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INTERNATIONAL MACROECONOMICS

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ABSTRACT

Does Fiscal Policy Matter? Blinder and Solow Revisited*

This paper uses the old-Keynesian representative agent model developed in Farmer (2010) to answer two questions: 1) do increased government purchases crowd out private consumption? 2) do increased government purchases reduce unemployment? Farmer compared permanent tax financed expenditure paths and showed that the answer to 1) was yes and the answer to 2) was no. We generalize his result to temporary bond-financed paths of government purchases that are similar to the actual path that occurred during WWII. We find that a temporary increase in government purchases does crowd out private consumption expenditure as in Farmer (2010). However, in contrast to Farmer's experiment we find that a temporary increase in government purchases can also reduce unemployment.

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1 Introduction

On Monday October 28th 1929 the stock market fell 13% in one day. That event ushered in the Great Depression, a period when unemployment climbed to 25% and remained above 10% for ten years in a row. Keynes argued that the drop in the stock market in 1929 *caused* the Great Depression. Some empirical evidence for this view can be found in the work of Romer (1990) and a theory of how it can be consistent with rational behavior by individuals can be found in Farmer (2010b). Economists are still debating the causes of the Great Depression seventy years later.[1]

For thirty years following the publication of Keynes book, *The General Theory of Employment Interest and Money* (1936), the concept of involuntary unemployment was widely used to characterize the inefficiencies that were thought to characterize the loss of output that occurs during major recessions. In the 1970s the tide changed. Following the work of Lucas and Rapping (1969), it became accepted practice by macroeconomists to model the labor market as an equilibrium between demand and supply. Part of the reason that the profession gave up on Keynesian economics was empirical; the disappearance of the Phillips curve in the 1970s discredited Keynesian theory. But that is only part of the story. A second important reason for the abandonment of Keynesian ideas was Keynes's failure to provide a theory of the labor market that was consistent with an established body of microeconomic theory.

Most contemporary interpretations of Keynes are based on the idea that unemployment occurs because prices and wages adjust slowly in response to

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[1]Monetary explanations of the Great Depression include the work of Friedman and Schwartz (1963) who blame the Fed for failing to prevent a collapse of the money supply and Bernanke (1983) who points to the effects of banking panics. Real explanations include the work of Temin (1978) who cites an autonomous drop in consumption, Ohanian (2009) who blames Herbert Hoover's labor policies and Cole and Ohanian (2004) who argue, using a neo-classical model, that the industrial policy of President Roosevelt's New Deal made an ordinary recession much worse. McGrattan and Ohanian (2011, Forthcoming) have used the same model to study the role of fiscal policy in aiding the recovery.

monetary shocks (Clarida, Galí, and Gertler, 1999; Galí, 2008; Woodford, 2003). In a series of books and papers, Farmer (2008a,b, 2009, 2010b,c,d) develops an alternative interpretation of Keynesian economics that does not rely on sticky prices. In (2010b) he raises the possibility, in a representative agent model with Keynesian unemployment, that a permanent increase in government expenditure will be ineffective at restoring full employment.

Farmer's (2010d) paper compared two steady state policies within the context of the *old-Keynesian model*. In that model, confidence is an independent driving variable that determines the amount that households are willing to pay for assets. Farmer studied what would happen if an exogenous drop in confidence were to shift the economy from an equilibrium with full employment to a new equilibrium with high unemployment. By assumption, confidence would remain low for all future periods. He showed, in the context of that model, that a class of stationary balanced budget fiscal policies cannot restore full employment.

In this paper we revisit that result by studying temporary increases in government purchases. Our work is motivated by US experience during WWII when government purchases increased from 16% of GDP to 52% and government debt climbed from 40% of GDP to 120% in the space of three years.

In the paper we prove two propositions. First, we generalize the crowding out result of Farmer (2010b, Proposition 6.3, page 103) to non-stationary sequences of government expenditures. Second, we study a stylized class of policies in which there is a temporary boost to government expenditure of fixed duration. This class mimics the experience of the US during WWII. We prove, for this class of policies, that unemployment falls temporarily during the period of fiscal expansion. At the end of the boost it falls back to the level that would have occurred in the absence of the expansion.

We show that our model can quantitatively explain the movements in the unemployment rate and consumption during WWII by feeding into the model the actual paths of stock market wealth and government expenditures that

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occurred during this period. In the conclusion, we discuss the implications of our results for current economic policy.

2 Comparing 2008 with the Great Depression

Figures 1 and 2 give some evidence in support of the fact that stock market wealth and unemployment are related at medium frequencies. Figure 1 covers the period from January 1929 to December of 1939 and Figure 2 covers the period from January 2000 through October of 2010. Both figures plot the S&P 500 deflated by the CPI on the left axis and the unemployment rate as a percentage of the labor force on the right axis . Unemployment is measured on an inverted scale.
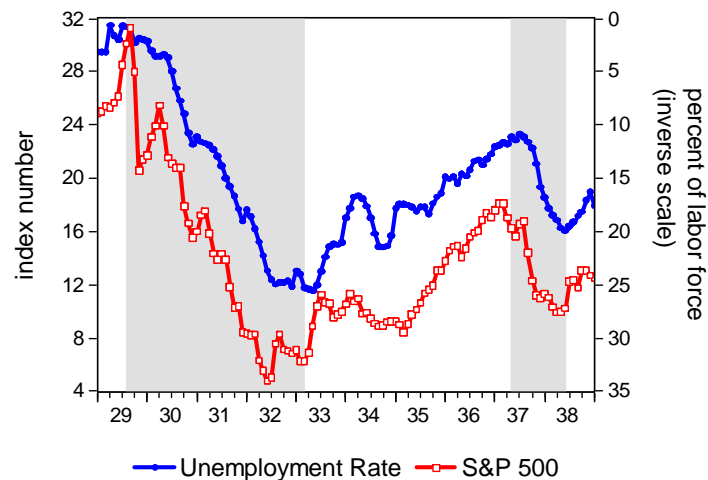

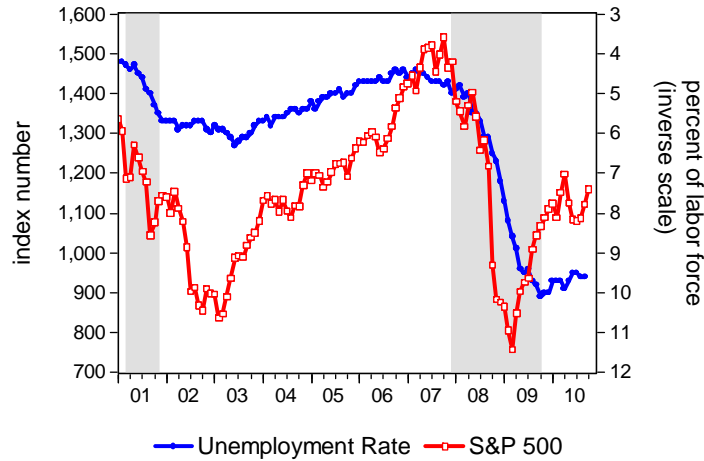Figure 1: Unemployment and the Stock Market During the Great Depression

Figure 2: Unemployment and the Stock Market in the Last Two Recessions

We realize that correlation is not causation and these graphs do not prove that the stock market crash caused the Great Depression. However, they do suggest to us that a theory that *does* make that causal link deserves further consideration. Old-Keynesian economics is one such theory.

