rate of interest. The natural level of output is the output that would be produced if prices were flexible, i.e. $\delta = 0$ in equation (3). Using this equation in conjunction with (6) we obtain

$$\hat{Y}_t^n = \frac{\sigma^{-1}}{\sigma^{-1} + \omega} \hat{F}_t \tag{14}$$

where $\sigma \equiv \frac{C}{Y}$, $\hat{F}_t = \log F_t/\bar{Y}$ and the natural level is expressed in log deviation from steady state output. Output under flexible prices does not depend on the shock b_t but increases with $\hat{F}_t$ for familiar reasons from the RBC literature: Higher level of government consumption increases the marginal utility of consumption and thereby increases labor supply. The natural level of interest is the real interest rate when prices are flexible, i.e.

$$r_t^n = \bar{r} + \hat{b}_t - E_t\hat{b}_{t+1} + \frac{\sigma^{-1}\omega}{\sigma^{-1} + \omega}(\hat{F}_t - E_t\hat{F}_{t+1}) = r_t^e + \frac{\sigma^{-1}\omega}{\sigma^{-1} + \omega}(\hat{F}_t - E_t\hat{F}_{t+1}) \tag{15}$$

where $\bar{r} \equiv \log \beta^{-1}$, $\hat{b}_t \equiv \log b_t/\bar{b}$. The natural rate of interest depends both on the intertemporal shock and fiscal spending. I summarize the exogenous component of the natural rate by r_t^e.

A linear approximation of the private sector first order conditions can be written in terms of deviations from these variables. The consumption Euler equation (2) is

$$x_t = E_t x_{t+1} - \sigma(i_t - E_t\pi_{t+1} - r_t^n) \tag{16}$$

where $\pi_t = \log \Pi_t$ is inflation, x_t is the output gap $x_t \equiv \hat{Y}_t - \hat{Y}_t^n$ where $\hat{Y}_t \equiv \log Y_t - \log \bar{Y}$. The term i_t now refers to $log(1+i_t)$ in the notation of the previous section so that we can still express the zero bound in the form (7). This equation can be forwarded to yield

$$x_t = E_t x_T - E_t \sum_{s=t}^{T-1} \sigma(i_s - \pi_{s+1} - r_s^n)$$

which illustrates that the output gap does not only depend on the current nominal interest rate and expected inflation but the entire expected path of future interest rates and inflation.

Equation (3) can be approximated as

$$\pi_t = \kappa x_t + \beta E_t \pi_{t+1} \tag{17}$$

where $\kappa \equiv \frac{\theta}{\delta}(\sigma^{-1} + \omega)$. If this equation is forwarded it says that inflation depends on the expected path of future output gaps.

of equilibria, only local uniqueness. Proving global uniqueness is hard except in simpler models (see Eggertsson and Swansson (2006) for examples). The timing assumption here is the same as in the linear-quadratic literature on discretion such as for example Clarida, Gali and Gertler (1999) and Woodford (2003).

Finally the budget constraint of the government is approximated by

$$w_t - \bar{w}i_t = \beta^{-1}w_{t-1} - \beta^{-1}\bar{w}\pi_t + \beta^{-1}\hat{F}_t - \beta^{-1}\hat{T}_t \tag{18}$$

where $\hat{T}_t = \log T_t/\bar{Y}$ and I have linearized around a given level for outstanding debt $\bar{w}$. The budget constraint says that for *a given* level of debt monetary policy can improve government finances through two channels. The second term on the left hand side indicates that a lower nominal interest rate will reduce the burden of debt rolled over to the next period. The second term on the right hand side indicates that inflation will reduce the real value of outstanding debt because all the debt is issued in nominal terms (nominal bonds and the money supply). Equations (14)-(18) summarize the private sector equilibrium constraints. I now turn to government policy.

This paper is about government policy when there are sufficiently large deflationary shocks that cause the nominal interest rate to decline to zero. I assume that r_t^e is temporarily negative at time 0, $r_L^e < 0$, and returns to steady state with a probability α in each period. To ensure bounded solution I impose the restriction on α that $\alpha(1-\beta(1-\alpha)) - \sigma\kappa(1-\alpha) > 0$. I call the date r_t^e returns to steady state τ. Once it returns to steady state it stays there forever.

To clarify the organization of the results, diagram 2 shows a road map for the remainder of this section. I analyze the results in four steps. I first show the equilibrium when fiscal policy is inactive ($\hat{F}_t = \hat{T}_t = 0$) which is equilibrium A in diagram 2. I then analyze the consequences of optimally increasing real government spending, $\hat{F}_t$, but holding the budget balanced (so that $\hat{T}_t = \hat{F}_t$) which is equilibrium B. In equilibrium C the government optimally uses deficit spending $\hat{T}_t$ to stimulate demand but real government spending is kept constant at its steady state ($\hat{F}_t = 0$). Finally, equilibrium D considers the effect of using both deficit and real spending optimally.

Applied to the Great Depression,Eggertsson (2008) argues that equilibrium A corresponds to the policies of President Hoover because he aimed both at keeping the government small and balancing the budget. In that model the "Hoover regime" is optimal discretion under the constraint of "balance budget dogma" and "small government dogma". FDR, in contrast, broke both these dogmas. His policy regime corresponded to equilibrium D, which is unconstrained discretion.

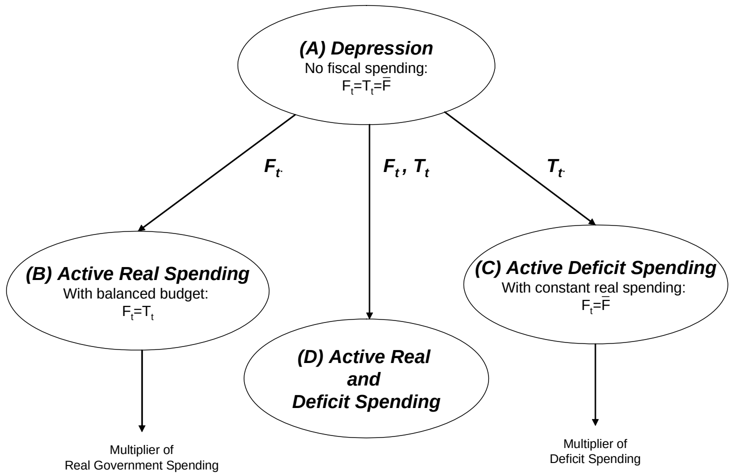

Diagram 2: Roadmap for results under coordination.

The policy rule the government follows under discretion is found by approximating the first order conditions of the maximization problem (13). These conditions are shown in the Appendix. Since these are 7 first order conditions and two complementary slackness conditions, it is cumbersome to write them out in the main text. Fortunately, however, one can infer the form of the solution – and even obtain some closed form solutions – using almost no algebra by considering a second order approximation of the household utility

$$U_t = -\frac{1}{2}\sum_{T=t}^{\infty}\beta^{T-t}\left\{\pi_T^2 + \lambda_x x_T^2 + \lambda_F \hat{F}_T^2 + \lambda_T \hat{T}_T^2\right\}. \tag{19}$$

Consider first the solution in equilibrium A from the perspective of $t > \tau$ when the deflationary shock has subsided (recall that we impose $\hat{F}_t = \hat{T}_t = 0$). Under discretion the government seeks to maximize this objective regardless of its actions in the past. It should be obvious, then, that the best possible equilibrium is when

$$\pi_t = x_t = 0 \text{ for } t \geq \tau. \tag{20}$$

which can be achieved at that time and is dynamically consistent.

Consider now the solution in period $t < \tau$. Ideally the government would wish to achieve zero inflation and zero output gap. The assumption that the shock r_t^e is negative, however, makes this infeasible since it would imply a negative nominal interest rate by equation (16). Hence the government tries to achieve maximum accommodation by setting the interest rate to zero. Because the shock is the same in all $t < \tau$ the solution for π_t and x_t solves the two equations

$$x_t = (1-\alpha)x_t + \sigma(1-\alpha)\pi_t + \sigma r_L^e \tag{21}$$

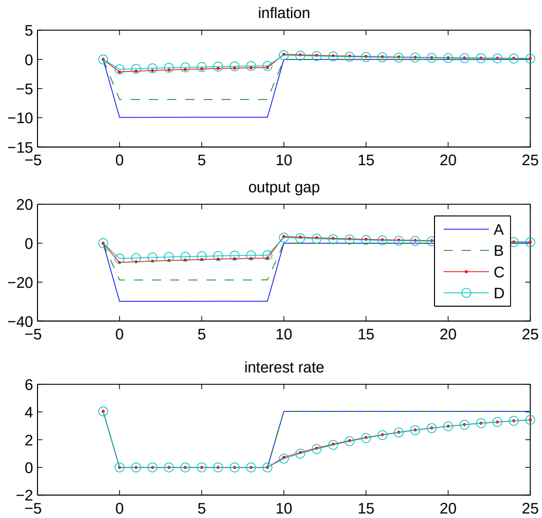

Figure 1: Inflation, the output gap and interest rates under the optimal policy under discretion in equilibrium A,B,C and D (Great Depression calibration).

