Comment on Eggertsson, "What Fiscal Policy Is Effective at Zero Interest Rates?"
Paper and comment forthcoming in NBER Macroeconomics Annual, 2010
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July 29, 2010

1. Introduction

This paper represents an important contribution to the analysis of fiscal policy in the New Keynesian model when the zero lower bound on the nominal interest rate is binding. The paper accomplishes a lot. It analyzes two types of taxes on capital and labor, the investment tax credit, a sales tax and two types of government spending. It deserves to be an important reference on fiscal policy in a binding zero lower bound. In my discussion, I focus on the subset of Eggertsson's results that initially surprised me and that I think will surprise many other readers too.

Eggertsson shows that if output collapses because of a binding zero lower bound, then a cut in the household labor income tax is likely to simply aggravate the collapse. A binding zero bound causes a recession by triggering a fall in the demand for goods. Eggertsson's result is surprising because it seems to contradict a long-standing centerpiece of Keynesian orthodoxy. According to that orthodoxy, cutting taxes in a recession - particularly one caused by inadequate aggregate demand - helps to stimulate the economy. As it turns out, there is no contradiction between Eggertsson's analysis and the Keynesian orthodoxy. The New Keynesian model replaces the orthodox Keynesian transmission mechanism for taxes with a different mechanism. In the orthodox analysis - featured in standard undergraduate macroeconomics textbooks - consumption is principally determined by current disposable income and a tax cut stimulates spending by raising disposable income. In the standard New Keynesian environment adopted by Eggertsson, households are Ricardian. They set consumption as a function of lifetime wealth, and this is unaffected by a tax cut.

But, Eggertsson's result is nevertheless still surprising. In his environment, an income tax cut affects the economy by stimulating labor supply. Conventional economic reasoning suggests that something which stimulates labor supply will increase output, not accelerate its collapse. But, conventional reasoning is not a good guide about what happens in a binding zero lower bound. The increased labor supply induced by a labor income tax cut leads to a drop in marginal cost and, hence, the price level. When there are price setting frictions, a drop in the price level is accomplished by a period of falling prices. With the nominal interest rate unable to fall, the price deflation necessarily corresponds to a rise in the real interest rate. The increased real rate reduces aggregate demand and, hence, output. This is the mechanism whereby a cut in the labor tax rate magnifies a zero-bound output collapse in Eggertsson's model.

The following section summarizes the intuition behind the output collapse occasioned by a binding zero bound and elaborates on the intuition behind Eggertsson's tax result. I initially describe the result in an environment with price setting frictions, but no wage setting frictions. As emphasized in Christiano, Eichenbaum and Evans (2005) and Smets

[1]In preparing this comment, have benefited from conversations with Martin Eichenbaum and Daisuke Ikeda.

and Wouters (2007), to successfully match aggregate data it is essential to also include wage setting frictions. The presence of wage setting frictions has important implications for the magnitude of the impact of a change in the labor tax rate. Without wage setting frictions, the impact can be enormous and with these frictions the impact on employment and output may be very small. The intuition for this sensitivity is - as explained by Eggertsson - straightforward. A change in the labor tax rate affects the economy by shifting labor supply and labor supply is largely irrelevant in the New Keynesian model with wage frictions.

The sensitivity of the quantitative impact of a tax change to the presence of wage setting frictions goes away if the tax on labor is instead paid by the employer. This is because a labor tax rate levied on the employer hits firm marginal cost directly, without having to work its way through a potentially irrelevant labor supply curve.

That a cut in the labor tax rate paid by employers may exacerbate a recession is at least as surprising as Eggertsson's result for the household labor income tax rate. For example, a component of the American Recovery and Reinvestment Act of 2009 provides subsidies to firms to help pay the wages of qualified workers. Congress included this provision on the expectation that employment subsidies will stimulate employment. Eggertsson's argument suggest that the subsidies will instead exacerbate the recession by raising the real interest rate.

In my concluding remarks, I draw attention to several broader issues that must be addressed to fully evaluate the practical relevance of Eggertsson's result.

2. Zero Bound, Output Collapse and Marginal Cost

To explain Eggertsson's result, it is useful to briefly review the intuition underlying the economic collapse that can occur when the zero lower bound on the nominal rate of interest binds. Consider Figure 1, which displays the demand and supply of saving. The supply of saving is represented as an increasing function of the real interest rate,

$$\text{real interest rate}=\frac{1+R_t}{1+\pi^e_{t+1}}.$$

Here, R_t denotes the nominal return on household saving from t to $t+1$, and π^e_{t+1} denotes the expectations of inflation over the same period. The vertical line represents the demand for funds. In Eggertsson's model the demand for funds is inelastic at zero. This is because there is nothing to do with savings in his environment. For example, there is no capital in the model. Nothing qualitative depends on this assumption about the demand for saving.

