# Uncertainty and Fiscal Cliffs*

-Preliminary and Incomplete-

Troy Davig† Andrew T. Foerster‡

April 5, 2013

**Abstract**

This paper develops and studies a model of the uncertainty generated by expiring tax provisions, such as those associated with the recent "Fiscal Cliff" in the US. The economy progresses towards a specific date at which a time an change in distortionary tax rates may or may not take effect. This source of uncertainty affects the level of expected values of future variables, not simply their variances. As the cliff nears, uncertainty about future tax rates slows investment, consumption, and labor. If the cliff is avoided, the economy experiences a significant rebound in activity, with above-average growth for several periods after the resolution of uncertainty.

*JEL Classification*: E20, E60, E62

*Keywords*: Fiscal Policy, Uncertainty, Distorting taxation

*The views expressed herein are solely those of the authors and do not necessarily reflect the views of the Federal Reserve Bank of Kansas City or the Federal Reserve System. We thank seminar participants at the 2013 Missouri Economics Conference and Florida State for helpful comments.

†Research Department, Federal Reserve Bank of Kansas City, 1 Memorial Drive, Kansas City, MO 64198, troy.davig@kc.frb.org.

‡Research Department, Federal Reserve Bank of Kansas City, 1 Memorial Drive, Kansas City, MO 64198, andrew.foerster@kc.frb.org.

# 1 Introduction

During the summer of 2011, the US government approached its statutory borrowing limit, as total outstanding debt neared the "debt ceiling." The agreement for raising the ceiling included provisions for tax increases and spending cuts set to go into effect in January 2013, setting the stage for a "Fiscal Cliff" scenario. In theory, the combination of tax increases and spending cuts, all substantial in magnitude and clustered at one time, was supposed to be so drastic that it would prompt another agreement to avert the Cliff. However, during the latter half of 2012, a deal to avert the cliff looked increasingly unlikely. While a late deal ultimately averted the major impacts of the cliff, the uncertainty about future government policies weighed on the economy as the cliff approached. News stories and anecdotal evidence suggested that firms were less willing to undertake large investment projects and hire new workers, contributing to the sluggish recovery from the financial crisis.

The uncertainty generated by the Fiscal Cliff has several unique features relative to general uncertainty about future policy. First, uncertainty is often viewed as a mean-preserving spread in possible outcomes, but the Fiscal Cliff is more appropriately viewed as the potential for a change in the average tax or spending rates in the economy. Second, the timing of the Cliff is specific in that taxes and spending may change at, but not before or after, a certain date. Third, after reaching the Cliff and either averting it with a deal or moving to a new set of tax and spending polices, there is a quick resolution of uncertainty as the tax and spending policies remain in place for an extended period of time.

This paper considers the effects of uncertainty associated with Fiscal Cliff-type episodes that are generated by expiring tax provisions. Motivated by anecdotal evidence towards the end of 2012, it investigates the impact of economic policy uncertainty on investment and employment, especially with regard to the type of investment project. Increases in policy uncertainty lower investment and employment, with some investment dropping immediately and some more gradually, depending upon the ease of installation of types of capital. Based upon this empirical evidence, the paper then discusses a model of expiring tax provisions, and shows that the model generates responses to uncertainty that match the features of the data.

Many papers have studied the importance of uncertainty about the future. Bloom (2009) shows that after an increase in uncertainty, firms pause in their hiring and investing, with a overshooting response several periods in the future. Other papers include Bloom et al. (2012) Fernández-Villaverde et al. (2011), Basu and Bundick (2012), and Christiano et al. (2012).