3   The Wartime Recovery

Even if one were to accept that the Great Crash caused the Great Depression, one would still be left with the puzzle of what generated the remarkable recovery that occurred with the onset of WWII.
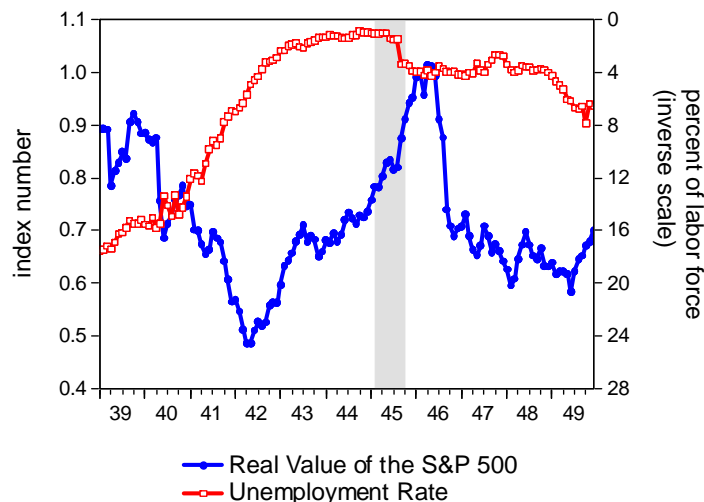
Figure 3: Unemployment and the Stock Market During WWI

Figure 3 replicates figures 1 and 2 for the period from January 1939 through December 1949. The figure shows that the stock market and unemployment were unrelated during this period. Something else must have caused the unemployment rate to fall from 20% in June 1938 to 1.2% in February 1944. An obvious candidate is the huge increase in the size of government that occurred as the economy geared up for and entered WWII.

In textbook Keynesian analysis, fiscal policy works because consumption depends on income. But research on the consumption function after WWII (Dusenberry, 1949; Friedman, 1957) found that consumption is better explained by wealth. Milton Friedman developed the *permanent income theory* in which he explained how long-lived agents would plan to smooth out their consumption over time. His theory predicts that households will expect an increase in government borrowing to lead to future tax increases.

The permanent income theory predicts that increased government purchases will *crowd out* private consumption expenditure. Crowding out reduces the stimulative effect of increased government purchases and, in the

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extreme case, every dollar spent by government may cause households to consume one dollar less. In this extreme case fiscal policy will have no effect on output or employment.
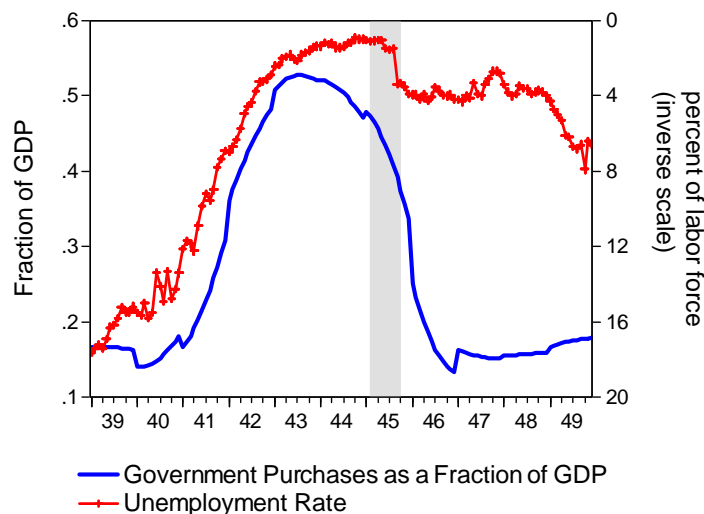

Figure 4: Unemployment and Government Purchases During WWII

Figure 4 plots government purchases measured on the left axis and unemployment measured on the right axis for the period from 1939 through 1949. Unemployment is measured on an inverted scale. The interesting feature of this graph is the correlation between the rise in government purchases and the reduction in the unemployment rate that begins in 1939 and ends in 1944.[2]

This paper asks a simple question in the framework of the old-Keynesian model: Can the reduction of unemployment be explained by a temporary increase in government purchases in a representative agent version of the model?

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[2]This is the evidence that led Keynesians to hope that fiscal stimulus would jump-start the economy in the 2008 recession. It is also this evidence that Keynesians point to when they argue that Obama's 2008 stimulus was too small. The 2008 US stimulus caused government purchases to increase from 20% to 25% of GDP. In WWII government purchases went from 16% to 52% of GDP.

4 The Old-Keynesian Model

We assume that utility is logarithmic and that households have access to one period nominal bonds. Since there is no aggregate uncertainty, markets are complete. The assumption that utility is logarithmic implies that the following Euler equation holds in nominal terms,

$$\frac{1}{C_t} = \frac{\beta}{C_{t+1}}(1 + i_t), \tag{1}$$

where C_t is the dollar value of consumption expenditure and i_t is the nominal interest rate.

Households' assets are the liabilities of a competitive financial sector which holds capital and government bonds. We assume that capital is non-reproducible and that it is valued at the price $p_{k,t}$. Capital is rented to the firms for the rental rent rr_t. The no arbitrage condition between investing in government bonds and investing in capital implies

$$1 + i_t = \frac{p_{k,t+1} + rr_{t+1}}{p_{k,t}}. \tag{2}$$

The price of capital is not equal to the price of the consumption good because capital and consumption are different goods. We assume that there is one unit of non-reproducible capital.