$$\pi_t = \kappa x_t + \beta(1-\alpha)\pi_t \tag{22}$$

yielding

$$x_t = \frac{1-\beta(1-\alpha)}{\alpha(1-\beta(1-\alpha)) - \sigma\kappa(1-\alpha)}\sigma r_L^e \text{ for } t < \tau \tag{23}$$

$$\pi_t = \frac{1}{\alpha(1-\beta(1-\alpha)) - \sigma\kappa(1-\alpha)}\kappa\sigma r_L^e \text{ for } t < \tau \tag{24}$$

Figure 1 shows the solution for a numerical solution of the model that is calibrated to replicate some basic features of the Great Depression in the US. Each period is a quarter. The parameter $\beta = 0.99$ is set to match 4% real interest rate, $\sigma = 0.9$ is set to match government spending. The parameter α is set at 0.1 so that the shock is expected to last for 10 quarters. The parameter κ governs how much inflation reacts to movements in output. I pick this parameter to match data from 1932. Observe that in 1932 the average nominal interest rate was close to zero. Furthermore there was 10 percent deflation. There is no reliable data on the output gap at that time. A reasonable lower bound for the output gap, however, is that output had declined by about a third from its peak in 1929. Given the calibrated value of α, I can use equation (22) to pick a κ that matches these facts

$$\kappa \equiv (1-\beta(1-\alpha))\frac{\pi}{x} = 0.0091$$

Finally, I use (23) to pick the value of the shock r_L^e to match a 30 percent output gap which results in $r_L^e = -3\%$.

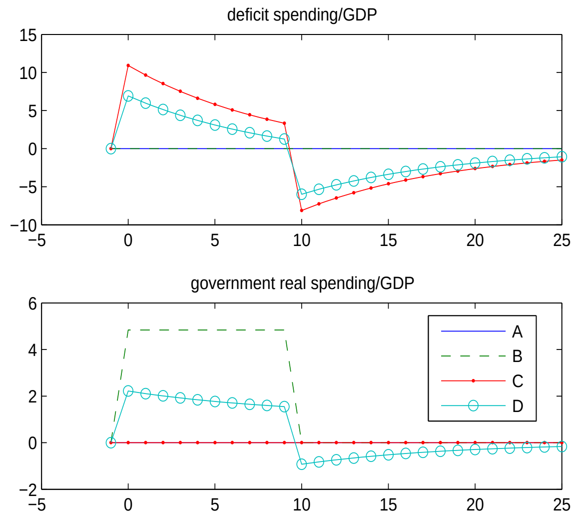

Figure 2: Deficit and real government spending under optimal policy under discretion in equilibrium A,B,C and D (Great Depression calibration).

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 (23) and (24) 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 price and output contraction in future periods $t+j < \tau$ for $j > 0$. The contraction in period $t+j$ in turn depends on expectations of contraction in periods $t+j+i < \tau$ for $i > 0$. This creates a vicious cycle that does not even converge unless the restriction on α is satisfied. The overall effect is an output and price collapse.

Observe that the contraction in the model is entirely driven by monetary forces and the zero bound. If the central bank would be able to accommodate the shock by setting negative nominal interest rate of -3% there would be no output contraction and no deflation. The contraction is caused by a discrepancy between long-term real interest rate and the long-term natural interest rate. Due to the zero bound and the expectation that inflation will be set at zero at $t > \tau$ this difference cannot be reduced by nominal interest rate cuts. The difference increases with expectations about future deflation, since expected deflation increases the short and long-term real interest rates. Real interest rates can be particularly high when there is expected deflation. During the contraction phase of the Great Depression in the US the real rates were of the order of

10 percent (see table 2) – and the Federal Reserve was unable to lower these rates in 1933 because the nominal interest rate was close to zero.

It has no effect to print money in this equilibrium. The reason is that expectations are pinned down by (20) so that any increase in the money supply in periods $t < \tau$ will be expected to be reversed in period τ. Because in periods $t < \tau$ money and bonds are perfect substitutes (so that equation (8) is slack) printing money has no meaningful implication at the time the money is printed: households simply replace government bonds in their portfolio with money. It is impossible for a discretionary central bank to change expectations in period $t < \tau$ under the assumption of discretion. Even if it would be beneficial in period $t < \tau$ to create expectations of lower future interest rates and inflation in period $t \geq \tau$, the bank has an incentive to renege on this promise once the shock has subsided in period τ (this should be obvious because from that time on the government can achieve $\pi_t = x_t = 0$ which maximizes its objective). This problem of discretionary policy is coined the "deflation bias" in Eggertsson (2006). While the classic inflation bias of Kydland and Prescott (1977) and Barro and Gordon (1983) is a steady state inefficiency, the deflation bias arises due to temporary deflationary shocks.

The dashed line in figures 1 and 2 shows equilibrium B in diagram 2. In this case the government is no longer constrained to keep real government spending constant. In addition to the parameters I have already specified I need to calibrate the parameter ω which is the inverse of the Frisch elasticity of labor supply. I calibrated it at $\omega = 2$, which strikes a middle ground between micro-studies (which are usually much higher than 2) and parameters often used in the RBC literature (which are usually around 0.5). The form of the solution can once again be inferred by inspecting (19). In periods $t > \tau$ the government can once again maximize its objective by setting $\pi_t = x_t = \hat{F}_t = 0$. In periods $t < \tau$, however, temporarily increasing $\hat{F}_t$ can improve the outcome. To see this recall that the cause of the contraction is that the real interest rate is higher than the natural rate of interest. The natural rate of interest, however, depends in fiscal spending as seen in equation (15) so that increasing $\hat{F}_t$ in periods of the shocks increases the natural interest rate and thus reduces the output gap and deflation in periods $t < \tau$. The cost of doing this is that in these period there is an oversupply of public goods so that the level of $\hat{F}_t$ goes above what would be optimal in the absence of the demand driven depression. A discretionary policy maker trades off the costs and benefits and the resulting government expansion is shown in the figure.

Output increases more than corresponding to the improvement in the output gap reported in the figure. The output effect of the fiscal expansion can be decomposed into an RBC and New Keynesian channel. Observe first that we can write output as

$$\hat{Y}_t = x_t + \hat{Y}_t^n$$

so that the increase in output, by definition, is due to an improvement in the output gap and an increase in the natural rate of output. It is well known from the RBC literature that an increase in government spending increase the natural level of output, and this effect can be seen by equation (14).

A "multiplier" of government spending answers the question: How much does each dollar of real spending increase output moving from the equilibrium in which $\hat{F}_t = 0$ (equilibrium A in diagram 2) to the one where $\hat{F}_t$ is optimally set (equilibrium B in diagram 2)? I measure each variable in net present value. This statistic can be analytically derived, yielding the following result

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

This multiplier is 2.33 under the baseline calibration outlined above. The Keynesian channel, i.e. the improvement in output due to the improvement in the output gap, accounts for 85 percent of the size of the multiplier.

In both equilibrium A and B the private sector expects zero inflation after the deflationary shocks have subsided. Even if the government expands the money supply the private sector expects it to be reversed once deflationary pressures subside. Can a permanent increase in the money supply be credible? There is a straightforward policy tool to increase inflation expectations in the model, even when the government is discretionary as we have assumed. One way of making inflation policy credible is to expand government liabilities, i.e. the sum of the monetary base and the government debt, given by the variable w_t in equation (18). This is what I call deficit spending or credit expansion and is shown in the third line in figure 1 called equilibrium C. In this case the government is no longer constrained to keep deficit spending constant and instead I hold real spending constant. As the figure reveals the government chooses to increases deficit spending in period $t < \tau$ and then runs surpluses when the deflationary shocks have subsided. This in turn has a large positive effect on both inflation and output.

The reasons for the big impact of deficit spending on prices and output is that it changes expectation about future inflation, output and nominal interest rates. As can be seen in figure 2 the deficit spending implies that the central bank will keep the nominal interest rate low for a substantially longer time than the duration of the shock and accommodate and an output expansion and inflation in period $t > \tau$. These expectations feed into a large stimulus in period $t < T$ through several channels. The expectation of future inflation lowers the real interest rate, even if the nominal interest rate cannot be reduced further, thus stimulating spending. Similarly, a commitment to lower future nominal interest rate (once the deflationary pressures have subsided) stimulates demand for the same reason. Finally, the expectation of higher future income, as manifested by the expected output boom, stimulates current spending, in accordance with the permanent income hypothesis

The reason why expansionary policy in periods $t > \tau$ are credible for the discretionary policymaker in equilibrium C but not in equilibrium A or B can be seen by inspecting (19) and the government budget constraint (18). The government accumulates additional debt in periods $t < \tau$. Because there is cost of taxation the government wishes to reduce the real value of its debt in periods $t > \tau$ by accommodating inflation (and we assume it only issues nominal bonds and money). Furthermore, because it is rolling its debt over from period to period it wants to keep the real interest rate low. Both considerations give the government an incentive to keep the nominal interest rate low and accommodate inflation and output expansion in periods $t > \tau$ even if it could in principle stabilize prices and output at that time.