So far, there is no reason to suppose that the zero lower bound on R_t matters. It is the real interest rate that enters the demand and supply of saving, not the nominal interest rate. In principle, π^e_{t+1} could be any positive or negative number, so that non-negativity of R_t does not imply any restriction on the real rate. The zero lower bound matters when we suppose that the public does not expect positive inflation, that is,

$$\pi^e_{t+1} \leq 0. \tag{2.1}$$

In his dissertation, Eggertsson proposed a formal rationale for (2.1). He posited that the monetary authority lacks the ability to commit to its future actions. In addition, households

understand at time t that when the monetary authority sets the realized value of π_{t+1} in $t+1$, it has both the incentive and ability (because it can always tighten monetary policy) to prevent $\pi_{t+1} > 0$. At the same time, it is not always feasible for the monetary authority to prevent deflation, $\pi_{t+1} < 0$. These are the elements of Eggertsson's model which rationalize (2.1). From a more pragmatic perspective, it may be hard for the Federal Reserve to persuade the US public to raise π^e_{t+1} after having spent decades insisting that it will never tolerate a significant increase in inflation. Regardless of how (2.1) is interpreted, it is clear that under (2.1) the non-negativity constraint on the nominal rate of interest implies a non-negativity constraint on the real rate of interest.

Imagine the supply of saving in Figure 1 shifting back and forth, say in response to disturbances in the rate at which households discount future utility. As long as the intersection between supply and demand occurs above the real interest rate lower bound, movements in the real rate can bring about equilibrium without output, consumption and other variables being unduly disturbed.[2] However, suppose that at some point there is a very large jump in the supply of saving, so that loan market clearing cannot be accomplished by a move in the real interest rate. In this case, something else must happen to bring loan supply into line with demand.

In the New Keynesian model, a decline in output helps to shift the supply of funds back to the left for consumption smoothing reasons. If this were all there was to it then there would be a relatively modest recession whose dynamics correspond to the Keynesian 'paradox of thrift' emphasized in undergraduate macroeconomics textbooks. However, in the New Keynesian model this is only part of the story of what happens when the lower bound on the interest rate starts to bind. The rest of the story can be a real disaster.

The problem is that while a drop in income is helping to restore equality between the demand and supply of saving, other forces come into play which increase how much income must fall to maintain equilibrium. In particular, the fall in income sets off a vicious deflation cycle that perversely raises the real rate of interest and thus increases the desire to save. The logic of the deflation cycle is depicted in Figure 2. At the top of the figure we have the decline in spending associated with the rise in saving. The decline in spending produces a fall in output and, hence, in marginal cost. What happens next to expected inflation is crucial. The decline in marginal cost motivates firms to reduce prices. But, what would be an instantaneous drop in the price level in a flexible price environment becomes a period of falling prices when there are Calvo-type price frictions. This happens because only a subset of firms adjust their prices in the period of the fall in marginal cost. The price level falls more in future periods as the other firms also adjust prices. That is, with price setting frictions the drop in marginal cost produces a drop in π^e_{t+1}. With R_t at its lower bound, the drop in π^e_{t+1} necessarily raises the real interest rate. This encourages households to further increase saving and cut back spending, initiating another cycle in Figure 2. This deflation spiral idea

[2] In the Ramsey-optimal equilibrium of a model like Eggertsson's (in which there is no capital), a shock to households' discount rate has no impact on consumption and employment. This is because the equilibrium values of these variables are determined by the resource constraint and the intratemporal efficiency condition. Neither of these equations involves the discount rate. In this equilibrium, the real interest rate simply adjusts recursively to ensure that the intertemporal saving decision is consistent with the Ramsey-optimal level of output and employment. For a recent review of this well known result, see Christiano, Trabandt and Walentin (forthcoming).

is not new to the recent zero lower bound literature. For example, it is the focus of the analysis in DeLong and Summers (1986a,b) and in the earlier literature that they cite.

The deflation spiral idea can be used to evaluate the likely effectiveness of policies designed to address the fall in output associated with a binding zero lower bound. For example, policies that reduce marginal cost are like throwing gasoline on a fire: they only accelerate the deflation spiral that sends the economy into output collapse. On the flip side, anything that raises marginal cost interrupts the deflation spiral and slows or even reverses the collapse in output.

Eggertsson's point is that a cut in household labor income taxes is counterproductive in the zero lower bound because it increases household labor supply and so reduces equilibrium wages. The fall in wages reduces marginal cost and accelerates output collapse, in his model.

3. Impact of Wage-Setting Frictions

I show that introducing wage setting frictions into Eggertsson's model can have a substantial quantitative impact on the quantitative nature of his result. To understand why wage setting frictions might make a difference, consider the supply and demand for labor in Figure 3. Consider the extreme case in which the nominal wage rate (see the horizontal axis) is completely fixed. The assumption is that the quantity of labor is demand determined, so that employment is E. Suppose that initially labor supply is the upward sloped curve to the left. With this curve, the level of employment corresponding to the intersection of demand and supply lies to the right of E. A cut in the labor tax rate has the effect of shifting labor supply to the right. Note that the shift has no impact on employment or the wage rate. In the extreme example in Figure 3, labor supply is irrelevant for price, wage and employment determination. As a result, the impact on labor supply of a change in taxes has no effect at all on the equilibrium. This result is far more extreme than what we find in dynamic models with wage setting frictions, but we now show that Figure 3 does convey the qualitative impact of wage frictions.