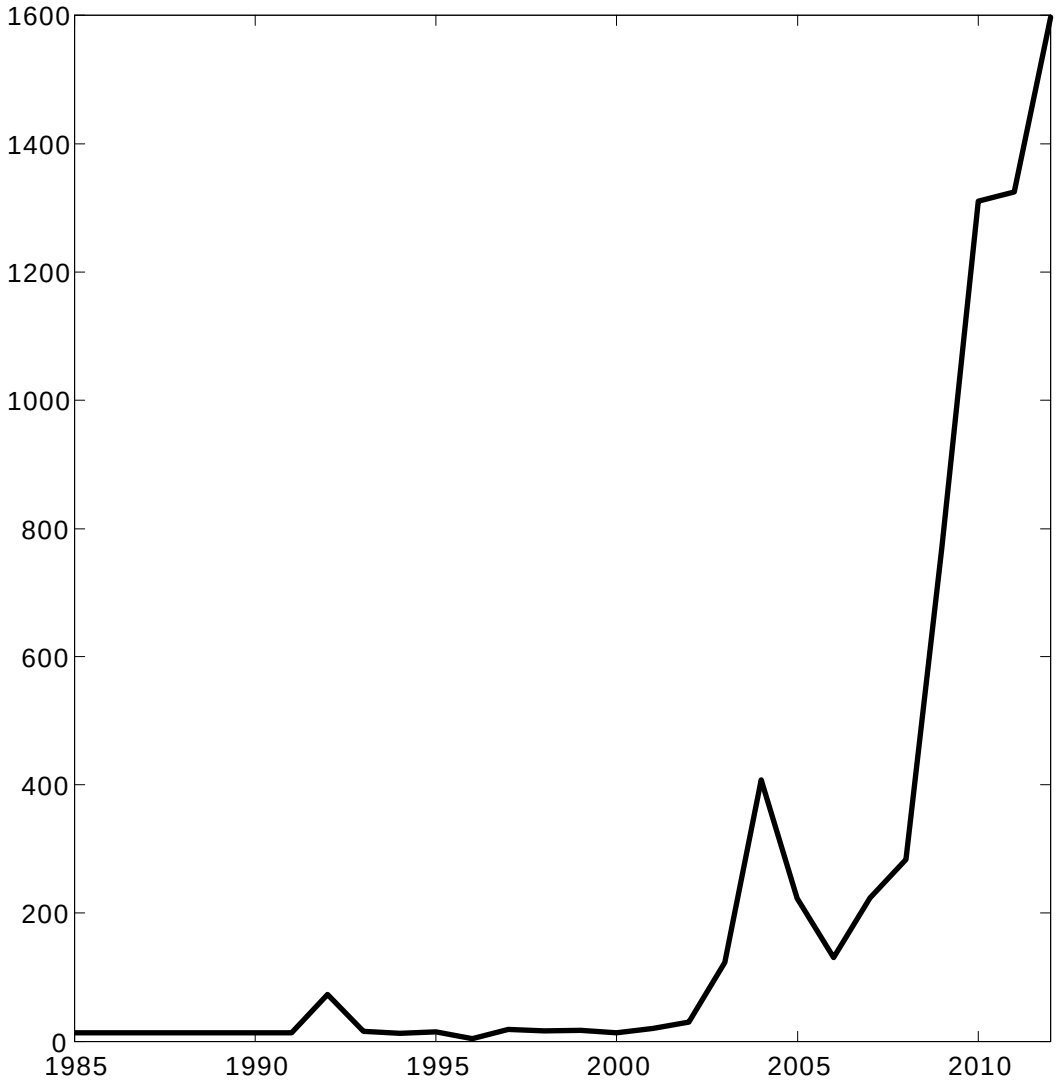
The Fiscal Cliff represents a specific source of uncertainty, which is uncertainty about economic policy. Baker et al. (2013) develop an economic policy index, and show that increases in policy uncertainty lower investment and employment. The economic policy index shows that the Fiscal Cliff marked the second-highest degree of policy uncertainty, exceeded only by the combination of the debt ceiling dispute and the Euro debt crisis. In addition, the economic policy index includes a measure of the degree of expiring tax provisions, which have increased substantially in recent years, as shown in Figure 1. The increased use of expiring tax provisions suggests that episodes similar to that studied in this paper may be increasingly important in the future. Fernández-Villaverde et al. (2012) estimate a process for fiscal uncertainty, and show that inserting this process into a New Keyensian model produces adverse effects on economic activity. However, Fernández-Villaverde et al. (2012) define uncertainty as a mean-preserving spread in tax and spending processes that gradually dissipate over time, whereas this paper considers a model with a specific type of uncertainty and resolution.