For the calculation reported in figure 1 we need to choose the cost of tax collection in the function $\frac{\gamma}{2}T_t^2$. This parameter is chosen so that this cost corresponds to 10 percent of government spending to match the level of deficit spending once FDR took power in 1933 (which was about 9 percent of GDP). A lower value for γ would have little effect on the results but only change the scale of the deficit spending. Once it is taken into account that there was already some debt outstanding in 1933 (once FDR embarked on an inflationary program), one could set this value much smaller and still match the evolution for deficit spending.

Again it may be instructive to summarize the effect of the deficit spending/credit expansion on output through the multiplier. I need to make some adjustment to the definition of the multiplier, however, for it to be useful. What I consider instead is a variable $\tilde{T}_t$ defined as $\tilde{T}_t = \hat{T}_t$ if $\tilde{r}_t^n = r_t^L$ and $\tilde{T}_t = 0$ if $\tilde{r}_t^n = 0$. (The results derived for $\hat{F}_t$ would have been unchanged if I had defined $\tilde{F}_t$ in this way because $\hat{F}_t = 0$ if $\tilde{r}_t^n = 0$). This variable captures the deficit spending used in the depression state. The value of this multiplier answers the following question: By how much does each dollar spent on deficit spending/credit expansion in a liquidity trap increase output? In our baseline calibration the answer is 4.4. One can decompose the size of the multiplier between the RBC channel and the New Keynesian channel. No part of the multiplier can be explained by the RBC channel. The reason is that the effectiveness of deficit spending comes entirely through increasing inflation expectations, and this is only valuable if one assumes sticky prices. Since prices are flexible in an RBC model this channel has no role in that model.

4.3 Extensions: Exchange interventions, unconventional open market operations, bank bailouts, helicopter money, long term bonds

While the last section emphasized cutting taxes relative to spending (deficit spending) to shift expectations about policy in periods $t \geq \tau$, several other policy actions can be described through the same mechanism. Government debt is the driving force for shifting expectations rather than tax cuts in themselves. Government debt, however, can be increased in a variety of other ways. It can, for example, be increased by printing money (or bonds) and buying some private assets such as foreign exchange. As shown in Eggertsson (2003) these actions have the same implication for future government policy. A bailout of domestic banks by money printing or, even more exotically, dropping money from helicopters would have exactly the same effect. While FDR did not drop money from helicopters in 1933, he took a variety of actions beyond deficit spending that expanded government credit such as purchases of gold and the refinancing of private banks. These actions, too, had a large effect on the government balance sheet and should thus have feed into expectations about the future money supply.

I want to add I brief discussion of one additional instrument.[13] It is often suggested that if long-term bonds have yields above zero, purchases of such bonds by the Central Bank should lower long-term interest rate and therefore increase spending. As stressed by Eggertsson and Woodford (2003), however, the expectation theory of the term structure implies that this should not be possible,unless such actions are taken to signal a change in the bank's commitments regarding future monetary policy. Under coordination if the Central Bank buys long-term bonds with money in a liquidity trap under cooperation, it is in effect changing the maturity structure of outstanding government debt (if we consider the monetary base as government liability). Since money and short-term bonds are perfect substitutes in a liquidity trap, replacing long-term bonds with money is equivalent to replacing long-term bonds with short-term bonds. Thus the question of whether open market operations in long-term bonds is effective in a liquidity trap can be rephrased: Does changing the maturity structure of government debt increase inflation expectations? Preliminary results from work in progress by the author suggest that the answer is yes. The logic behind this is straight forward. If the government holds long-term bonds it reduces its incentives to lower the short-term real rate of return as those returns will not apply to debt already issued. One of the two inflation incentives we discussed (for the case when all debt is short term) is thus reduced with higher maturity. Since open market operations in long-term bonds shortens the maturity of outstanding debt, our preliminary results suggest that it may be effective to increase inflation expectations. An important caveat is that this channel will only be effective if the central bank is not independent.

5 Discretionary Equilibrium when the Central Bank is Independent

5.1 Definition

In the preceding section I assume that monetary and fiscal policy are coordinated to maximize social welfare. This assumption may be questionable. In many countries the central bank has more narrow goals than social welfare. I now analyze the consequence of this alternative assumption,

[13] This discussion in this paragraph is taken almost word for word from my 2001 working paper "Committing to being Irresponsible: Deficit Spending to Escape a Liquidity Trap" posted on my webpage. Embarrassingly, however, the results with respect to long-term debt are still "preliminary".

supposing the central bank is independent in the way defined in section 3.

The timing of events in the game is as follows: At the beginning of each period t, w_{t-1} is a predetermined state variable. At the beginning of the period, the vector of exogenous disturbances b_t is realized and observed by the private sector, the treasury and the central bank. The monetary and fiscal authorities simultaneously choose policy at time t given the state and the private sector forms expectation

$$\begin{bmatrix} F_t \\ T_t \end{bmatrix} = \begin{bmatrix} \bar{F}(w_{t-1}, b_t) \\ \bar{T}(w_{t-1}, b_t) \end{bmatrix} = \bar{T}r(w_{t-1}, b_t) \tag{25}$$

$$i_t = i(w_{t-1}, b_t). \tag{26}$$

Under discretion the Treasury maximizes the value function $J^{TR}(w_{t-1}, b_t)$ by its choice of the policy instruments, taking the expectation functions $\bar{f}^e(w_t, b_t)$, $\bar{S}^e(w_t, b_t)$ as given because it cannot commit to future policy. It solves

$$J^{Tr}(w_{t-1}, b_t) = \max_{T_t, F_t}\{[\log C_t + \chi \log G_t + \psi \frac{h_t^{1+\omega}}{1+\omega})]b_t + \beta E_t J^{Tr}(w_t, b_{t+1})\} \tag{27}$$

s.t. (4), (5), (6), (7), (11), (12), (26).

The Central Bank solves

$$J^{Cb}(w_{t-1}, b_t) = \max_{i_t}[-(\Pi_t - 1)^2 - \lambda(\frac{Y_t}{Y_t^n} - 1)^2 + \beta E_t J^{Cb}(w_t, b_{t+1})] \tag{28}$$

s.t. (6), (7), (11), (12), (25).

The conditions that constrain the actions of the treasury and the central bank in (27) and (28) are the private sector equilibrium conditions and the strategy functions of the other government agency.[14] The debt is a state variable in the central bank problem only because it enters in the strategy function of the Treasury. Apart from the other players strategy functions these constraints are the same for both the treasury and the central bank but with one important exception. The borrowing and budget constraint of the treasury is *only a restriction on the treasury taxing and borrowing strategies*, it does not impose any constraints on the central bank. To see why this is important suppose the contrary was true. In this case there would be a much more complicated strategic game between the treasury and the central bank. The treasury could, for example, accumulate large amounts of debt up to its debt limit $\bar{w}$ and then cut taxes further. In this case, in order not to violate the borrowing constraint, the central bank would need to inflate away some of the existing debt. The definition of an independent central bank proposed here is therefore that the central bank has its own objective AND carries no responsibility for government finances.

[14] Note that the government budget constraint can equivalently be interpreted as the budget constraint of the household and it thus belong in both maximization problems as a private sector equilibrium constraint.

5.2 Results

I first consider the power of real government spending when the central bank is goal independent. In order to isolate the effect of real government spending I constrain the budget to be balanced at all times so that $\hat{F}_t = \hat{T}_t$ (corresponding to equilibrium B in diagram 2 when the central bank is goal independent). The solution does not depend on whether the central bank is goal independent or not. This can be proved in two steps. Observe first that the solution when the natural rate of interest becomes positive (and the zero bound is no longer binding) is the same under either coordination or goal independence because the central bank will target zero inflation and zero output gap at that time (and the treasury will then set $\hat{F}_t = 0$). Consider now the solution when the zero bound is binding. Since monetary policy is constrained by the zero bound at this time, its different objective is irrelevant during this period as long as it implies a zero interest rate. The central bank interest rate policy, therefore, only matters in period $t \geq \tau$ and I have just argued that its policy will be the same in those periods as under coordination. Turning to the the treasury, it maximizes social welfare and therefore it follows that the path for government spending will be exactly the same as analyzed in last section when $t < \tau$. It follows that the solution is the same under coordination and goal independence. A formal way of verifying this is to write out the first order conditions of the two maximization problems and verify that they are identical to the one implied by the joint maximization problem analyzed in the last section.[15]

Consider now the case of deficit spending when the central bank is goal independent and suppose that now instead the real spending is held constant so that $\hat{F}_t = 0$. Now there is dramatic difference in the power of deficit spending depending on whether the central bank is goal independent. If the central bank is goal independent deficit spending has *no effect* on inflation or output.