We define Z_t to be the money value of GDP. From the national income accounting identity this is equal to the sum of nominal consumption C_t and nominal government expenditure G_t,

$$Z_t = C_t + G_t. \tag{3}$$

The structure of the labor market is explained in Farmer (2010b). Briefly, we assume two technologies; one for producing goods and one for matching workers with jobs. Firms take wages and prices as given and they allocate workers between production and recruiting to maximize profit. Farmer shows

that this leads to a reduced form technology

$$y_t = Q_t^{1-\alpha} L_t^{1-\alpha} K_t^{\alpha} \tag{4}$$

where Q_t is an externality that depends on the number of workers being hired in the aggregate economy and y_t is the real value of output measured in physical units.[3]

This economy has the same two first order conditions as a standard neo-classical economy. These are represented by equations (5) and (6),

$$(1 - \alpha) Z_t = w_t L_t, \tag{5}$$

$$\alpha Z_t = rr_t, \tag{6}$$

where $Z_t = p_t y_t$ is nominal GDP as defined above.

5 Wages and the Labor Market

The model we have developed looks a lot like a one good representative agent model with a fixed labor supply. It behaves very differently. We assume that every household sends a measure 1 of workers to look for a job every period and that L_t of them find a job. To keep the labor market dynamics simple, we assume that the entire work force is fired every period and the process starts again next period.

Since this is a general equilibrium model without money, we are free to pick the numeraire. As in Farmer (2009) we choose the money wage to be the numeraire by setting

$$w_t = 1. \tag{7}$$

To map our model economy into the data we will normalize nominal variables

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[3]This assumption generalizes to an economy with many different consumption goods and multiple capital goods. See Farmer (2010b).

by a measure of the money wage. The money wage grows because of inflation and because of productivity improvements. By deflating GDP, consumption and government purchases by the money wage we are able to generate data series that are stationary.

6   What the Government Does

Households each supply one unit of labor and pay a labor income tax $\tau_t L_t$. Since labor is inelastically supplied, this tax is non distortionary. We abstract from capital taxes and sales taxes. We assume that government purchases G_t dollars worth of goods in period t and that the service flow provided by these goods is separable from private consumption in utility. Government chooses sequences $\{\tau_t, G_t, B_t\}$ that satisfy the intertemporal budget constraint

$$\sum_{s=t}^{\infty} \left(\frac{1}{1+i_s}\right)^{s-t} G_s + B_t(1 + i_{t-1}) = \sum_{s=t}^{\infty} \left(\frac{1}{1+i_s}\right)^{s-t} (1 - \alpha)\, \tau_s L_s. \quad (8)$$

Here, B_t is nominal government debt, G_t is nominal government expenditure and τ_t is the tax rate on labor income.

7   Closing the Model with Beliefs

Most models of search are closed by assuming that firms and workers bargain to determine the wage. Following Farmer (2010b), we assume instead that workers and firms take the wage and the price as given. This leads to a labor market with one less equation than unknown. To close the model we assume that households form a sequence of self-fulfilling beliefs about the value of assets. We operationalize this assumption by taking the sequence $\{p_{k,s}\}_{s=t}^{\infty}$

to be chosen exogenously.[4] We call this sequence the *state of expectations.*

For any given state of expectations, our model contains the following four equations,

$$\frac{1}{Z_t - G_t} = \frac{\beta}{Z_{t+1} - G_{t+1}}(1 + i_t),$$ (9)

$$1 + i_t = \frac{p_{k,t+1} + \alpha Z_{t+1}}{p_{k,t}},$$ (10)

$$L_t = (1 - \alpha) Z_t,$$ (11)

$$\sum_{s=t}^{\infty} \left(\frac{1}{1 + i_s}\right)^{s-t} G_s + B_t(1 + i_{t-1}) = \sum_{s=t}^{\infty} \left(\frac{1}{1 + i_s}\right)^{s-t} (1 - \alpha) \tau_s L_s,$$ (12)

together with the initial condition,

$$B_t = \bar{B}_t.$$ (13)

A *fiscal policy* is a set of sequences $\{B_{s+1}, G_s, \tau_s\}_{s=t}^{\infty}$. If there exists a solution to equations (9)–(13) that remains bounded for all t we say that the fiscal policy is *feasible*. A perfect foresight equilibrium given the state of expectations $\{p_{k,s}\}_{s=t}^{\infty}$ is a feasible fiscal policy and a bounded set of sequences $\{Z_t, i_t, L_t\}$ that satisfy equations (9)–(13).

8   Steady State Solution

Farmer (2010b) showed that a stationary equilibrium of the model for a given state of expectations $\{p_{k,s}\}_{s=t}^{\infty}$ and a stationary sequence of government expenditures $G_s = G$ for $s = t \cdots \infty$ implies

$$C_s + G_s = Z_s = \frac{1 - \beta}{\beta \alpha} p_k, \quad \text{for all } s.$$ (14)

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[4]Farmer (2010a) shows how to operationalize the idea of animal spirits by defining a *belief function.* He estimates a three equation old-Keynesian model and shows that it fits the US data better than a three equation new-Keynesian model.

Two interesting facts follow from Equation (14). First, one additional dollar of government expenditure decreases private consumption by one dollar. This follows because the RHS of Equation (14) does not depend on government expenditure, G_s. Second, the stationary equilibrium value of GDP depends on the state of expectations, p_k. Farmer (2010b) shows that p_k can taken any value in a bounded set and it follows from this fact that there is a continuum of stationary equilibria, each supported by a different stationary value of p_k and each associated with a different stationary unemployment rate.

Now consider the following experiment. Let the state of expectations fall from $p_{k,1}$ to $p_{k,2}$ where

$$p_{k,2} < p_{k,1}. \tag{15}$$

In the new stationary equilibrium, GDP will be lower and the unemployment rate will be higher. If expectations about the future prices of the assets in the economy never recover, the economy will be in a new equilibrium with a higher unemployment rate for ever. But how does the economy behave if $p_{k,t}$ and G_t are not constant sequences? Will the above result about crowding out hold? We turn to that question next.

9   Main Results

This section presents the main results of the paper. First, we show that increased government spending lowers consumption. Second, we show that a temporary increase in government purchases can increase employment in the short-run.