The paper proceeds as follows. Section 2 presents empirical evidence on the effects of policy uncertainty. Based upon this evidence, Section 3 discusses a model that captures the main features of the Fiscal Cliff. Using this model, Section 4 shows the impact of fiscal uncertainty, and Section 5 concludes.

# 2 Empirical Evidence

Before turning to the theoretical model, we consider the effects of uncertainty about policy on economic activity, specifically on how uncertainty impacts investment and employment. Using the economic policy uncertainty index developed by Baker et al. (2013), we estimate an SVAR and consider the effects of an identified shock to the policy uncertainty index. In addition

Figure 1: Exipring Tax Provision Index (Baker et al. (2013))




to the economic policy uncertainty index, we use private employment from the Current Establishment Survey and fixed-nonresidential investment from the National Income and Product Accounts, and the lag length is four. The structural shocks are identified using the Cholesky decomposition, with uncertainty ordered first.

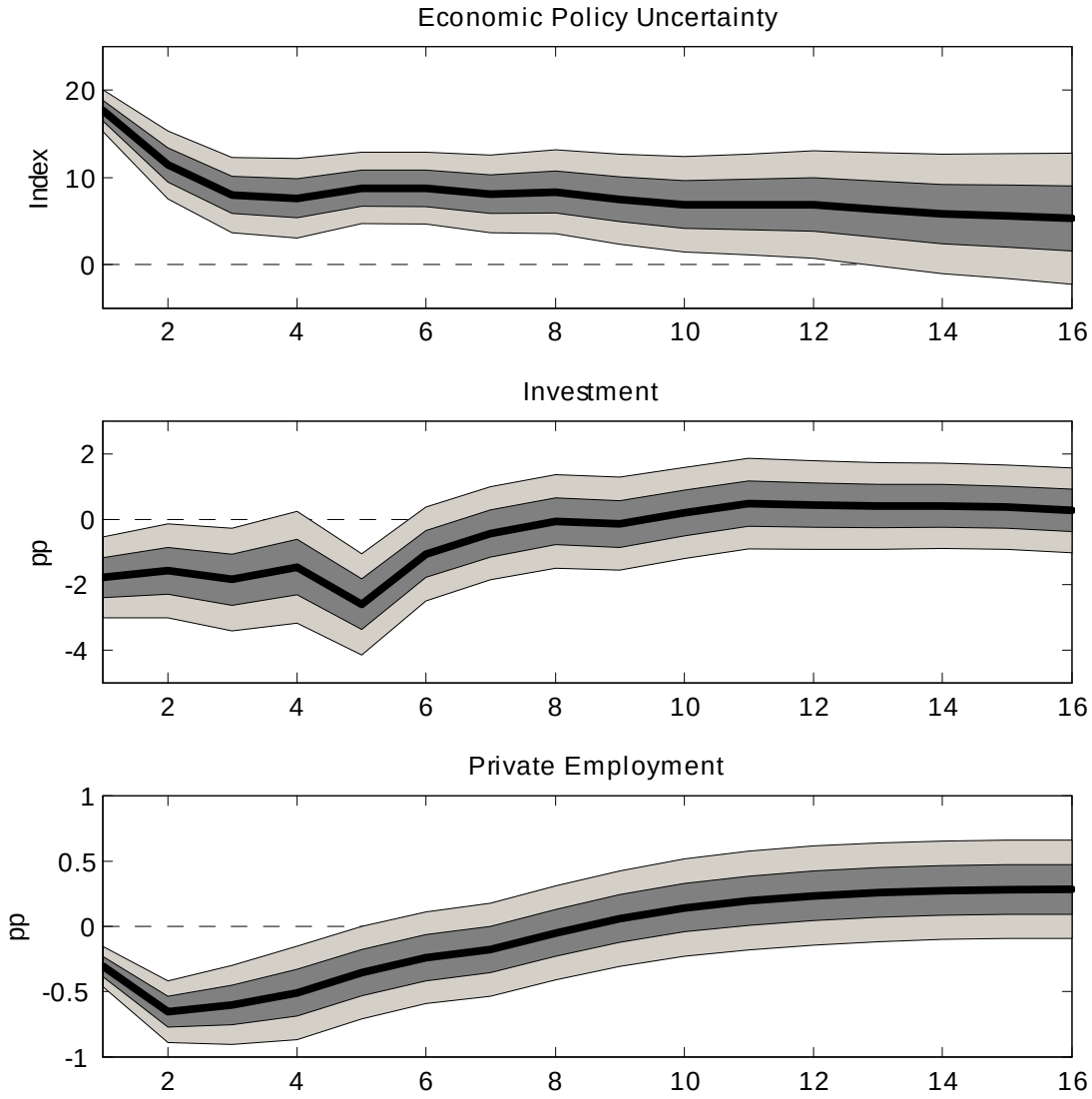
Figure 2 shows the impulse responses to an identified two standard deviation shock to the economic policy uncertainty index. The shock raises the index by nearly 20 points, in line with the increase in the fourth quarter of 2012 as US neared the fiscal cliff. In response to the shock, both investment and employment decline over several quarters. Private nonresidential employment falls by around 2 percentage points at an annualized rate for about 5 quarters. Private employment declines as well, by about 0.75 percentage points for about 5 quarters.