Proposition 1 *If the central bank is goal independent, and* $\hat{F}_t = 0$, *deficit spending has no effect on output and prices.*

A formal proof can be obtained by writing out the first order conditions of each of the maximization problems of the treasury and the Central Bank.[16] The logic of the result is as follows: For a given path of F_t, Ricardian equivalence holds in the model so that debt does not enter into any of the equilibrium conditions of the private sector apart from the budget constraint of the private sector. Monetary policy is set to minimize $(\Pi_t - 1)^2 + \lambda_x x_t^2$. Government debt or deficits do not enter this objective or the constraints that limit the actions of the central bank. It follows that debt has no effect on the equilibrium determination of inflation, output and interest rates which are determined by exactly the same set of equations as if fiscal policy was completely

[15] See an earlier working paper version of this paper, NYFED Staff Report #241.

[16] See an earlier working paper version of this paper, NYFED Staff Report #241.

inactive (i.e. in equilibrium C in diagram 2). It follows that if I set $\hat{F}_t = 0$ to be exogenously given, deficit spending has no effect on the equilibrium outcome when the central bank is goal independent. The central bank will determine inflation and the output gap without any reference to deficits or debt.[17] The effect of fiscal policy when coordinated with monetary policy is thus fundamentally different depending on whether or not monetary and fiscal policy are coordinated. When the central bank is goal independent the deficit spending multiplier is zero.

5.3 Extension: Irrelevant policies such as exchange interventions, unconventional open market operations, bank bailouts, helicopter money, long term bonds

There are many commentator and researchers that have suggested within the context of the current crisis in the US, as well as in Japan during the past years, various policy options to stimulate demand, such as unconventional open market operations, "helicopter money", purchases of long-term debt, and so on.

In the way we have defines "independent" central bank, none of these policies have any effect. Their effect relies entirely on the aspect of policy coordination that implies that a current fiscal burden implies inflation incentive in the future. It is worth stressing that the theory we lay out leaves no room for channels such as "portfolio effect" or different degree of liquidity of various assets. While this is arguable unrealistic the current setup clarifies that the signalling effect many of those who suggest these policies rely on hinges critically on monetary and fiscal coordation.

There is another mechanism that may be important, even for a central bank that is "independent". If the central bank cares about its own balance sheet, these operations may well operate under "independence" in a similar fashion as the "coordinated" solution implies. One can even argue that the balance sheet consideration may be so strong, that it would preclude a central bank from taking sufficiently strong actions.

6 Fiscal multipliers and policy coordination: US during the Great Depression and Japan in the Great Recession

A possible reconciliation of the different outcomes of US during the Great Depression in 1933-37 and 1938-41 and Japan today is the different policy multipliers under coordination and central bank independence. To make the comparison more concrete I recalibrate the model to match some basic features of the Great Recession in Japan. This calibration is not based on a estimation on

[17] Note that if the treasury chooses F_t in each period, deficit spending can in principle have effect by influencing the expectations about future spending F_{t+j}.It can be verified, however, that in this model this effect is only of second order.

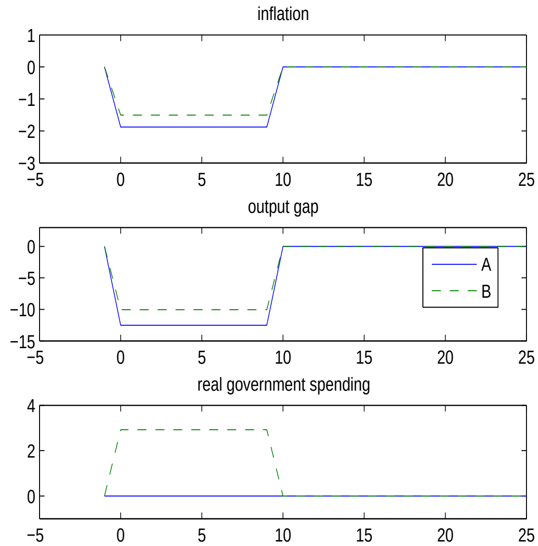

Figure 3: Policy under discretion under central bank independence (Great Recession).

Japanese data and is made purely for illustrative purposes. It should be interpreted in this light. Again I assume the same values for β, α as in the previous section. Now I assume $\sigma = 0.8$ to match to size of the Japanese government. To pick the value of κ we can again take advantage of equation 16. To do this we need to take a stance on the size of the output contraction, or the output gap in the Great Recession. There is no reliable measure of this variable (the numerical example here is preliminary). In a recent study, Kamada (2004) reviews several measures of the output gap at the use at the Bank of Japan that are in the range 5-15 percent in this period. Using 10 percent as a value for the output gap and -1.5 percent for deflation we obtain the value

$$\kappa \equiv (1 - \beta(1 - \alpha))\frac{\pi}{x} = 0.0041.$$

which is a lower number than we used for the US during the Great Depression. This indicates that higher degree of price rigidity is needed in Japan to account for the features I match. I assume a shock $r_L^e = -4.5\%$ to match this output gap. In contrast to the other exercise, I assume that the central bank is goal independent but that the treasury uses fiscal spending to stimulate demand.

Figure 3 shows the response of the output gap, inflation and government spending policy to the shock r_L^e, given goal independence and discretionary government spending. Observe that the optimal response of the Ministry of Finance is to increase government spending by 3 percent of GDP. An interesting counterfactual is to ask what would have happen in the absence of the expansion of real government spending. The solid line shows that in this case the Great Recession in Japan would have resulted in additional 2.5 percent increase in the output gap (or 3.5 percent in output).

Table 1. Fiscal Multipliers for Coordinated Policy

US during the Great Depression

	$i = 0$	$i > 0$
Real Spending Multiplier	2.2	0.33
Deficit Spending Multiplier	4.2	0.5

Table 2. Fiscal Multipliers for Uncoordinated Policy

Japan during the Great Recession

	$i = 0$	$i > 0$
Real Spending Multiplier	1.2	0.33
Deficit Spending Multiplier	0	0

Table 1 and 2 compare the multiplier of real spending across the Great Depression in the US and the Great Recession in Japan in our illustrative calibration examples. The multiplier is higher in the calibrated example for the US which is driven by the different parameter values assumed for κ and σ. I do not wish to dwell on whether these different result reflect important differences in the structure of the US economy during the Great Depression vs. Japan in the Great Recession, since the parameters picked to generated the results are only aimed to match the basic features of the data I outlined above. If those parameters were assumed to be the same in the two calibrations the real spending multiplier would be the same in the two countries. A formal estimation strategy may yield results that are quite different and these calibrations simply show that the model can replicate certain features of the data. The main point I wish to stress is the dramatic difference in the multiplier of deficit spending between the two examples, and this is true regardless of the parameter values assumed. While the deficit spending multiplier is substantial in the US during the Depression in 1933-37, it is zero in Japan during the Great Recession.

The result in the table result reflects that deficit spending, foreign exchange interventions or any other actions by the treasury that affects the government balance sheet are completely irrelevant if the central bank is independent. This can explain the difference between the responses of the Japanese and the US economies to the various stimulative actions.

For comparison I have also included in the table the multipliers for the "scenario" when interest rate are positive. This "scenario" reflects the response of output when there are no deflationary pressures but (counterfactually) the path for both the deficit and real spending is the same as if the shocks occurred. In this case the multipliers are much smaller. The reason is that the central bank counteracts the positive pressure on inflation and the output gap by raising interest rates. When the deflationary shock actually occurs, however, the central bank does not react in this way because both the output gap and inflation are below the level the central bank would wish them to be. This indicates that fiscal policy is mainly effective when the interest rate is zero.

The multipliers under coordination are much bigger than have been found in the traditional Keynesian literature. The most cited paper on fiscal policy during the Great Depression, for example, is Brown (1956). In his baseline calibration the real spending multiplier is 0.5 and the deficit spending multiplier is 2.[18] The reason for this large difference is that the old models ignore the expectation channel. Modeling expectations is the key to understanding the large effect of government spending.

6.1 The evolution of the money supply

So far I have not discussed the implied path of the money supply for the different policy regimes. As mentioned in section 2, the equilibrium can be fully characterized without any direct reference to the money supply. For a given path of output, prices and interest rates, the money supply is given by equation 8 which I re-report below

$$M_t \geq \nu P_t Y_t. \tag{29}$$

This inequality has to hold with equality at all times when the nominal interest rate is greater than zero. The reason is that at positive interest rate the household would prefer acquiring interest on its assets. At zero interest rate, however, the household is indifferent between holding money or government bonds as assets so that the money supply is indeterminate.[19] This has strong implication for the evolution of money supply during the Great Depression and the Great Recession.