3.1. Bringing Wage-Setting Frictions into the Model

I follow the currently-standard Erceg, Henderson and Levin (2000) approach to introducing wage-setting frictions into the model studied by Eggertsson. In the model, a homogeneous final good is produced by a representative, competitive firm using the following technology:

$$Y_t = \left[\int_0^1 Y_{t,i}^{\frac{1}{\lambda_f}} di\right]^{\lambda_f}, \ 1 \leq \lambda_f < \infty. \tag{3.1}$$

The i^{th} intermediate good is produced by a monopolist using the following production function:

$$Y_{t,i} = H_{t,i},$$

where $H_{t,i}$ denotes the quantity of a homogeneous labor input hired by the i^{th} monopolist in a competitive market. The monopolist maximizes profits subject to the demand for its

product, its production function, the wage rate, W_t, and Calvo price setting frictions. The latter are characterized as follows:

$$P_{t,i} = \begin{cases} P_{t-1,i} & \text{with probability } \xi_p \\ \text{chosen optimally} & \text{with probability } 1-\xi_p \end{cases},$$

where $P_{t,i}$ denotes the i^{th} monopolist's time t price.

Homogeneous labor is produced using the following aggregator function by a representative, competitive labor contractor:

$$H_t = \left[\int_0^1 (h_{t,j})^{\frac{1}{\lambda_w}}\, dj\right]^{\lambda_w}, 1 \leq \lambda_w < \infty.$$

Here, $h_{t,j}$ represents the quantity of a $j-$type differentiated labor service hired by the labor contractor at a wage rate, $W_{t,j}$, that it takes as given. The j^{th} type of labor, $h_{t,j}$, is supplied by a monopoly household with the following preferences:

$$E_0 \sum_{t=0}^{\infty} \beta^t \left[\log C_t - A\frac{h_{t,j}^{1+\phi}}{1+\phi}\right], \ \beta \in (0,1), \ A, \phi > 0.$$

The budget constraint is:

$$P_t C_t + B_{t+1} \leq R_{t-1} B_t + (1-\tau_t) W_{t,j} h_{t,j} + \Pi_{t,j},$$

where τ_t is the tax rate on labor income and the wage rate is set subject to Calvo-style frictions:

$$W_{t,j} = \begin{cases} W_{t-1,j} & \text{with probability } \xi_w \\ \text{chosen optimally} & \text{with probability } 1-\xi_w \end{cases}.$$

Here, B_{t+1} represents the household's time t purchase of a nominal bond. Finally, the object, $\Pi_{t,j}$, denotes profits, lump sum taxes and net transfers from an insurance arrangement against the Calvo wage-setting uncertainty. The operation of this insurance market ensures that equilibrium household consumption and saving are independent of j.

The resource constraint for this economy is:

$$C_t = Y_t.$$

I close the model with a characterization of monetary policy. Let Z_t denote the net 'shadow interest rate'. It is set as follows:

$$Z_t = \frac{1}{\beta} - 1 + 1.5\pi_t, \ \beta \in (0,1)$$

where, as before, π_t denotes the net rate of inflation. The actual rate of interest, R_t, is set as follows:

$$R_t = \begin{cases} Z_t & Z_t \geq 0 \quad \text{'zero bound not binding'} \\ 0 & \text{otherwise} \quad \text{'zero bound binding'} \end{cases}.$$

That is, the actual interest rate coincides with the shadow rate if the shadow interest rate is non-negative. Otherwise, the actual interest rate is zero.

3.2. Computational Experiment

In my benchmark parameterization, I set

$$\xi_p = \xi_w = 0.75,\ \beta = \frac{1}{1+r} = 0.99,\ r = 0.01,\ \lambda_w = \lambda_f = 1.20,\ \phi = 1,$$

so that the average amount of time between price and wage reoptimization is one year. In addition, households discount future utility at an annual rate of 4 percent. The object, $1/\phi$, is often interpreted as a Frisch elasticity and it is set here at unity.[3] The steady state price and wage markups are 20 percent.[4]

I conduct the zero bound experiment as follows. The model is in a deterministic steady state until $t = 1$. At $t = 1$, the rate at which period 2 utility is discounted drops from its steady state value of 0.01 (per quarter) to $r = -0.01$. The discount rate remains low for 15 quarters, after which it rises back to its steady state value. The experiment from $t = 1$ and on is fully deterministic. I do not implement Eggertsson's stochastic experiment because the simultaneous presence of both sticky wages and prices appears to inject an endogenous state variable into the system, making Eggertsson's stochastic experiment difficult to implement.[5] For an explanation of this point and for other technical details associated with the computational experiment reported here, see Christiano (2010).

I set the labor tax rate, τ, to 0.30 in the steady state. In the 'no policy response' simulation, the labor tax rate is held at its steady state value throughout the simulation. In the alternative simulation the labor tax rate is increased to $\tau = 0.40$ for as long as the zero lower bound on the interest rate is binding (the period over which the lower bound binds is endogenously determined). In the periods of the alternative simulation when the lower bound is not binding, the labor tax rate is held at its steady state value. Note that in the experiment, it is an increase, not a decrease, in the labor tax rate that I consider. The logic of Eggertsson's analysis implies that this policy intervention should stimulate the economy.