The fact that nonresidential fixed investment declines immediately and over a several quarter horizon masks some of the effects of an economic policy uncertainty shock. Certain types of investment may be immediate, whereas other investment projects may require a lengthy period of implementation. Similarly, different types of capital may be subject to different depreciation rates. As a result, we consider an additional SVAR separating nonresidential fixed investment into two components: structures, and equipment and software. Investment in structures typically constitutes a lengthy implementation process, and structures depreciate relatively slowly. On the other hand, equipment and software can be purchased relatively quickly but face a more rapid depreciation.

Figure 3 depicts the impulse responses to an identified two standard deviation shock to the economic policy uncertainty index. The two types of investment show markedly different responses to the uncertainty shock. Equipment and software declines immediately on impact, with an initial decline of 2 percentage points at an annualized rate. The impact of the shock is short-lived, however, with a rapid response towards no effect of the shock after only a couple of quarters. The response of investment in structures shows a larger, but slow moving decline by comparison. In this case, structures investment has little contemporaneous response to the shock, but becomes more negative, with a trough after 5 quarters, around 2.5 percentage points on an annual basis.

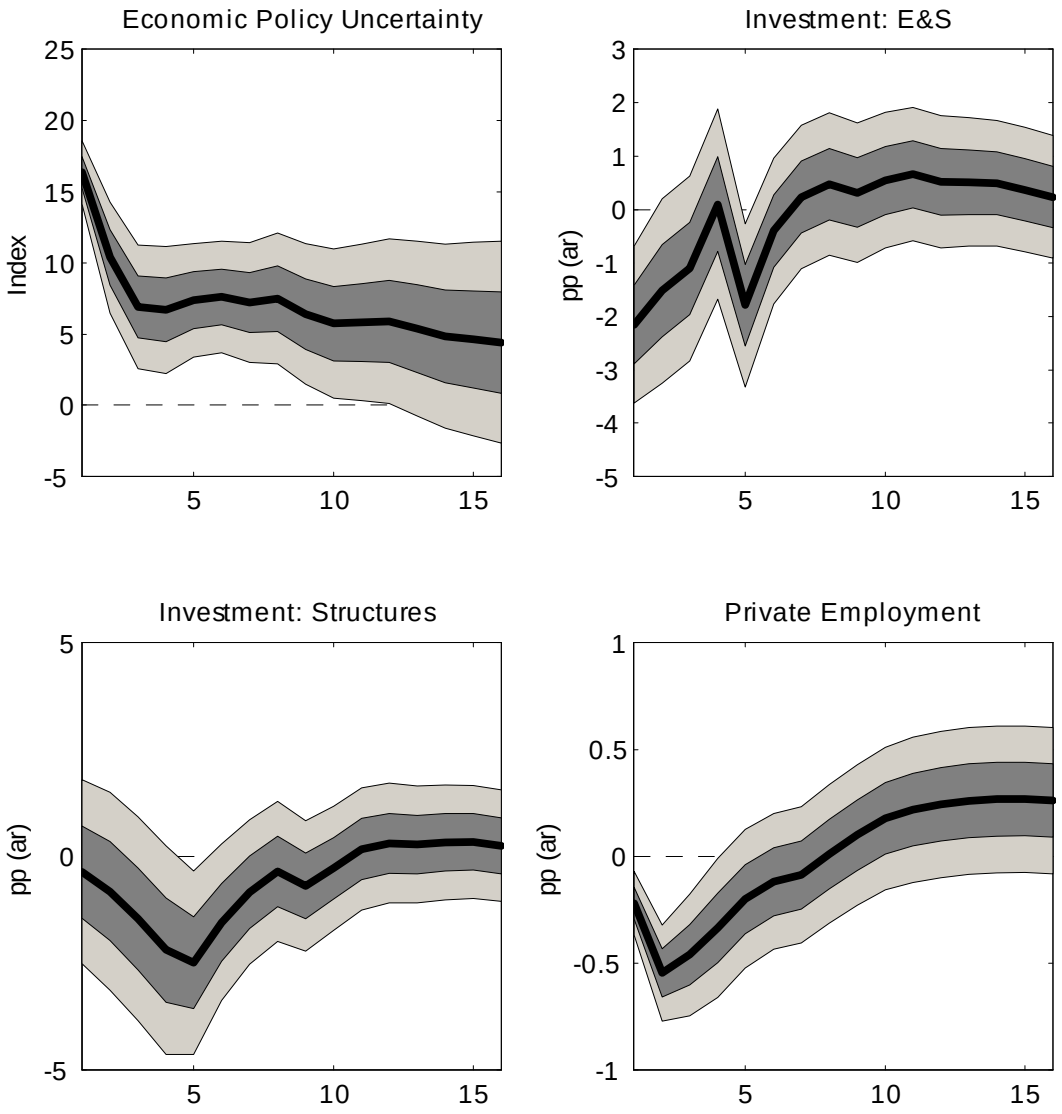
These impulse responses demonstrate that employment and investment both decline in response to an increase in economic policy uncertainty. Importantly, investment in structures responds with a lag, suggesting time-to-build and a lower depreciation rate induce firms and households to put off investment until uncertainty decreases. On the other hand, equipment

Figure 2: Impact of a Shock to the Economic Policy Uncertainty Index




and software show an immediate decline, since they are not subject to the same time-to-build and tend to depreciate faster. The next Section turns to developing a model that captures these features.

Figure 3: Impact of a Shock to the Economic Policy Uncertainty Index




# 3 Model Overview

This Section describes the model, first describing the representative household, the representative firm, and fiscal policy, followed by a discussion of the evolution of uncertainty and choice of parameters.

## 3.1 Households

The representative household chooses consumption $C_t$, labor $N_t$, investment $I_t$, and government-supplied bonds $B_{t+1}$ to maximize expected discounted lifetime utility

$$\mathbb{E}_t \sum_{t=0}^{\infty} \beta^t \frac{\left(C_t - \psi N_t^{\theta} X_t\right)^{1-\eta} - 1}{1-\eta} \tag{1}$$