Figure 4 shows the evolution of the nominal interest rate and the money supply for a scenario in which the natural rate of interest stays negative for 10 years for each of calibration examples (but interest rates remained close to zero from 1933-41 in Great Depression and from 1996-2006 in the Great Recession). Consider panel (a) in figure 4. For periods 0-10 the interest rates is zero in both policy regimes. Consider now the money supply in panel (b). For periods 0-10 (which is denoted by triangles) any money supply is consistent with the equilibrium as long as it is above the triangulated lines, because during those period the interest rate is zero so that the inequality (29) is not binding. In other words, the *velocity of money* is indeterminate in periods 0 to 10. What is uniquely determined, however, is the money supply in period 10 onwards when the natural rate of interest is positive again, in which case the nominal interest rate is no longer zero, as can be seen in panel (a). What this means is that money supply increases in periods years before 10 have no effect unless they change the expectations about the money supply in period 10 onwards. Hence, according to the model, the fact that the BoJ and the Federal Reserve both more than doubled the money supply in the periods in which interest rates were zero (roughly speaking 1996-2006

[18] See Table 1 in Brown (1956). Column 14 is his baseline calibration where he assumes: a="marginal propensity to spend disposable income and profits"=0.8 and b="marginal propensity to spend national product"=0.6. The real spending multiplier in his model is $\frac{1-a}{1-b}$ and the deficit spending multiplier is $\frac{a}{1-b}$ which give the numbers cited above.

[19] A more detailed money demand specification would have velocity, ν, as a function of the nominal interest rate. This is not required for the basic point I wish to make in this section. Also observe that with productivity growth, the implied money supply would be increasing at the phase of productivity.

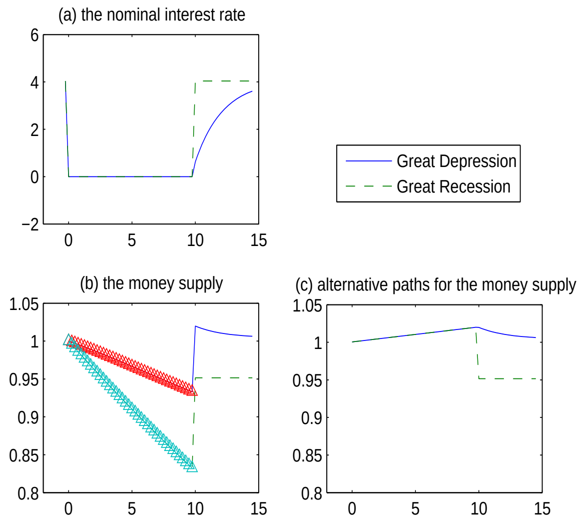

Figure 4: Implied money supply and nominal interest rate during the Great Depression and the Great Recession.

and 1933-1941) had no effect unless it changed expectations about the money supply from 2006 onwards on the one hand or 1941 onwards on the other. The expansionary stance of monetary policy in 1996-2006 versus 1933-1941, therefore, cannot be gauged by the level of money supply alone. What separates the two policy regimes, instead, was that the policy regime during the Great Depression implied a permanent increase in the money supply (post 1941), while policy during the Great Recession (post 2006) did not.

To illustrate this point panel (c) in figure 4 shows a possible path for the money supply for the Great Recession and the Great Depression. This hypothetical evolution of the money supply is the same in the periods when the interest rate is zero. The only difference between the two regimes is that policy during the Great Recession implies that the money supply is lower in 10 onwards so that as soon as the deflationary pressure have subsided the central bank contracts the money supply aggressively.

A monetary contraction was in fact observed in Japan as soon as deflationary pressures started to wane in 2006. In the spring of 2006, as the deflationary pressures had subsided, the BoJ ended its period of "quantitative easing". Following this the BoJ contracted the monetary base by about 30 percent. This is shown in figure 5. No such contraction was observed during the Great Depression, apart from in short period in 1937 through an increase in reserve requirement, a policy that was then reversed, as I discuss in the next section.

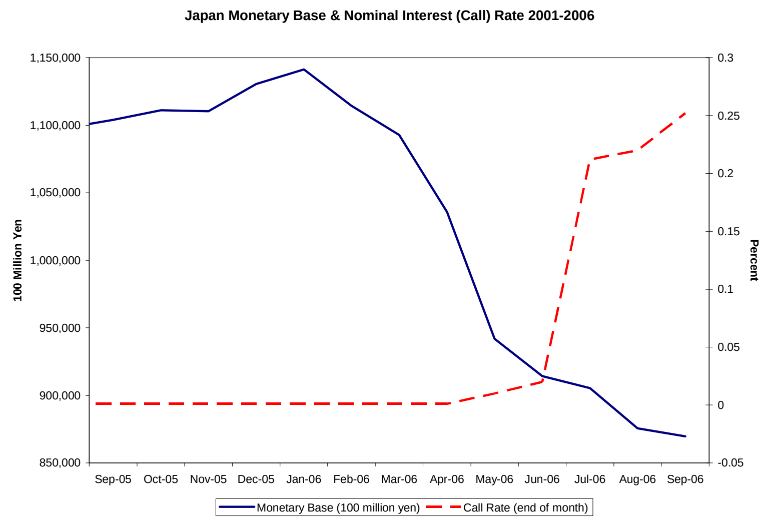

Figure 5: Money supply contracted dramatically in Japan in the spring of 2006.

7 The role of central bank independence during the Great Depression in the US

The model of the paper gives an interesting perspective on the recovery from the Great Depression from the perspective of the independence of the Federal Reserve. The model indicates, at least if one takes the institutional arrangement described here literally, that when the short-term nominal interest rate is zero, a move that coordinates monetary and fiscal policy would increase output and prices. This gives an interesting perspective on the recovery in 1933-37 in the US, the recession in 1937-38 and the recovery in 1938 onwards.

FDR was inaugurated in March 1933. The following month Congress passed a law, the Thomas Amendment, whose two most prominent features were that 1) the president could reduce the gold value of the dollar and 2) issue 3 billion dollars in currency. The 3 billion dollars corresponded to 30 percent of the monetary base at the time and more than half the currency in circulation.[20] While both provisions were only "authorizations" rather than requiring actions, they effectively ended the independence of the Federal Reserve for the time being. FDR used this power to go off the gold standard. In addition, he said on several occasions that he wished to inflate the price level to pre-Depression levels. On the 1st of May of 1933, for example, FDR said in the *Wall Street Journal*:

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

[20] The monetary base is defined as the sum of currency in circulation and non-borrowed reserves.

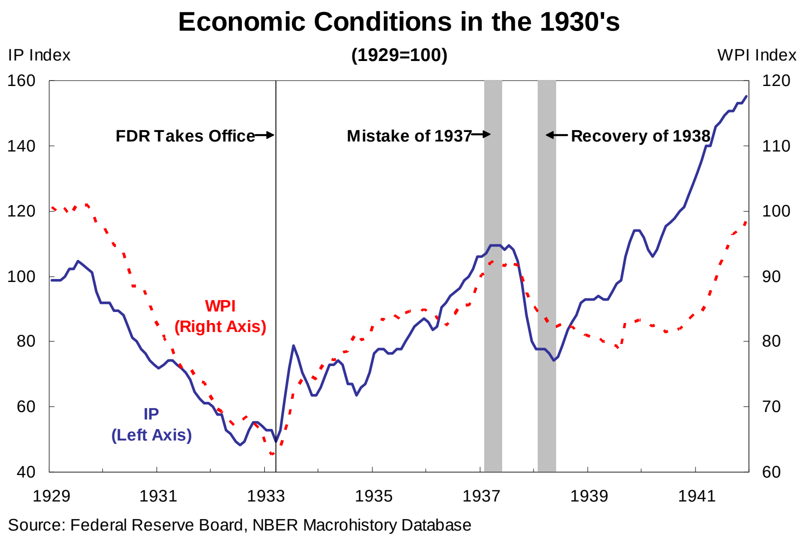

Figure 6: Monthly whole sale prices (WPI) and industrial production (IP) during the Great Depression.

economic and the monetary fields.

Figure 6 shows that prices and output immediately responded to these announcements and in addition the administration embarked on various spending programs that increased the budget deficit. Were these expansionary programs related to making inflation more "credible"? When the market seemed to be in doubt about the administration's commitment to inflation in the fall of 1933 FDR said in a radio address: "If we cannot do this [reflation] one way we will do it another. Do it, we will", adding

> that is why powers are being given to the Administration to provide, if necessary, for an enlargement of credit [...] These powers will be used when, as, and if it may be necessary to accomplish the purpose [i.e. increasing inflation].

Evidently the administration saw deficit spending – the enlargement of government credit – as crucial to increase inflation. Newspaper articles, etc. during this era provide anecdotal support for this claim. The violation of what Eggertsson (2008) calls the "balanced budget dogma" created widespread anger among some commentators in the press who believed the government would embark on a path of uncontrolled inflation, citing experiences of deficit spending in some countries in the aftermath of WWI (such as Germany).

Perhaps even more interesting, from a theoretical perspective, is the cause of the 1937 recession. Eggertsson and Pugsley (2006) argue that this recession was caused by the administration's abandonment of the commitment to inflate the price level to pre-depression levels. Their story is that the administration – especially the Federal Reserve – started warning of too high inflation in the early months of 1937, even though prices had not reached pre-depression levels. This resulted in a shift in expectations and a contraction as can be seen in figure 6. Eggertsson and Pugsley (2006) do not explain why the Federal Reserve started warning against too high inflation, but this paper proposes a reason why: The Federal Reserve reneged on the administration's commitment to inflation because the Fed saw their objectives as the one we show in this paper. In other words the Federal Reserve wanted to avoid inflation because they thought output had reached potential, an according to the objective we have specified for an independent bank, this suggest it should have raised interest rates.