The following proposition compares two economies: one with and one without government intervention. We hold the state of expectations fixed. The proposition states that there is a *crowding out* effect: private consumption will be lower in the economy with government spending.[5]

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[5]It is easy to extend this result to the case where expenditure is positive in the second

Proposition 1 *Consider two economies with the same state of expectations $\{p_{k,s}\}_{s=t}^{\infty}$ but with different feasible non-negative expenditure sequences $\{G_s\}_{s=0}^{\infty}$ and $\left\{\tilde{G}_s\right\}_{s=0}^{\infty}$. Let $\left\{\tilde{G}_s\right\}_{s=0}^{\infty}$ be equal to zero for all s. Let there be a date T such that $G_s = 0$ for all $s > T$ and $G_s > 0$ for all $s \leq T$. Then there is crowding out in the following sense. If $\{C_s\}_{s=t}^{\infty}$ is the sequence of private consumption in the first economy and if $\{\tilde{C}_s\}_{s=t}^{\infty}$ is the sequence of private consumption in the second economy then $\tilde{C}_s > C_s$ for all $s < T$.*

Proof. *See Appendix A.* ■

Figure 5 presents evidence that crowding out did occur during WWII. The figure illustrates consumption and GDP, both measured in wage units.
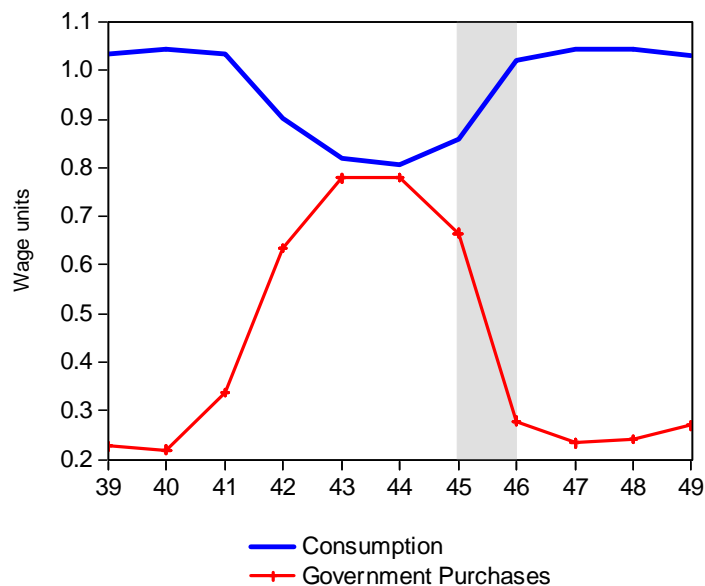

Figure 5: Crowding Out of Consumption Expenditure During WWII

A statement about the exact effect of a government expansion on unemployment is more difficult to prove. Ideally one would want to have a

economy but lower than in the first economy in every period. The extension of the proof is straightforward and is omitted.

condition for each sequence of government expenditures that would tell us, depending on parameter values and the state of expectations, whether such a policy will decrease or increase employment in the current and the following periods. We have not been able to prove a statement with this degree of generality.

Instead, we focus on a specific class of non-stationary fiscal policies, inspired by the experience of actual fiscal policy before and after WWII.
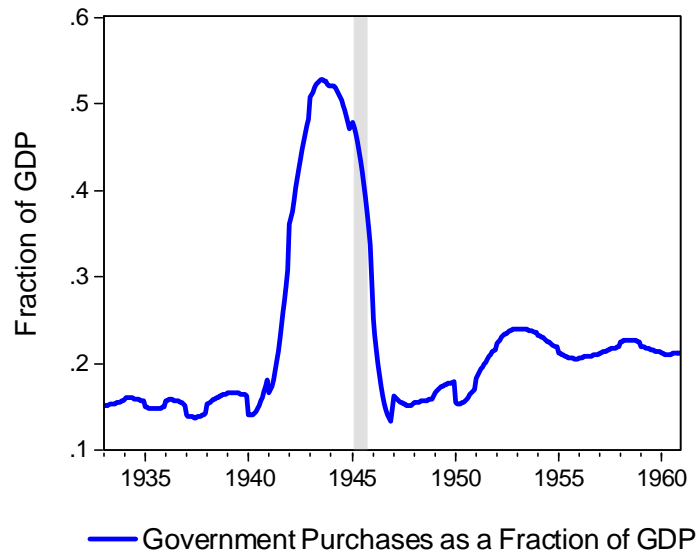

Figure 6: Government Purchases as a Fraction of GDP

Figure 6 shows that government purchases were approximately 16% of GDP before WWII. During the war they peaked at 52% and at the end of WWII they increased permanently to a new higher level of 23% of GDP.

We characterize this policy by studying the class of fiscal expansions depicted in Figure 7. We compare two economies with the same state of expectations but different fiscal policies. In the *control* economy there is a predetermined sequence of government expenditures $\tilde{G}_s$. In the *treatment* economy government expenditure increases by a fixed factor, $\Delta > 1$ at time

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$s = t_1{}^6$ and remains at $\Delta \cdot \tilde{G}_t$ for $t_2 - t_1$ periods. After period t_2, expenditure reverts to the sequence $\tilde{G}_s$. Figure 7 depicts a special case of this class where $\left\{ \tilde{G}_t \right\}$ is constant for $s < t_2$ and increases to a new higher level after date t_2.
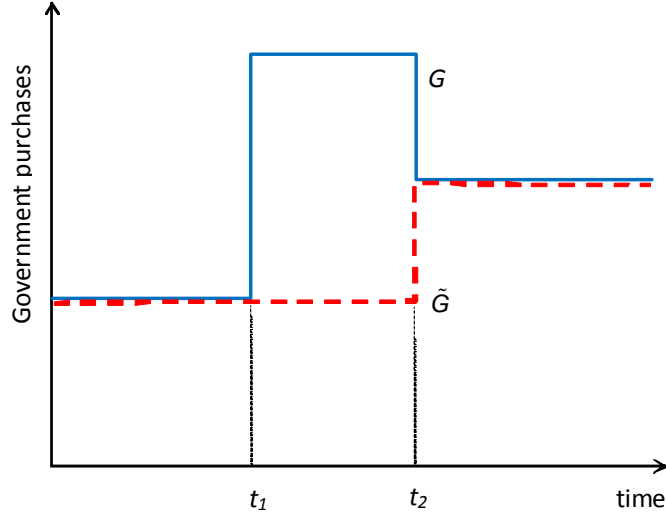

Figure 7: Government Purchases in the Treatment and Control Economies

Given these policies we prove that the change in fiscal policy reduces unemployment during the expansion period at the cost of higher unemployment before the expansion. If the policy is unanticipated, it reduces unemployment during the expansion period with no cost. This corresponds to the case $t_1 = 0$.