where the habit shock evolves according to

$$X_t = C_t^{\gamma} X_{t-1}^{1-\gamma}, \tag{2}$$

and $\beta \in (0,1)$ denotes the discount factor, $\eta > 0$ the coefficient of relative risk aversion, $\psi > 0$ the disutility of labor, and $\theta > 1$ controls the elasticity of labor supply. These preferences, from Jaimovich and Rebelo (2009), nest the preferences from King et al. (1988) (i.e. $\gamma = 1$) and Greenwood et al. (1988) (i.e. $\gamma = 0$), which can generate positive comovement between consumption and investment. Households consume, invest, and purchase bonds to satisfy the budget constraint

$$C_t + I_t + B_{t+1} \leq (1-\tau_t)\left(r_t K_t + w_t N_t\right) + \left(1 + r_t^b\right) B_t + H_t, \tag{3}$$

where $r_t$ denotes the real rental rate on capital, $w_t$ denotes the real wage rate, $r_t^b$ the real return on bonds, $H_t$ lump-sum transfers from the government, and $\tau_t$ the time-varying distortionary tax rate on income.

Given that the response of investment in equipment and software differed in response to an economic policy uncertainty shock from the response of investment in structures, this paper considers two processes for the evolution of capital. In the first process, which has frictionless investment, capital evolves according to

$$K_{t+1} = (1-\delta)K_t + I_t, \tag{4}$$

where $\delta$ denotes the rate of depreciation. The second process has a time-to-build friction, in which capital evolves according to

$$K_{t+1} = (1-\delta)K_t + \iota\left(I_t + v_{t-1}\right) \tag{5}$$

where the investment stock $\nu_t$ evolves according to

$$v_t = (1 - \iota)(I_t + v_{t-1}). \tag{6}$$

In this time-to-build alternative, only a fraction $\iota$ of new investment enters the capital stock, a fraction $(1 - \iota)$ enters a stock of investment in progress; similar fractions govern the transformation from the investment stock into capital. The process has similarities to a time-to-build technology, but conserves on state variables, providing a more tractable framework for solving the full nonlinear model.

## 3.2 Firms

The perfectly competitive, representative firm produces output $Y_t$ using the Cobb-Douglas production technology

$$Y_t = K_t^{\alpha} N_t^{1-\alpha} \tag{7}$$

The firm produces using a series of one-period problems, maximizing profits and taking the rental rate $r_t$ and wage rate $w_t$ as given. Assuming an interior solution, firms maximize profits by equating marginal products with factor prices.

## 3.3 Fiscal Policy

To focus the analysis on the effects of changes in the tax rate, the model uses constant government expenditures at a fraction $g$ of steady state output, so $G_t = \bar{G} = gY_{ss}$ for all $t$. Similarly, aggregate lump-sump transfers equal zero, so $H_t = \bar{H} = 0$ for all $t$. Given these restrictions, debt evolves according to the following flow constraint,

$$B_{t+1} = \left(1 + r_t^b\right) B_t + \bar{G} + \bar{H} - \tau_t Y_t. \tag{8}$$

The government must pay the real rate of return of $r_t^b$ on outstanding bonds. In equilibrium, the quantity of bonds willingly held be the representative agent, $B_t$, must equal the aggregate level of government debt.

All uncertainty is associated with the income tax rate, which follows

$$\tau_t = \mu(S_t) + \lambda B_{t-1} + \varepsilon_t, \tag{9}$$

where the innovation follows an autoregressive process

$$\varepsilon_t = \rho\varepsilon_{t-1} + \sigma u_t \tag{10}$$

with $u_t \sim N(0,1)$ and $E[u_t u_s] = 0$ for $s \neq t$. Innovations in $u_t$ represent intra-regime shocks and changes in $S_t$ represent regime shifts. The intercept in (9) governs the regime-dependent average level of taxation and debt, and takes one of two values

$$\mu(S_t) \in \{\mu_0, \mu_1\}. \tag{11}$$

The next subsection discusses how $\mu(S_t)$ evolves over time.