This interpretation seems to be consistent with some narrative evidence. Given the high level of outstanding government debt in 1937, the Fed's warning of "too high inflation" would, according to our theory, be consistent with the objective of the Fed (since they thought the depression was essentially over at that time, see Eggertsson and Pugsley (2006)) but inconsistent with the Treasury's objective i.e. the agency responsible for financing the budget deficits and outstanding debt payments. Historical evidence indicates that the Treasury reacted strongly to the Fed's actions in 1937, which included higher reserve requirements that raised short term interest rates, precisely *because* it was inconsistent with the policy regime of coordinated monetary and fiscal policy. Marriner Eccles, the governor of the Federal Reserve, described the reaction of the Secretary of Treasury, Henry Morgenthau, to the increase in interest rates in May 1937 triggered by an increase in reserve requirements (see Eccles (1951) p. 292)

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

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

The Federal Reserve did not budge in 1937. In 1938, however, the country had experienced another deep recession, as can be seen in figure 6, and a tumble in the price level. In early 1938, FDR restored an inflationary policy by overriding the Federal Reserve, giving them explicit directions on how to conduct policy. The first announcement of considerable importance was made at a February 15th press conference where FDR said that he believed, as he had announced in 1933, that prices should be inflated back to their pre-depression levels (Eggertsson and Pugsley (2006)).

Three days later FDR called another press conference where the explicit goal seems to have been to illustrate overall coordination of monetary and fiscal policy. On that occasion he read a statement which he had instructed Federal Reserve Chairman Eccles, Treasury Secretary Henry Morgenthau, and several other senior government officials to prepare jointly. Flanked by senior administration officials FDR announced, "it is clear that in the present situation a moderate rise in the general price level is desirable." Later that spring the administration took several steps to support an inflationary program, such as lowering the reserve requirement back to its 1936 level, increasing deficit spending and desterilizing government gold stocks. The 1938-1942 recovery was even stronger than the 1933-1937 recovery and by most measures the economy had fully recovered by 1942.

It is often argued that it was wartime spending that finally lifted the US economy out of the Great Depression. This "conventional wisdom" is probably colored by the Keynesian view that monetary policy was impotent during this period. There is no doubt that wartime spending helped stimulate demand. According to the current hypothesis, however, the turnaround from 1937-38 is more appropriately traced back to Roosevelt's recommitment to inflation and coordinated monetary and fiscal policy in the early months of 1938.

8 Coordination during the Great Depression in Japan

The main objective of this paper is to compare the US during the Great Depression and Japan during the Great Recession. The choice of these specific episodes was primarily motivated by the fact that they are relatively well known by economists. It is impossible, however, to leave the topic of coordination without mentioning another historical episode which, while less known, is of great interest to our analysis.[21]

There is perhaps some irony, given the "lost decade" in the 1990's and 2000's in Japan, that there is an interesting historical precedent from Japan for a cooperative solution. During the late 1920's Japan was slipping into a depression. Growth had slowed down considerably, GNP rose by only 0.5 percent in 1929, 1.1 in 1930 and 0.4 percent in 1931. At the same time deflation was crippling the economy. This was registered by several macroeconomic indicators as is illustrated in table 4. In December 1931, Korekiyo Takahasi was appointed the Finance Minister of Japan.

[21] See e.g. Patrick (1971), Nakamura (1971) and Nanto et al (1985) for discussion of this period in Japan.

Takahasi took three immediate actions. First, he abolished the gold standard. Secondly, he subordinated monetary policy to fiscal policy by having the BoJ underwrite government bonds. Third, he ran large budget deficits. These actions had dramatic effects as can be seen in table 4. All the macroeconomic indicators changed in the direction predicted by our model. As the budget deficit increased, GNP rose and deflation was halted. During the same period, interest rates were at a historical low. I do not have a good measure of the short-term riskfree nominal rate but the commercial rate, while low, was not zero and declined even further with Takahashi's actions. In addition to the nominal interest rate cuts, our model indicates that the other actions taken, i.e. aggressive deficit spending that was financed by underwriting of government bounds, could have had considerable effects on the real rate of return through increasing *expected inflation*. This channel can be of potential importance in explaining the success of these policy measures in Japan during the Great Depression. In 1936, Takahashi was assassinated and the government finances subjugated to military objectives. The following military expansion eventually led to excessive government debt and hyperinflation. Until Takahasi was assassinated, however, the economic policies in Japan during the 1930's were remarkably successful, as the figure reveals. The resulting hyperinflation that followed in later years, however, reflects the dangers associated with coordination of this kind.

	Change in GNP deflator	*Change in CPI*	*Change in WPI*	*Change in GNP*	*Government surplus over GNP*
1929	-	-2.3%	-2.8%	0.5%	-1.0%
1930	-	-10.2%	-17.7%	1.1%	2.0%
1931	-12.6%	-11.5%	-15.5%	0.4%	0.4%
1932	3.3%	1.1%	11.0%	4.4%	-3.5%
1933	5.4%	3.1%	14.6%	10.1%	-3.0%
1934	-1.0%	1.4%	2.0%	8.7%	-3.5%
1935	4.1%	2.5%	2.5%	5.4%	-3.3%
1936	3.0%	2.3%	4.2%	2.2%	-2.0%

Table 4: Coordination of Fiscal and Monetary Policy in the Great Depression in Japan.

9 Conclusions

Inflation has been considered the main threat to monetary stability for several decades. In the aftermath of the double digit inflation of the 70's, there was a movement to separate monetary policy from fiscal policy and vest it in the hands of "independent" central bankers whose primary responsibility was to prevent inflation. This development was reinforced by important contributions on the theoretical level, most notably by Kydland/Prescott (1977) and Barro/Gordon's

(1983) illustration of the "inflation bias" of a discretionary government. It is easy to forget that in the aftermath of the Great Depression, when deflation was the norm, the discussion at the political and theoretical level was quite the opposite. Paul Samuelson claimed that the Federal Reserve was "the prisoner of its own independence" during the Great Depression, exaggerating the slump by its inability to fight deflation.[22] Similarly, Milton Friedman claimed that "monetary policy is much too serious a matter to be left to the central bankers".[23] This paper explains the different reaction of nominal demand during the Great Recession vs. the Great Depression by illustrating the importance of central bank independence. Working out the normative implications of this is a hard task, that I do not attempt to address here. There are obvious and large benefits of central bank independence under regular circumstances, but the case for coordination when the economy is in dire straight is also there. To the extent the central bank has high degree of credibility, and is able to effectively use it to steer away from Depression style contraction, the need for coordination is weaker.

As I have stressed in this paper, the key differences between policy making in the Great Recession and the Great Depression are that (i) monetary and fiscal policy was coordinated during the Great Depression and (ii) the government made an explicit commitment to reflate the price level. What was the contribution of each of these channels? The model analysis takes a strong stance on this question by assuming that words have no weight so that channel (ii) played no role, which is essentially equivalent to assuming the government had no credibility. One cannot, however, infer whether or not this assumption is correct in the data because words and actions went together (i.e. the publicly communicated commitment to inflation in the US was concurrent with the reduction in central bank independence). Is it possible that the change in the institutional arrangement was irrelevant and that all that mattered was the commitment of the government to price level targeting? This is an question for future research, and one we may be left speculating about for years to come.

[22] See Mayer (1990) p. 6.

[23] Although he suggested rules to solve the problem rather than coordinated discretion as I do here.

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11 Appendix

11.1 Computation method

Let us define the following notation

$$\Lambda_t \equiv \left[\begin{array}{ccccc} \Pi_t & Y_t & i_t & F_t & T_t \end{array} \right], \text{ and } e_t \equiv \left[\begin{array}{c} f_t^e \\ S_t^e \end{array} \right].$$

I summarize conditions (2), (3) and (4) by the vector function Γ so that

$$\Gamma(\Lambda_t, w_{t,} w_{t-1}, b_t) = 0 \tag{30}$$

and the inequalities (5) and (7) by Υ so that

$$\Upsilon(\Lambda_t, w_t, b_t) \geq 0 \tag{31}$$

I summarize the utility as $U(\Lambda_t, b_t)$ so that the maximization problem can be written compactly as

$$J(w_{t-1}, \xi_t) = \max_{i_t, F_t, T_t} [U(\Lambda_t, b_t) + E_t \beta J(w_t, b_{t+1})] \tag{32}$$

s.t. (30) and (31).