Figure 4 displays the simulation results. In the no policy response simulation the zero bound is binding in periods 1 to 11, and ceases to bind in periods 12 and later. In the alternative simulation with the policy response, the zero bounds ceases to bind one period earlier, in period 11 (see the 1,1 and 2,2 panels). Note that wage and price deflation are -20 and -13 percent per annum respectively, at the beginning of the simulation. Evidently, the real rate of interest is very high. This helps explain the large drop in output. In the no policy response simulation, output drops a little over 35 percent in the first period and does not return to steady state until 15 quarters have elapsed. The impact of the increase in the labor tax rate on the shadow interest rate, Z_t, and on wage and price inflation is substantial. However, the impact on the drop in output and employment is only modest. With the rise in the labor tax rate, the output drop is reduced from a little over 35 percent to 30 percent.

[3] Christiano, Trabandt and Walentin (forthcoming) argue that there is no particular reason to think of $1/\phi$ as a Frisch elasticity. As a result, it is difficult to use empirical evidence on the Frisch elasticity to evaluate the value assigned to ϕ.

[4] Actually, λ_f plays no role in the linearized dynamics of the model when firm marginal cost is constant, as it is here. The wage markup does play a role because households have an upward-sloped marginal cost of working. For the reasons outlined in the literature on firm-specific capital, a smaller value of λ_w has the effect of flattening the wage Phillips curve (see Christiano, Trabandt and Walentin, forthcoming).

[5] I say 'appears to inject' because I did not rule out the possibility that there is a way to rewrite the system so that it has no state variable.

The impact of the degree of wage stickiness on the output drop in the zero bound can be seen in Figure 5. The top panel in the figure repeats the 2,1 panel in Figure 4 for convenience. The 2,1 panel in Figure 5 repeats the simulations for the case, $\xi_w = 0.2$, which corresponds to an average wage duration of 1.25 quarters. In this case, there is relatively little stickiness in wages. Two results are evident in Figure 5. First, consistent with findings reported elsewhere, the increased wage flexibility makes the zero bound far more severe.[6][7] Second, and more relevant to my present objective, the impact of the tax rise is enormous. The tax increase reduces the fall in output in the zero bound by a factor exceeding 4. The 2,2 panel displays the results when wages are more sticky than in the baseline. Consistent with the intuition in this comment, the impact of the tax hike is now virtually nil.

4. Concluding Remarks

Eggertsson's paper represents an eloquent and thoughtful analysis of fiscal policy when the zero bound on the nominal interest rate binds. In principle, this is a very difficult problem to analyze technically. However, Eggertsson's judiciously chosen simplifications enable him to conduct an analysis that is both transparent and interesting.

A full evaluation of Eggertsson's suggestion that a tax cut may be counterproductive when the zero bound binds requires investigating at least two issues. First, in the introduction I mentioned the 'orthodox Keynesian analysis', in which households are non-Ricardian and the primary mechanism by which a change in taxes on household labor income affects the economy operates through changes in household disposable income. If this is in fact the way tax changes operate on the economy, then a tax cut would have the traditional expansionary effect after all, even in a recession caused by a binding zero lower bound. This possibility deserves exploration.[8]

Second, the reason a tax cut - whether paid by the employer or the household - in Eggertsson's analysis causes a substantial drop in output when the zero bound binds is that it accelerates the destructive deflation cycle. As the intuition in the previous section emphasized, two ingredients are key for the existence of such a cycle: (i) that downward pressure on the price level produces deflation over time rather than an instantaneous price drop and (ii) that spending on goods displays substantial sensitivity to the real interest rate. Perhaps (i) is sensible. It is hard to imagine all the firms in a large, complex economy responding fully and simultaneously to a sudden change in costs. But, (ii) seems more debatable. The sensitivity of consumption to the real interest rate is captured by the intertemporal Euler

[6] This is consistent with DeLong and Summers (1986a), who find that given the degree of wage stickiness in US data, an increase in wage flexibility leads to greater volatility. This is also consistent with the results in Christiano, Eichenbaum and Rebelo (2009), who consider an experiment like the one reported here. Holding fixed the size of the shock, they find that the magnitude of the output drop in the zero bound is greater, when price flexibility is increased above the value calibrated to the US economy. As we find here, they find that the increase in the amount by which output drops is very large.

[7] The dop in hours worked in the 2,1 panel is so large that there must surely be substantial error in the linear approximation. I assume that while the precise magnitudes may be off, the qualitative result that the impact of the tax hike is bigger with greater wage flexibility is correct.

[8] Johnson, Parker and Souleles (2009) is an example of the kind of empirical research that is relevant. For an extension of the New Keynesian model to allow for non-Ricardian consumers, see Gali, Lopez-Salido and Valles (2007).

equation and the empirical evidence on this equation is at best mixed. On the one hand, there is the literature starting with the classic work of Hansen and Singleton (1983) which tests and rejects the orthogonality implications of this equation. On the other hand, there is the vector autoregression evidence which estimates the empirical response of consumption and investment to real interest rate movements induced by monetary policy shocks. The estimated dynamic responses in this literature are reasonably similar to the dynamic responses implied by empirical versions of the model studied by Eggertsson.[9] To assess the risks of a deflation cycle, it would be useful to resolve the conflicting implications of (i) and (ii).

[9] See, e.g., Christiano, Eichenbaum and Evans (2005) and Christiano, Trabandt and Walentin (forthcoming) and the literature that they cite.