Given there is no long-run growth and the real interest rate is positive, the transversality condition holds as long as debt does not grow faster than the real interest rate. To satisfy this condition, we calibrate the tax rule to generate sufficient tax revenue to return the debt-to-output ratio to its long-run average. In linearized versions of this model, the condition requires $\lambda > 1/\beta$, which is satisfied in each fiscal regime.

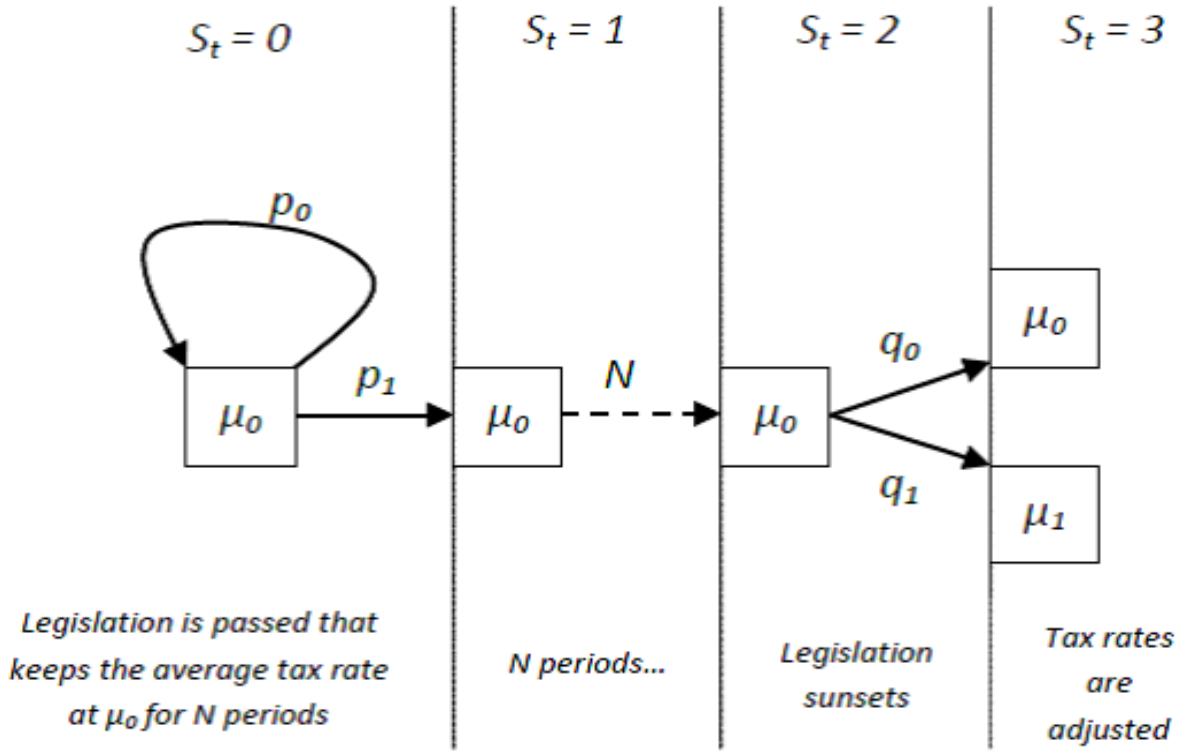
In this framework, a shift from a low average tax regime to a high average tax regime entails transition dynamics that may not immediately be intuitive. For example, a low average tax regime has a steady state level of debt lower than a regime with higher taxes on average. The reason being that higher taxes can support higher interest costs in the steady state, so debt is correspondingly higher. In the simulations below, we consider a transition from an average high tax regime, which has a higher average debt level, to a lower tax regime. However, the transition to the low tax regime requires a transitional period when debt is paid down, which requires taxes to temporarily rise.

## 3.4 Information Structure

Figure 4 illustrates the flow of information and how uncertainty is resolved. For $S_t = 0$, existing tax policy remains set by $\mu_0$, and with probability $p_1$, the economy experiences an uncertainty

shock that in $N$ periods the tax rate may change. After $N$ periods, the fiscal authority keeps the existing tax rate governed by $\mu_0$ with probability $q_0$, and with probability $q_1$ adjusts the average tax rate to $\mu_1$.