I obtain the necessary conditions for a Markov Perfect equilibrium by differentiating the Lagrangian.

$$\mathcal{L}_t = U(\Lambda_t, \xi_t) + E_t \beta J(w_t, \xi_{t+1}) + \phi_t' \Gamma(e_t, \Lambda_t, w_{t,} w_{t-1}, \xi_t) + \delta_t' \Upsilon(\Lambda_t, w_t, \xi_t)$$

where ϕ_t is a (5×1) vector and γ_t is (2×1). The first order conditions for $t \geq 0$ are (where each derivatives of $\mathcal{L}$ are equated to zero):

$$\frac{d\mathcal{L}}{d\Lambda_t} = \frac{dU(\Lambda_t, \xi_t)}{d\Lambda_t} + \phi_t' \frac{E_t d\Gamma(\Lambda_t, w_{t,} w_{t-1}, \xi_t)}{d\Lambda_t} + \delta_t' \frac{d\Upsilon(\Lambda_t, \xi_t)}{d\Lambda_t} \tag{33}$$

$$\frac{d\mathcal{L}}{dw_t} = E_t \frac{d\beta J(w_t, \xi_{+1})}{dw_t} + \phi_t' \frac{E_t d\Gamma(\Lambda_t, w_{t,} w_{t-1}, \xi_t)}{dw_t} + \delta_t' \frac{d\Upsilon(\Lambda_t, w_t, \xi_t)}{dw_t}$$

$$\gamma_t \geq 0, \quad \Upsilon(\Lambda_t, w_t, \xi_t) \geq, 0 \quad \delta_t' \Upsilon(\Lambda_t, w_t, \xi_t) \tag{34}$$

Here $\frac{d\mathcal{L}}{d\Lambda_t}$ is a (1×5) Jacobian. I use the notation

$$\frac{d\mathcal{L}}{d\Lambda_t} \equiv [\frac{\partial \mathcal{L}}{\partial \Pi_t}, \frac{\partial \mathcal{L}}{\partial Y_t}, \frac{\partial \mathcal{L}}{\partial i_t}, \frac{\partial \mathcal{L}}{\partial F_t}, \frac{\partial \mathcal{L}}{\partial T_t}]$$

so that (33) is a vector of 6 first order conditions. The Markov equilibrium must also satisfy an envelope condition:

$$J_w(w_{t-1}, \xi_t) = \ \phi_t' \frac{d\Gamma(e_t, \Lambda_t, w_{t,} w_{t-1}, \xi_t)}{dw_{t-1}} \tag{35}$$

and the derivative of $J(.)$ with respect to all other elements of Λ_t is zero.

As proved in Eggertsson (2006), this system has a steady state with $\Pi = 1, Y = \bar{Y}, 1 + i = \beta^{-1}, F = \bar{F} = T = \bar{T}$ and $w = 0$ and $\phi_1 = \frac{\gamma\beta\bar{F}}{\bar{F}(1-\gamma)}$ while all the other elements of the vector ϕ and δ are zero. The system is linearized around this steady state, as described in Eggertsson (2006), for each set of equalities that have to hold when the zero bound is binding and when it is not, and the resulting solution is accurate to the first order. I wrote a Matlab file to numerically approximate the linearized system. The numerical solution obtained is then found using the solution method in Eggertsson and Woodford (2003) and Eggertsson (2006). This solution is shown in the Matlab files available at http://www.ny.frb.org/research/economists/eggertsson/index.html

11.2 Derivation of Objective

Here I do a linear quadratic approximation of the utility of the representative household to verify the statement in the text. The utility function of the household is

$$E_t \sum_{t=0}^{\infty} \beta^t \{u(Y_t - F_t - d(\pi_t), \xi_t) + g(F_t - s(T_t), \xi_t) - v(Y_t, \xi_t)\}$$

using a slightly more general notation than in the text. Note that in steady state we have

$u_c = C^{-\sigma^{-1}} u^{\sigma^{-1}} = 1$

$u_{c\xi} = \sigma^{-1} C^{-\sigma^{-1}} u^{\sigma^{-1}-1} = C^{-1}\sigma^{-1}$

$u_{cc} = -\sigma^{-1} C^{-\sigma^{-1}-1} u^{\sigma^{-1}} = -C^{-1}\sigma^{-1}$

$v_y = \lambda_1 Y^{\omega} q^{-\omega} = 1$

$v_{yy} = \omega\lambda_1 Y^{\omega-1} q^{-\omega} = \omega$

$v_{y\xi} = -\lambda_1 \omega Y^{\omega} q^{-\omega} = -\omega$

$g_G = \chi G^{-\sigma^{-1}} g^{\sigma^{-1}} = \chi$

$g_{GG} = -\sigma^{-1}\chi G^{-\sigma^{-1}-1} g^{\sigma^{-1}} = -\chi G^{-1}\sigma^{-1}$

$g_{G\xi} = \sigma^{-1}\chi G^{-\sigma^{-1}} g^{\sigma^{-1}-1} = \chi G^{-1}\sigma^{-1}$

$(1 - s\prime)\chi = 1$

Also recall that in steady state I normalize $Y = 1$.

The first piece of the utility is

$$\begin{aligned}
& u(Y_t - F_t - d(\pi_t), \xi_t) \\
= \; & u + u_c dY_t - u_c dF_t - u_c d' d\pi_t + u_\xi d\xi_t \\
& + \frac{1}{2} u_{cc} dY_t^2 + u_{c\xi} d\xi_t dY_t - u_{c\xi} d\xi_t dF_t - u_{c\xi} d\xi_t d' d\pi_t - u_{cc} dY_t dF_t + u_{cc} d' dY_t d\pi_t + u_{cc} d' dF_t d\pi_t \\
& + \frac{1}{2} u_{cc} dF_t^2 - \frac{1}{2} u_c d'' d\pi_t^2 + \frac{1}{2} u_{cc} (d')^2 d\pi_t^2 + \frac{1}{2} \xi_t' u_{\xi\xi} \xi_t \\
= \; & \hat{Y}_t - \hat{F}_t \\
& + [-\frac{1}{2}\sigma^{-1} C^{-1} \hat{Y}_t^2 + \sigma^{-1} C^{-1} \hat{Y}_t \hat{F}_t + \sigma^{-1} C^{-1} \hat{Y}_t \hat{u}_t - \sigma^{-1} C_t^{-1} \hat{F}_t \hat{u}_t - \frac{1}{2} d'' d\pi_t^2 - \frac{1}{2}\sigma^{-1} C^{-1} \hat{F}_t^2] \\
& + t.i.p.
\end{aligned}$$

where $t.i.p.$ stands for terms independent of policy. The second piece is:

$$\begin{aligned}
& g(F_t - s(T_t), \xi_t) \\
= \; & \bar{g} + g_G dF_t - g_G s' dT_t + g_\xi d\xi_t + \frac{1}{2} g_{GG} dF_t^2 + \frac{1}{2} g_{GG}(s')^2 dT_t^2 - \frac{1}{2} g_G s'' dT_t^2 \\
& + g_{G\xi} d\xi_t dF_t - g_{G\xi} d\xi_t s' dT_t + \frac{1}{2}\xi_t' g_{\xi\xi}\xi_t \\
= \; & \chi \hat{F}_t - s'\chi \hat{T}_t \\
& -\frac{1}{2}\chi\sigma^{-1}G^{-1}\hat{F}_t^2 - \frac{1}{2}\chi\sigma^{-1}G^{-1}(s')^2\hat{T}_t^2 - \frac{1}{2}s''\chi dT_t^2 + \chi G^{-1}\sigma^{-1}\hat{F}_t\hat{g}_t - \chi G^{-1}\sigma^{-1}s'\hat{T}_t\hat{g}_t] + t.i.p.
\end{aligned}$$

The final piece is

$$\begin{aligned}
v(Y_t, \xi_t) \; = \; & v + v_y dY_t + v_y d\xi_t \\
& + \frac{1}{2} v_{yy} dY_t^2 + v_{y\xi} d\xi_t dY_t \\
& + \frac{1}{2}\xi_t' v_{\xi\xi} d\xi_t \\
= \; & \hat{Y}_t + \frac{1}{2}\omega\hat{Y}_t^2 - \omega\hat{Y}_t\hat{q}_t + t.i.p.
\end{aligned}$$