Proposition 2 *Consider two economies with the same state of expectations $\{p_{k,s}\}_{s=t}^{\infty}$ but with different feasible non-negative expenditure sequences $\{G_s\}_{s=0}^{\infty}$ and $\left\{ \tilde{G}_s \right\}_{s=0}^{\infty}$ in "treatment" and "control" economies. Let these sequences satisfy the properties,*

$$
G_s = \begin{cases} \tilde{G}_s & \text{if } s < t_1 \\ \Delta \times \tilde{G}_s & \text{if } t_1 \leq s \leq t_2, \ \ \Delta > 1 \\ \tilde{G}_s & \text{if } t_2 < s \end{cases}
$$

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[6]This experiment makes sense if $\tilde{G}_s > 0$ which we assume from now on.

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These assumptions imply that the treatment economy undergoes a fiscal expansion during the time interval $\{t_1...t_2\}$. Let $\{U_s \equiv 1 - L_s\}$ and $\left\{\tilde{U}_s \equiv 1 - \tilde{L}_s\right\}$ be the unemployment rates in each economy. There exists an integer $T \geq 1$, where $t_2 \equiv t_1 + T$, such that,

Part 1 $U_s = \tilde{U}_s$ for $s > t_2$

Part 2 $U_s > \tilde{U}_s$ for $s < t_1$

Part 3 $U_s < \tilde{U}_s$ for $t_1 \leq s \leq t_2$ where $\Delta > 1$ is a constant.

Proof. *See Appendix B.* ∎

Part 3 of Proposition 2 implies that a temporary fiscal policy expansion will reduce unemployment and it provides a basis for understanding why the boost in government purchases that occurred in 1941-1945 resulted in the end of the Depression. This proposition implies that a boost to fiscal spending will be effective at increasing employment for a finite time.

Our next proposition discusses the effect of changing the length of the expansion period on the effectiveness of fiscal policy. One might think that government would want to increase the length of the fiscal expansion in order to exploit the benefit of an increase in government expenditure on the unemployment rate. Proposition 3 implies that a permanent increase in government expenditure at time $s = t_1$ will have *no* effect on the unemployment rate. Moreover, the positive effect on the unemployment rate at the beginning of the expansion becomes smaller at an exponential rate as the anticipated length of the expansion increases.

Because we are interested in the asymptotic behavior of GDP, we need to specify what happens to government expenditure in the limit. We will focus our analysis on the case when the share of government expenditure to GDP is constant as $t_2 \to \infty$. We distinguish two cases. As $t_2 \to \infty$:

$$\lim_{s \to \infty} \beta \left(1 + \alpha \frac{G_s}{p_{k,s}} \right) \equiv \beta \left(1 + \alpha x \right) < 1,$$
$$\lim_{s \to \infty} \beta \left(1 + \alpha \Delta \frac{G_s}{p_{k,s}} \right) \equiv \beta \left(1 + \alpha \Delta x \right) \geq 1, \qquad \text{(Condition A)}$$

Or

$$\lim_{s \to \infty} \beta \left(1 + \alpha \frac{G_s}{p_{k,s}} \right) \equiv \beta \left(1 + \alpha x \right) < 1,$$
$$\lim_{s \to \infty} \beta \left(1 + \alpha \Delta \frac{G_s}{p_{k,s}} \right) \equiv \beta \left(1 + \alpha \Delta x \right) < 1. \qquad \text{(Condition B)}$$

The first inequality that is common to Condition A and Condition B is necessary for the expenditure plan $\left\{ \tilde{G}_s \right\}$ to be feasible given that households hold expectations $\{ p_{k,s} \}$. The second inequality of Condition A will be satisfied if the increase in government purchases, represented by Δ, is large enough. In this case Proposition 3 implies that a boost to fiscal spending will only be effective at increasing employment for a limited time.

The second inequality of Condition B implies that the fiscal expansion is relatively small. Proposition 3 states that in this case an expansion in government spending, that is known to end at a some future date, will lower unemployment for an arbitrarily long period of time. But the longer the policy is expected to last, the less effective it will be when it is first implemented. Moreover, effectiveness at date t_1, decreases exponentially as $t_2 \to \infty$.

Proposition 3 *Consider two economies with the same state of expectations* $\{ p_{k,s} \}_{s=t}^{\infty}$ *but with different feasible non-negative expenditure sequences* $\{ G_s \}_{s=0}^{\infty}$ *and* $\left\{ \tilde{G}_s \right\}_{s=0}^{\infty}$ *in "treatment" and "control" economies. Let these sequences satisfy the properties,*

$$
G_s = \begin{cases} \tilde{G}_s & \text{if } s > t_2 \\ \Delta \times \tilde{G}_s & \text{if } t_1 \leq s \leq t_2, \ \ \Delta > 1 \\ \tilde{G}_s & \text{if } s < t_1 \end{cases}
$$

Let $\{U_s\}$ and $\{\tilde{U}_s\}$ be the unemployment rates in each economy and let $\Delta > 1$ and $x > 0$ be constants. Then

1. *$U_s = \tilde{U}_s$ for $s > t_2$*

2. *$U_s > \tilde{U}_s$ for $s < t_1$*

    (a) *If Condition A holds then there exists an integer $T \geq 1$ such that*

        i. *If $|t_2 - t_1| \leq T$ then $U_s < \tilde{U}_s$ for $t_1 \leq s \leq t_2$*
        ii. *If $|t_2 - t_1| > T$ then $U_s > \tilde{U}_s$ for $t_1 \leq s < t_2 - T$ and $U_s < \tilde{U}_s$ for $t_2 - T \leq s \leq t_2$*

    (b) *If Condition B holds then $U_s < \tilde{U}_s$ for $t_1 \leq s \leq t_2$, but for all fixed $\bar{s} \in [t_1, t_2)$ $U_{\bar{s}} \to \tilde{U}_{\bar{s}}$ as $t_2 \to \infty$ monotonically at an exponential rate.*

Proof. *See Appendix C.* ∎

Note that as a special case, Proposition 3 states that if Condition B holds and if $t_2 = \infty$, then $U_s = \tilde{U}_s$ for all $s \geq t_1$. In other words, the fiscal expansion has no effect on the unemployment rate.

10 An Application to the Data

Our theory predicts that movements in the unemployment rate are caused by movements in aggregate demand. In the model, demand consists of government purchases and consumption since we are ignoring fluctuations in

investment. To address the plausibility of our explanation, we took the observed movements in wealth and government purchases from the data and we used them to infer the implied movements in consumption from the model.