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[5] DeLong, J. Bradford and Lawrence H. Summers, 1986a, "Is Increased Price Flexibility Stabilizing?," American Economic Review, vol. 76, no. 5, December, pages 1031-1044.

[6] DeLong, J. Bradford and Lawrence H. Summers, 1986b, "The Changing Cyclical Variability of Economic Activity in the United States," in R. J. Gordon, editor, The American Business Cycle: Continuity and Change, National Bureau of Economic Research.

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Figure 1: Consequence of Increase in Saving When
There is Lower Bound on Real Interest Rate

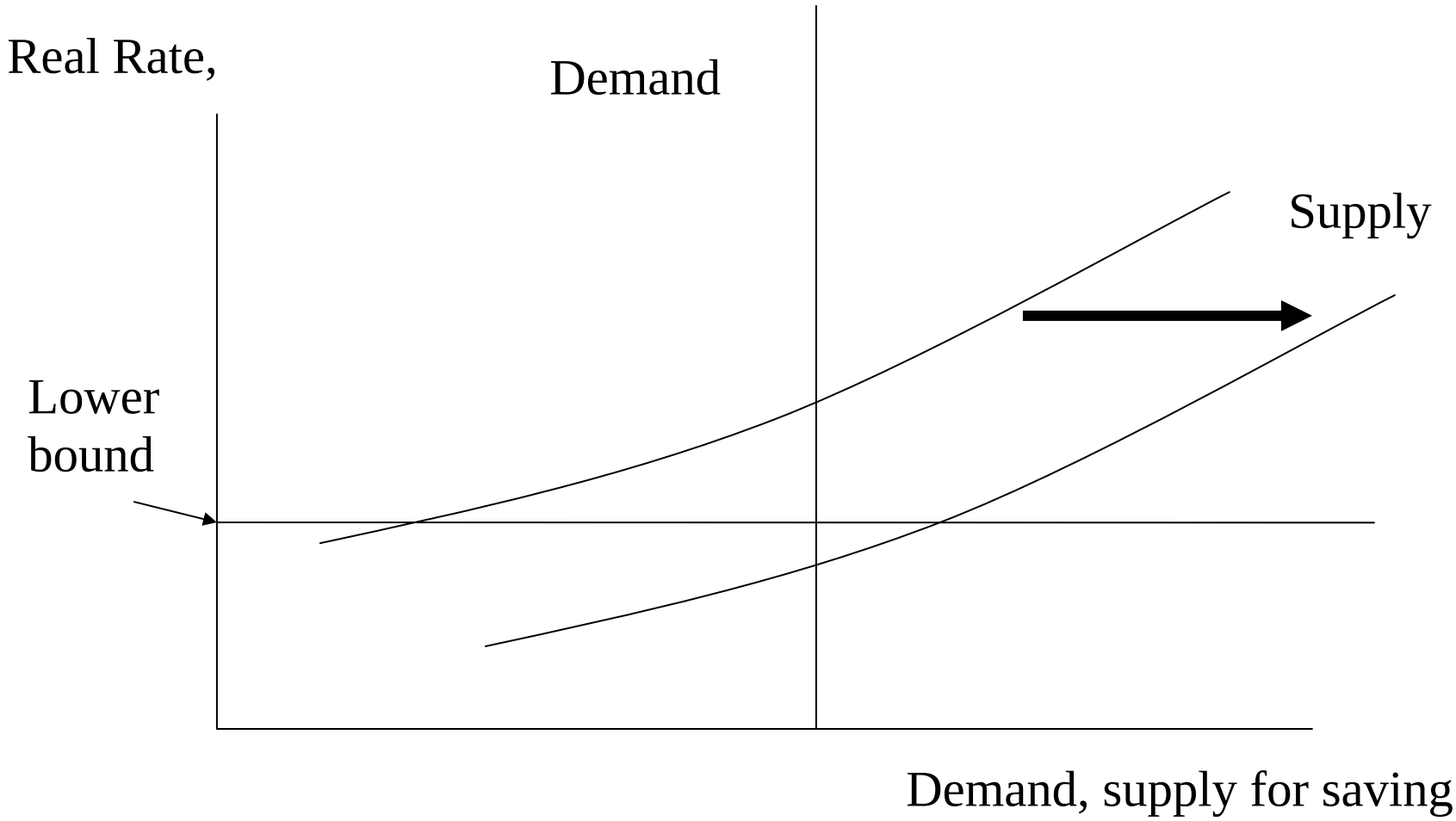


Figure 2: Deflation Spiral in Zero Bound

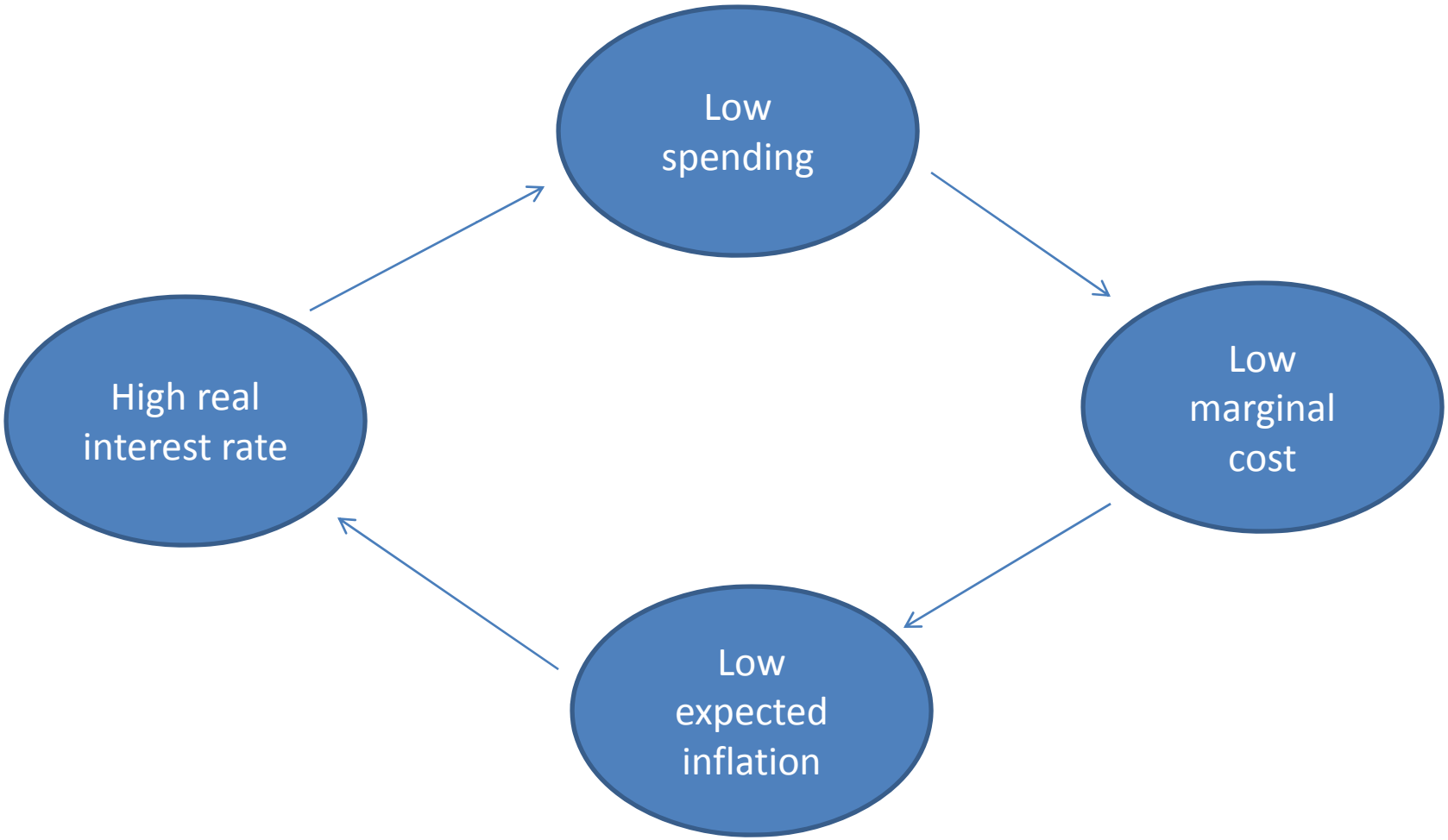


Figure 3: Sticky Wages and Labor Supply

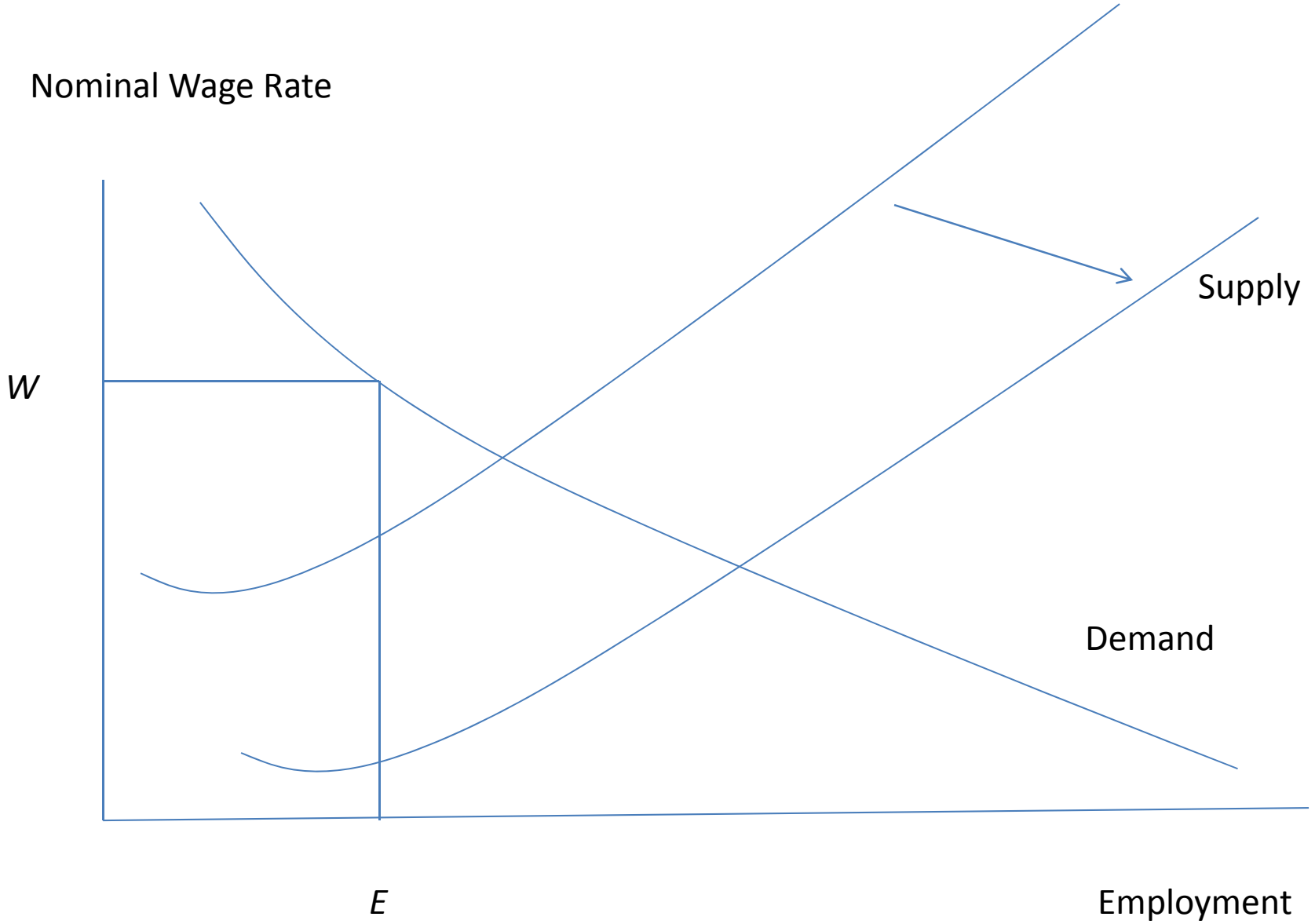
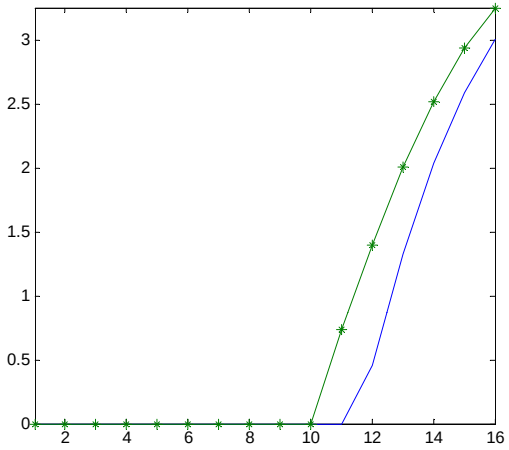
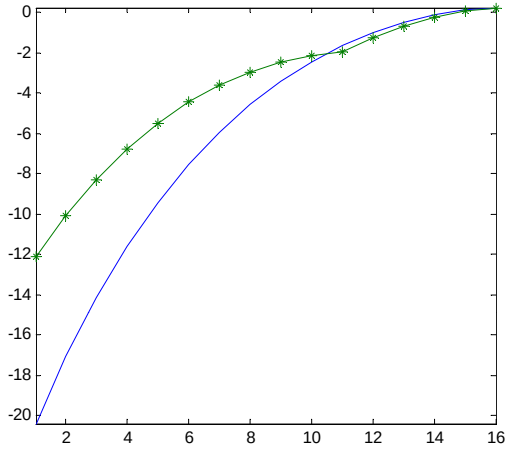