Combine period utility to yield:

$$\begin{aligned}
= \; & \hat{Y}_t - \hat{F}_t - \frac{1}{2}\sigma^{-1}C^{-1}\hat{Y}_t^2 + \sigma^{-1}C^{-1}\hat{Y}_t\hat{F}_t + \sigma^{-1}C^{-1}\hat{Y}_t\hat{u}_t - \sigma^{-1}C_t^{-1}\hat{F}_t\hat{u}_t - \frac{1}{2}d'' d\pi_t^2 - \frac{1}{2}\sigma^{-1}C^{-1}\hat{F}_t^2 \\
& + \chi\hat{F}_t - s'\chi\hat{T}_t - \frac{1}{2}\chi\sigma^{-1}G^{-1}\hat{F}_t^2 - \frac{1}{2}\chi\sigma^{-1}G^{-1}(s')^2\hat{T}_t^2 - \frac{1}{2}s''\chi\hat{T}_t^2 + \chi G^{-1}\sigma^{-1}\hat{F}_t\hat{g}_t - \chi G^{-1}\sigma^{-1}s'\hat{T}_t\hat{g}_t] \\
& - \hat{Y}_t - \frac{1}{2}\omega\hat{Y}_t^2 + \omega\hat{Y}_t\hat{q}_t \\
= \; & (\chi - 1)\hat{F}_t - s'\chi\hat{T}_t - \frac{1}{2}d''\pi_t^2 + [-\frac{1}{2}(\sigma^{-1}C^{-1} + \omega)\hat{Y}_t^2 + \sigma^{-1}C^{-1}\hat{Y}_t\hat{F}_t + \sigma^{-1}C^{-1}\hat{Y}_t\hat{u}_t + \omega\hat{Y}_t\hat{q}_t] \\
& + [-\frac{1}{2}\sigma^{-1}(C^{-1} + \chi G^{-1})\hat{F}_t^2 + \chi G^{-1}\sigma^{-1}\hat{F}_t\hat{g}_t - \sigma^{-1}C_t^{-1}\hat{F}_t\hat{u}_t] \\
& + [-\frac{1}{2}\chi(\sigma^{-1}G^{-1}(s')^2 + s'')\hat{T}_t^2 - \chi G^{-1}\sigma^{-1}s'\hat{T}_t\hat{g}_t]
\end{aligned}$$

Welfare criterion can now be written as

$$\begin{aligned}
& \sum_{t=0}^{\infty}\beta^t[-\frac{1}{2}d''\pi_t^2 - \frac{1}{2}(\sigma^{-1}C^{-1} + \omega)(\hat{Y}_t - \hat{Y}_t^n)^2 \\
& - \frac{1}{2}\sigma^{-1}(C^{-1} + \chi G^{-1})(\hat{F}_t - \hat{F}_t^n)^2 - \frac{1}{2}\chi(\sigma^{-1}G^{-1}(s')^2 + s'')(\hat{T}_t - \hat{T}_t^n)^2]
\end{aligned}$$

where

$$\hat{Y}_t^n \equiv \frac{\sigma^{-1}C^{-1}}{\sigma^{-1}C^{-1} + \omega}\hat{F}_t + \frac{\sigma^{-1}C^{-1}}{\sigma^{-1}C^{-1} + \omega}\hat{u}_t + \frac{\omega}{\sigma^{-1}C^{-1} + \omega}\hat{q}_t$$

$$\hat{F}_t^n \equiv \frac{\chi G^{-1}}{C^{-1} + \chi G^{-1}}\hat{g}_t - \frac{C^{-1}}{C^{-1} + \chi G^{-1}}\hat{u}_t$$

$$\hat{T}_t^n \equiv -\frac{G^{-1}\sigma^{-1}s'}{\sigma^{-1}G^{-1}(s')^2 + s''}g_t$$

Because

$$\sum_{t=0}^{\infty} \beta^t [\chi - 1] dF_t - s' \chi dT_t = w_{-1} + \sum_{t=0}^{\infty} \beta^t [-1 + \chi(1 - s')] dF_t = w_{-1} = 0$$

12 Data

The data in Table 1 are from various sources noted below the table. All those data are in calender years.

The data in Table 2 are from Eggertsson (2008), where details are provided. I use the third estimate of the budget deficit reported in that paper. Observe that all the data is in fiscal years, apart from the data on nominal GDP an interest rates. The data on the short rate are end of year data from Cecchetti (1988).

Japan 1990-2006

in ten billion Japanese yen

	1990	1991	1992	1993	1994	1995	1996	1997
Nominal GDP	4,401.67	4,682.91	4,805.14	4,841.42	4,865.23	4,931.40	5,028.72	5,125.67
Government Expenditure	1395.65	1474.95	1559.29	1657.46	1693.06	1763.92	1823.40	1797.02
per cent of GDP	31.71	31.50	32.45	34.24	34.80	35.77	36.26	35.06
Deficit (-) / Surplus (+)	90.24	84.83	37.90	-115.10	-182.70	-232.45	-254.81	-194.44
per cent of GDP	2.05	1.81	0.79	-2.38	-3.76	-4.71	-5.07	-3.79
Nominal Monetary Base	3,922.01	3,981.29	3,892.81	4,024.69	4,209.61	4,415.16	4,778.78	5,144.47
Short-term Interest Rates (per cent)	8.25	5.50	3.84	2.38	2.22	0.40	0.38	0.44
Real GDP	100.00	105.81	109.97	112.00	109.17	111.22	114.16	115.74
per cent change	5.26	3.33	0.95	0.20	-2.52	1.87	2.65	1.39
Real Monetary Base	100.00	98.26	94.31	96.33	100.05	105.22	113.93	121.05
GDP Deflator	100.00	100.55	99.27	98.20	101.24	100.74	100.08	100.61
per cent change	-3.00	0.55	-1.28	-1.07	3.09	-0.50	-0.65	0.53
CPI	100.00	103.31	105.25	106.53	107.28	106.99	106.95	108.36
per cent change	3.10	3.31	1.88	1.22	0.71	-0.27	-0.04	1.32

	1998	1999	2000	2001	2002	2003	2004	2005
Nominal GDP	5,027.52	4,956.31	5,013.39	4,968.74	4,897.47	4,907.74	4,961.24	5,026.07
Government Expenditure	1,815.90	1,659.28	1,789.89	1,810.81	1,845.99	1,830.20	1,812.10	1,867.69
per cent of GDP	36.12	37.70	38.22	37.68	38.13	36.75	36.75	37.16
Deficit (-) / Surplus (+)	-277.27	-318.13	-350.11	-294.35	-381.73	-373.36	-321.50	-322.99
per cent of GDP	-5.51	-7.23	-7.48	-6.13	-7.88	-7.67	-6.52	-6.42
Nominal Monetary Base	5,585.80	5,993.81	6,450.79	6,930.20	8,711.11	10,142.94	10,865.43	11,079.76
Short-term Interest Rates (per cent)	0.34	0.01	0.22	0.00	0.00	0.00	0.00	0.00
Real GDP	113.59	113.47	116.76	117.19	117.35	119.49	122.20	125.40
per cent change	-1.86	-0.11	2.90	0.37	0.14	1.82	2.27	2.62
Real Monetary Base	130.35	140.46	152.67	165.89	210.65	246.23	264.04	270.69
GDP Deflator	100.55	99.24	97.55	96.33	94.81	93.31	92.24	91.06
per cent change	-0.06	-1.31	-1.70	-1.25	-1.57	-1.58	-1.15	-1.28
CPI	109.27	108.80	107.74	106.52	105.44	105.03	104.92	104.36
per cent change	0.84	-0.42	-0.98	-1.13	-1.01	-0.39	-0.10	-0.53

Sources: Bank of Japan, OECD Economic Outlook 76 Database, The World Bank Group.

United States of America 1930-1941

in millions of US dollars

	1930	1931	1932	1933	1934	1935	1936	1937	1938	1939	1940	1941
Nominal GDP	97,400	83,800	67,600	57,600	61,200	69,600	78,500	87,800	89,000	89,100	96,800	114,100
Government Expenditure	3,545.90	4,300.30	4,572.30	5,115.60	5,216.00	6,843.80	8,532.80	8,835.00	8,453.34	9,319.80	9,794.45	19,052.80
per cent of GDP	3.64	5.13	6.76	8.88	8.52	9.83	10.87	9.38	9.50	10.46	10.12	16.70
Deficit (-) / Surplus (+)		-1,402.00	-1,520.00	-3,305.00	-5,502.50	-5,440.00	-6,659.00	-3,158.00	-738.00	-5,558.00	-5,735.00	-7,038.00
per cent of GDP		-1.67	-2.25	-5.74	-8.99	-7.82	-8.48	-3.60	-0.83	-6.24	-5.92	-6.17
Nominal Monetary Base	6,393	6,426	7,364	7,821	9,402	11,405	13,014	13,283	15,428	18,883	22,539	23,597
Short-term Interest Rates (per cent)	1.25	2.75	0.05	0.5	0.2	0.15	0.2	0.12	0.05	0.05	0.06	0.35
Real GDP	100.00	93.60	81.43	80.37	89.05	96.98	109.59	115.18	111.26	120.27	130.86	153.23
per cent change	-8.60	-6.40	-13.00	-1.30	10.80	8.90	13.00	5.10	-3.40	8.10	8.80	17.10
Real Monetary Base	100.00	110.53	141.10	158.22	183.77	217.25	245.42	241.61	286.20	354.88	420.55	419.24
GDP Deflator	100.00	89.60	79.03	76.95	81.20	82.84	83.80	87.35	84.84	84.06	85.01	90.73
per cent change	-3.67	-10.38	-11.76	-2.7	5.57	2.01	1.12	4.32	-2.91	-0.97	1.17	6.7
CPI	100.00	90.94	81.63	77.33	80.03	82.12	82.95	86.00	84.33	83.24	83.84	88.05
per cent change	-2.55	-9.06	-10.23	-5.28	3.50	2.61	1.01	3.68	-1.95	-1.29	0.72	5.02

Source: Federal Reserve Board, Banking and Monetary Statistics