Equations (1), (2) and (6) imply that consumption is related to wealth and government purchases by the following expression,

$$C_t = \frac{p_{k,t} C_{t+1}}{\beta \left(\alpha C_{t+1} + p_{k,t+1} + \alpha G_{t+1} \right)}. \tag{16}$$

We used government purchases from the NIPA accounts and the S&P 500 and we deflated both series by a measure of the nominal wage. The wage series was also constructed from NIPA data using the methodology described in Farmer (2010b). Using these series we fixed C_T where $T = 1947$ and we calculated the implied consumption series by setting $\alpha = 0.33$, $\beta = 0.96$ and using the actual values of the series on government expenditure and the stock market $\{G_s, p_{k,s}\}_{s=1929}^{1947}$, by solving Equation (16). The result of this experiment is graphed in Figure 8.
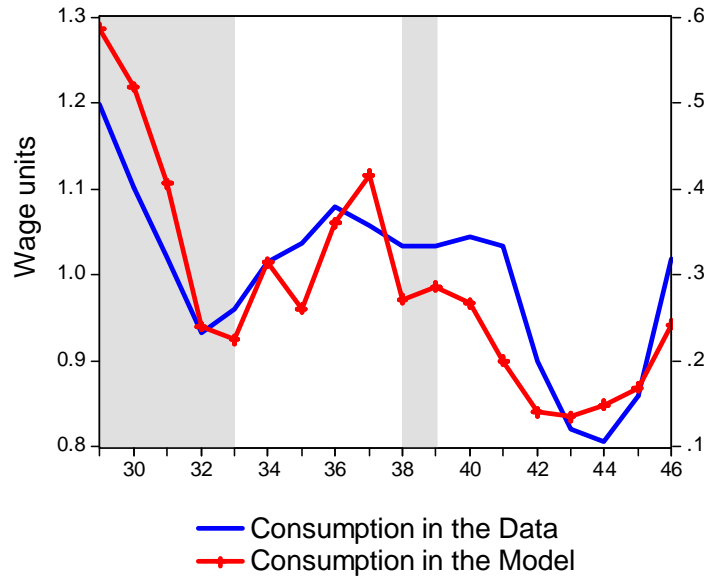

Figure 8: Consumption in the Data and in the Model

Since the S&P is an index number, the units of our real wealth variable are only defined up to a scalar multiple where the weight attached to each data point reflects money prices at the inception date of the index. We normalized the value of the index by scaling the S&P series by 579, a value that implies that the economy was in a steady state in 1929. This scaling factor, μ, is defined by the steady state relationship

$$\mu = \frac{C_{1929} + G_{1929}}{p_{k,1929}} \frac{\beta\alpha}{(1-\beta)}. \tag{17}$$

Figure 9: Unemployment in the Data and in the Model

The model predicts that consumption is related to wealth. Since the S&P is only a partial measure of all tangible assets, our model is unlikely to capture all of the movements in employment and consumption in the data. We would hope, however, the model is capable of capturing the movements in the consumption series implied by changes in government expenditure and in stock market wealth. The fact the actual and model series for consumption

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move relatively closely gives us some encouragement that the theory is on the right track.

In Figure 9 we plot the unemployment rate in the data and the unemployment rate implied by our model using Equation (11) where Z_t is the sum of the actual government expenditure series and the consumption series implied by our model.

We have more confidence in the *movements* of this series than in its *level* which is sensitive to a normalization constant that defines the supply of labor. Notice that our model is able to capture the reduction in the unemployment rate as the US economy gears up for WWII which occurs as a result of the huge increase in government purchases that began in 1941.

We can also use our model to ask a second question. What would have happened to the unemployment rate in the early 1940s if the government had not increased expenditures from 16% to 52% of the economy and if the stock market had followed the same path that we observed during this period? To answer this question we took the same series for $p_{k,t}$, but we fed in a different series for government expenditures for the years $1941-1945$ by assuming that government spending during these years remained at the 1940 level. Since we are treating the state of expectations as an independent variable, that is a legitimate question within the context of the model. Figure 10 presents results of this experiment. The actual unemployment rate is plotted on the left axis and the model unemployment rate on the right.
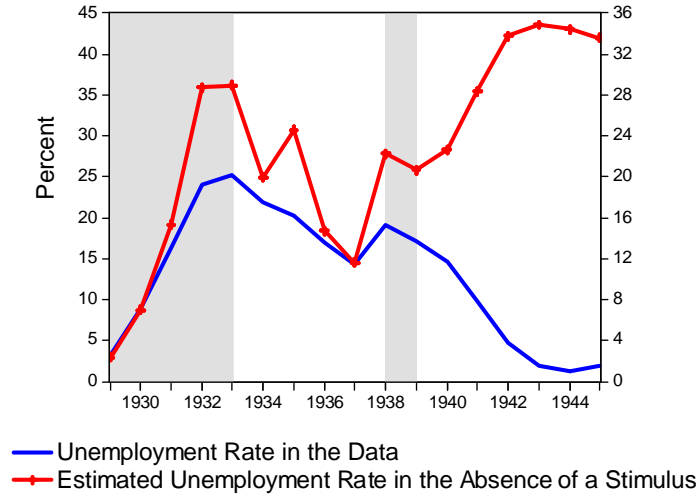
Figure 10: Predicted Unemployment without a Fiscal Stimulus

The model predicts that without a large fiscal stimulus, and conditional on the actual path of the stock market, the unemployment rate would have increased dramatically in the early 1940s. These findings are consistent with propositions 1 and 2 which show that a *temporary* increase in government expenditure is predicted to crowd out consumption and reduce unemployment.

11   Conclusion

To summarize, the paper studies the effect of an expansionary fiscal policy on output and employment in the economy using Farmer's (2010b) old-Keynesian framework. We find that expansionary fiscal policy increases economic activity and reduces unemployment in the short-run at the cost of reduced consumption.   If the stimulus is foreseen, there will be an additional cost of reduced employment in the years leading up to the increase in government purchases.

Given its simplicity, the model does a good job of fitting actual data for the period of the Great Depression and the early years of WWII. It is encouraging that the dynamic version of the model can explain why a fiscal stimulus increased employment in the 1940s since the steady state version of the same model implies 100% crowding out of consumption and no effect on the unemployment rate.