Figure 4: Baseline Simulation

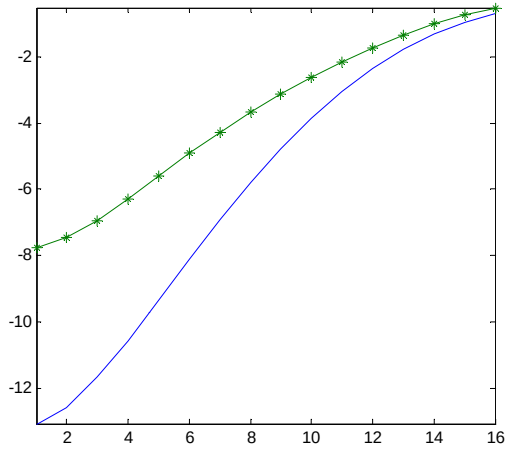
nominal rate of interest, $400*R_t$



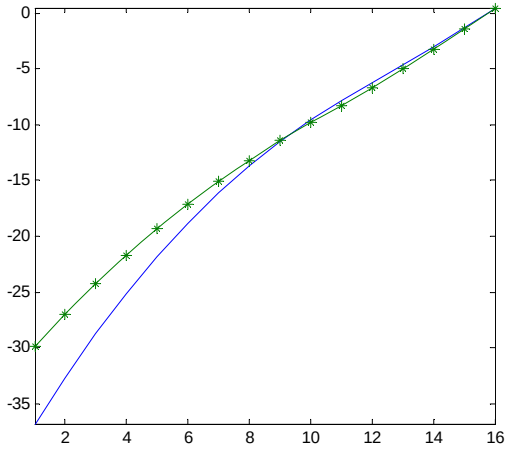
wage inflation, $400*\pi_{w,t}$



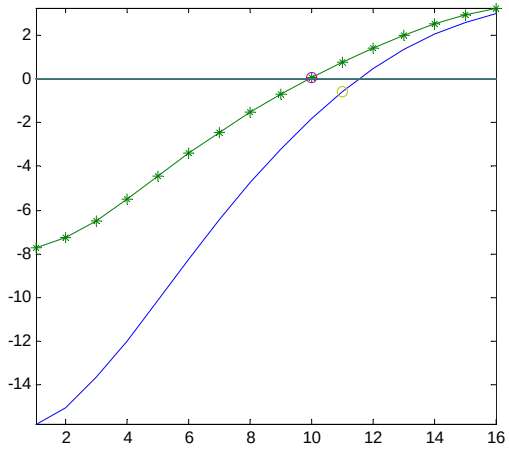
price inflation, $400*\pi_t$



hours, percent deviation from steady state



shadow interest rate, $400*Z_t$



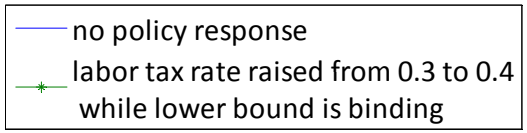
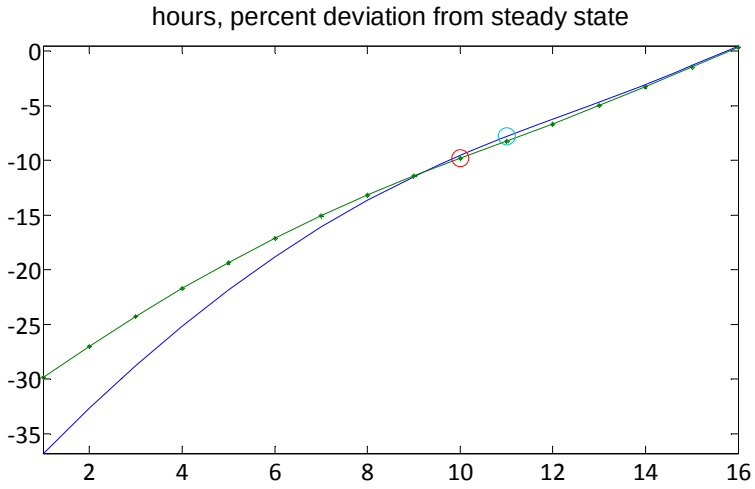


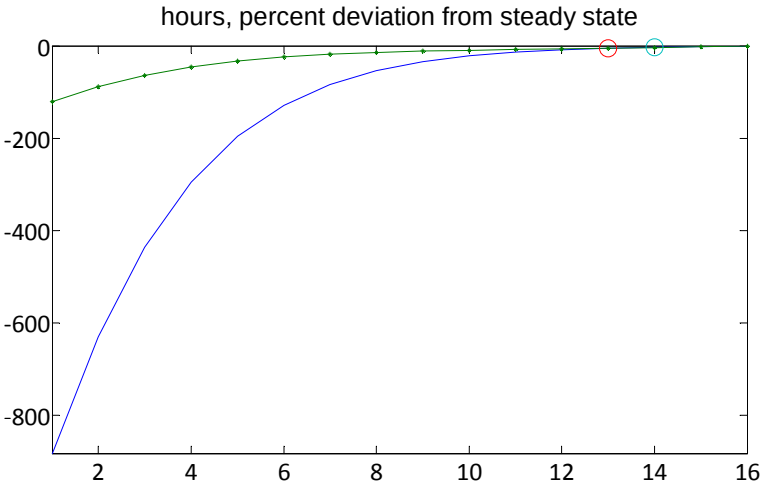
Figure 5: Different Degrees of Wage Stickiness

Time between wage reoptimization = 4 quarters

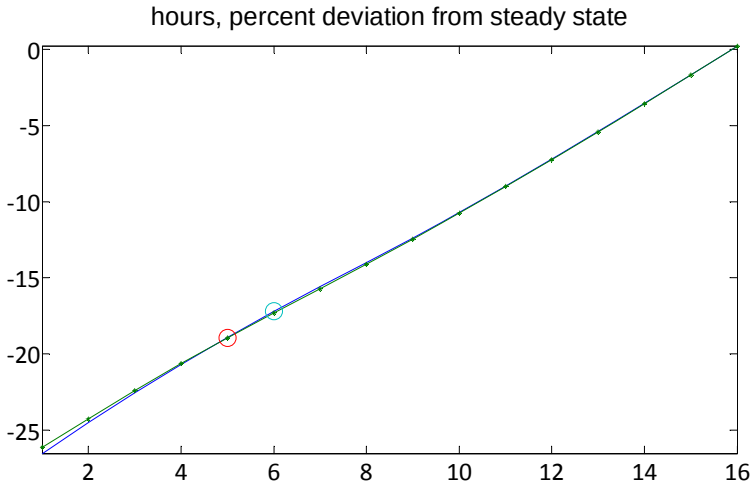
Circles indicate date when zero bound ceases to bind



1.25 quarters



6.7 quarters



Starred line: no policy response, solid line: tax rate increased from 0.30 to 0.40 while zero bound binds