But the fact that a temporary fiscal stimulus can be shown to increase employment does not mean that it is the right policy to cure a depression. The crowding out of consumption that occurs in the model implies a substantial welfare loss associated with increased government expenditure unless the government purchases goods that have a significant social value. That clearly *was* the case in WWII since the US was fighting for its survival. Most of the newly employed people were directed to the war effort either directly by enlisting in the army or indirectly by producing munitions.

The case for fiscal stimulus in the current crisis is less clear. If the economy is not self-correcting as Keynes believed, a large fiscal expenditure may not be the best way to restore full employment. In the model we have outlined in this paper, it is critical to increase the value of confidence in the value of private wealth in order to permanently restore jobs.

Appendix A: Proof of Proposition 1

To prove Proposition 1 we first prove:

Lemma 1: *If there exists a date s for which $\tilde{C}_{s+1} > C_{s+1}$ then $\tilde{C}_s > C_s$.*

Proof. Combining equations (1), (2) and (6), it follows that $\{\tilde{C}_s\}_{s=t}^{\infty}$ satisfies the equation

$$\frac{1}{\beta}\frac{p_{k,s}}{\tilde{C}_s} = \alpha + \frac{p_{k,s+1}}{\tilde{C}_{s+1}}, \tag{A1}$$

and $\{C_s\}_{s=t}^{\infty}$ satisfies

$$\frac{1}{\beta}\frac{p_{k,s}}{C_s} = \alpha + \frac{p_{k,s+1}}{C_{s+1}} + \alpha\frac{G_{s+1}}{C_{s+1}}. \tag{A2}$$

Dividing (A2) by (A1) and defining

$$f(x) = \frac{1}{\beta}\frac{p_{k,t}}{x} - \alpha, \tag{A3}$$

we have

$$\frac{f(C_s)}{f(\tilde{C}_s)} = \frac{\tilde{C}_{s+1}}{C_{s+1}}\left[1 + \alpha\frac{G_{s+1}}{p_{k,s+1}}\right]. \tag{A4}$$

Since $f(x)$ is decreasing in x, it follows that if

$$\frac{\tilde{C}_{s+1}}{C_{s+1}}\left[1 + \alpha\frac{G_{s+1}}{p_{k,s+1}}\right] > 1, \tag{A5}$$

then $\tilde{C}_s > C_{s+1}$. QED ∎

Proof of Proposition 1. Note that $\tilde{C}_{T+1} = C_{T+1}$ and $\{G_s = 0\}_{s=T+1}^{\infty}$ since the economies are identical from date $T + 1$ onwards, it follows from (A1) and (A2) that $\tilde{C}_T = C_T$. Since $G_s/p_{k,s} > 0$ for $s \leq T$,

$$\frac{\tilde{C}_T}{C_T}\left[1 + \alpha\frac{G_T}{p_{k,T}}\right] > 1. \tag{A6}$$

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But then, it follows from Lemma 1 that $\tilde{C}_s > C_s$ for $s < T$. QED ∎

Appendix B: Proof of Proposition 2

Proof. It follows from Equation (11) and the definitions of U_t and $\tilde{U}_t$ that

$$U_s < \tilde{U}_s \iff Z_s > \tilde{Z}_s. \tag{B1}$$

Thus, instead of proving a statement about a relationship between unemployment rates, we can prove an equivalent statement about GDP.

Combining (1) and (3) gives the following expressions that must hold in each economy

$$\frac{1}{\beta}\frac{p_{k,s}}{C_s} = \frac{p_{k,s+1}}{C_{s+1}} + \alpha\frac{G_{s+1} + C_{s+1}}{C_{s+1}}, \tag{B2}$$

$$\frac{1}{\beta}\frac{p_{k,s}}{\tilde{C}_s} = \frac{p_{k,s+1}}{\tilde{C}_{s+1}} + \alpha\frac{\tilde{G}_{s+1} + \tilde{C}_{s+1}}{\tilde{C}_{s+1}}. \tag{B3}$$

Proof of Part 1: By assumption, the sequence of government expenditures is the same in both economies for $s > t_2$. It follows that

$$C_s = \tilde{C}_s \quad \forall s > t_2 \tag{B4}$$

Combining Equation (B4) with the national accounting identity for $s > t_2$ we obtain that $Z_s = \tilde{Z}_s \quad \forall s > t_2$. This proves Part 1.

Proof of Part 2

Note that, by assumption, there is a fiscal expansion in the treatment economy during the period $[t_1, t_2]$. It follows from Proposition 1, that

$$C_s < \tilde{C}_s \quad \forall s < t_2 \tag{B5}$$

But $G_s = \tilde{G}_s$ if $s < t_1$. It follows from the national income accounting

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identity that $Z_s < \tilde{Z}_s, \quad \forall s < t_1$. This proves Part 2.

Proof of Part 3.

We must show that if $|t_2 - t_1| \leq T$ where T is a fixed number then

$$C_s + G_s > \tilde{C}_s + \tilde{G}_s \quad \forall t_1 \leq s \leq t_2. \tag{B6}$$

Suppose first that $T = |t_2 - t_1| = 1$. Since $C_T = \tilde{C}_T$, and $G_T > \tilde{G}_T$, it follows immediately that $Z_T > \tilde{Z}_T$ and hence a one period increase in government expenditure increases GDP. To establish that T may be greater than 1, consider the following change of variables. Divide both sides of Equation (B6) by $\tilde{C}_s$ and define $\tilde{y}_s$ and y_s,

$$\tilde{y}_s \equiv \frac{\tilde{G}_s}{\tilde{C}_s}, \quad y_s \equiv \frac{G_s}{C_s}. \tag{B7}$$

Since we assume that, for $t_1 \leq s \leq t_2$,

$$\frac{G_s}{\tilde{G}_s} \equiv \Delta > 1, \tag{B8}$$

some simple algebra establishes that inequality (B6) is equivalent to the statement

$$\Delta > \frac{\frac{1}{\tilde{y}_s} + 1}{\frac{1}{y_s} + 1} \equiv \frac{1 + \tilde{y}_s}{g(s) + \tilde{y}_s} \equiv f(s), \tag{B9}$$

for all $t_1 \leq s \leq t_2$ where $g(s) \equiv \frac{\tilde{y}_s}{y_s}$. To establish (B9), we will show (1) that $\tilde{y}_s$ and y_s each satisfy a non-autonomous quasi-linear difference equation (2) that $\tilde{y}_s = y_s$ for $s > t_2$ (3) $g(t_2 + 1) = 1$ and (4) $g(s) < g(s + 1)$ for $t_1 < s < t_2$. Together, these statements imply that $f(t_2 + 1) = 1 < \Delta$ and that $f(s)$ is increasing as we move backwards in time from t_2. Since (B9) is equivalent to (B6), for all s for which $f(s) < \Delta$, a fiscal expansion increases GDP and reduces unemployment. We now turn to the properties of $f(s)$ by showing that (1)–(4) hold.

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(1) Define two exogenous variables $\tilde{x}_s$ and x_s

$$\tilde{x}_s \equiv \frac{\tilde{G}_s}{p_{k,s}}, \quad x_s \equiv \frac{G_s}{p_{k,s}}, \tag{B10}$$

and let

$$\lambda_s \equiv \beta \left(\frac{x_s}{x_{s+1}} + \alpha x_s \right), \quad \theta_s \equiv \alpha \beta x_s, \tag{B11}$$

and

$$\tilde{\lambda}_s \equiv \beta \left(\frac{\tilde{x}_s}{\tilde{x}_{s+1}} + \alpha \tilde{x}_s \right), \quad \tilde{\theta}_s \equiv \alpha \beta \tilde{x}_s. \tag{B12}$$

Using these definitions, it follows from equations (B2) and (B3) that $\{y_s\}$ and $\{\tilde{y}_s\}$ are characterized by the following simple recursions:

$$y_s = \lambda_s y_{s+1} + \theta_s, \tag{B13}$$

and

$$\tilde{y}_s = \tilde{\lambda}_s \tilde{y}_{s+1} + \tilde{\theta}_s. \tag{B14}$$

This establishes (1).

(2) Notice that from date $t_2 + 1$ onwards both economies are identical and hence

$$\tilde{y}_{t_2+1} = y_{t_2+1}. \tag{B15}$$

This establishes (2).

(3) Since $\tilde{y}_{t_2+1} = y_{t_2+1}$ it follows from the definition of $g(s)$ that $g(t_2 + 1) = 1$. This establishes (3).

(4) Notice that for $t_1 \le s \le t_2$

$$\theta_s = \Delta \tilde{\theta}_s > \tilde{\theta}_s, \quad \text{and} \quad \tilde{\lambda}_s > \lambda_s. \tag{B16}$$

For $s = t_2$

$$\lambda_s = \Delta \tilde{\lambda}_s > \tilde{\lambda}_s, \tag{B17}$$

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while for $t_1 \leq s < t_2$,

$$\lambda_{t_2} = \beta \left(1 + \alpha \Delta x_{t_2}\right) > \beta \left(1 + \alpha x_{t_2}\right) = \tilde{\lambda}_{t_2}. \tag{B18}$$

Moving backwards in time from t_2, it follows from (B13)–(B18) that for $t_1 \leq s \leq t_2$,

$$\frac{y_s}{y_{s+1}} > \frac{\tilde{y}_s}{\tilde{y}_{s+1}}, \tag{B19}$$

and hence

$$g\left(s\right) = \frac{\tilde{y}_s}{y_s} < \frac{\tilde{y}_{s+1}}{y_{s+1}} = g\left(s+1\right). \tag{B20}$$

This establishes (4).

We have established that $f\left(t_2\right) = 1 < \Delta$ and that $f\left(s\right)$ is increasing as s moves back in time from t_2. It follows that there exists a $T \geq 1$ such that $f\left(s\right) | s \in \{t_2 - T, ...t_2\} < \Delta$. QED. ∎

Appendix C: Proof of Proposition 3

Proof. Using the notation from the proof of Proposition 2, there are two possible cases: either at some $s = t_2 - T$, $f\left(s\right) > \Delta$ or $f(s) \to \Delta$ as $s \to -\infty$. The first case correspond to Condition A and the second corresponds to Condition B. It follows from Condition A that for sufficiently small s,

$$\lambda_s \equiv \beta \left(\frac{\tilde{x}_s}{\tilde{x}_{s+1}} + \alpha \Delta \tilde{x}_s\right) \geq 1, \tag{C1}$$

and

$$\tilde{\lambda}_s \equiv \beta \left(\frac{\tilde{x}_s}{\tilde{x}_{s+1}} + \alpha \tilde{x}_s\right) < 1. \tag{C2}$$

These inequalities imply that the gap between $\tilde{y}_s$ and y_s will grow as s decreases from t_2 and hence there must be a T such that at $s = t_2 - T$, $f\left(s\right) > \Delta$. At this point the fiscal expansion will lower output and increase unemployment. This establishes that T is finite if Condition A holds.

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Now suppose that Condition B holds. Recall (B9), which we restate below

$$\Delta > \frac{\frac{1}{\tilde{y}_s} + 1}{\frac{1}{y_s} + 1} \equiv \frac{1 + \tilde{y}_s}{g(s) + \tilde{y}_s} \equiv f(s). \tag{C3}$$

We established in the proof of Proposition 2 that y_s and $\tilde{y}_s$ satisfy the recursions

$$y_s = \lambda_s y_{s+1} + \theta_s,$$

and

$$\tilde{y}_s = \tilde{\lambda}_s \tilde{y}_{s+1} + \tilde{\theta}_s,$$

and since we restrict ourselves to the case where $x_s \to x$ as $s \to -\infty$,[7] it follows from Condition B that $\lambda_s, \tilde{\lambda}_s, \theta_s$ and $\tilde{\theta}_s$ are constants in the limit and that λ_s and $\tilde{\lambda}_s$ are both positive and less than one. Hence as $s \to -\infty$

$$y_s \to y = \frac{\theta}{1 - \lambda}, \tag{C4}$$

and

$$\tilde{y}_s = \tilde{y} = \frac{\tilde{\theta}}{1 - \tilde{\lambda}}. \tag{C5}$$

From the definitions of $\lambda_s, \tilde{\lambda}_s, \theta_s$ and $\tilde{\theta}_s$ and the definition of $f(s)$ one can establish that as $s \to -\infty$

$$f(s) \to \frac{\frac{1-\beta}{\alpha\beta\tilde{x}}}{\frac{1-\beta}{\alpha\beta\Delta\cdot\tilde{x}}} = \Delta. \tag{C6}$$

Since establishing that $f(s) = \Delta$ is equivalent to showing that (B6) holds as an equality we have shown that a fiscal expansion that is expected to persist for an arbitrarily long period will have an arbitrarily small effect on GDP and employment. QED ∎

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[7]This is identical to the statement that government purchases constitute a constant share of GDP since in the long-run GDP itself is proportional to $p_{k,s}$.

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