Figure 4: Fiscal Uncertainty




Since households understand tax rates could change after the $N$ period horizon, they begin adjusting their behavior once the sunset provision is passed - that is, once $S_t = 1$. Several practical examples of such legislation exist. In the US, the tax reforms originally passed in 2001 and 2003 were set to expire at the end of 2010, but were subsequently extended for a year. The negotiations in the US around raising the debt ceiling in August of 2011 set up the 2012 "fiscal cliff" scenario that many analysts pointed to as weighing on the economy in the latter portion of 2012. More broadly, several tax and spending provisions are often set to expire after a given period, so households and firms understand the timing of when future fiscal policies are most

Table 1: Parameterization

| Parameter | Description | Value |
|---|---|---|
| $\alpha$ | Capital Share | 0.33 |
| $\beta$ | Discount Factor | 0.98 |
| $\eta$ | Cofficient of Relative Risk Aversion | 1 |
| $\delta$ | Depreciation Rate | 0.025 |
| $\iota$ | Time-to-Build Friction | 0.25 |
| $\theta$ | Elasticity of Labor | 1.4 |
| $\gamma$ | Degree of Consumption Habit | 0.05 |
| $\psi$ | Disutility from Labor | 2.6431 |
| $g$ | Share of Government Purchases in Steady State | 0.2 |
| $\lambda$ | Response of Tax Rate to Debt | 0.1 |
| $\rho$ | Serial Correlation of Shock to Tax Rate | 0.9 |
| $\sigma$ | Standard Deviation of Tax Rate Shock | 0.0001 |
| $p_1$ | Probability of Uncertainty Shock | 0.02 |
| $q_1$ | Probability of Hitting Fiscal Cliff | 0.25 |
| $N$ | Length of Fiscal Cliff Uncertainty | 4 |
| $\mu_0$ | Tax Process Intercept, High Debt Regime | 0.1440 |
| $\mu_1$ | Tax Process Intercept, Low Debt Regime | 0.1905 |

likely to change.

## 3.5 Parameter Values and Model Solution

Table 1 displays the full set of parameter values. Many of the parameters follow standard choices from the literature, but a few deserve special attention.

Following Jaimovich and Rebelo (2009), the risk aversion equals $\eta = 1$ and the elasticity of labor equals $\theta = 1.4$. The value of $\gamma$ governs the degree to which the wealth effect impacts household decisions. If $\gamma = 0$, as in Greenwood et al. (1988), then employment only responds

to the current after-tax real wage, whereas if $\gamma = 1$, then the substitution and wealth effects cancel as in King et al. (1988). The results below use $\gamma = 0.05$, a bit higher than Jaimovich and Rebelo (2009), who use $\gamma = 0.001$, which would imply an extremely large response of current employment to changes in tax rates. The time-to-build friction equals $\iota = 0.25$, which attempts to capture a four-quarter investment lag.

The two probabilities $p_1$ and $q_1$ control the likelihood of an uncertainty shock and of an adjustment in tax rates. The baseline parameterization has $p_1 = 0.02$, capturing the unlikely nature of fiscal cliff episodes, and $q_1 = 0.25$, meaning the tax rate changes in one-quarter of fiscal cliff episodes. The parameter $N$ dictates the length of uncertainty about future tax rates, a value of 4 implies duration of a year. Finally, the choice of $\mu_0 = 0.1440$ and $\mu_1 = 0.1905$ imply steady state marginal tax rates of 0.22 and 0.205, respectively. Note that $\mu_1$ exceeds $\mu_0$, and corresponds to a lower steady state marginal tax rate, which occurs because of a lower steady state debt level associated with $\mu_1$. So a switch from $\mu_0$ to $\mu_1$ produces a period of higher taxes that eventually pays down debt to a lower level, leading to a lower tax rate in steady state.

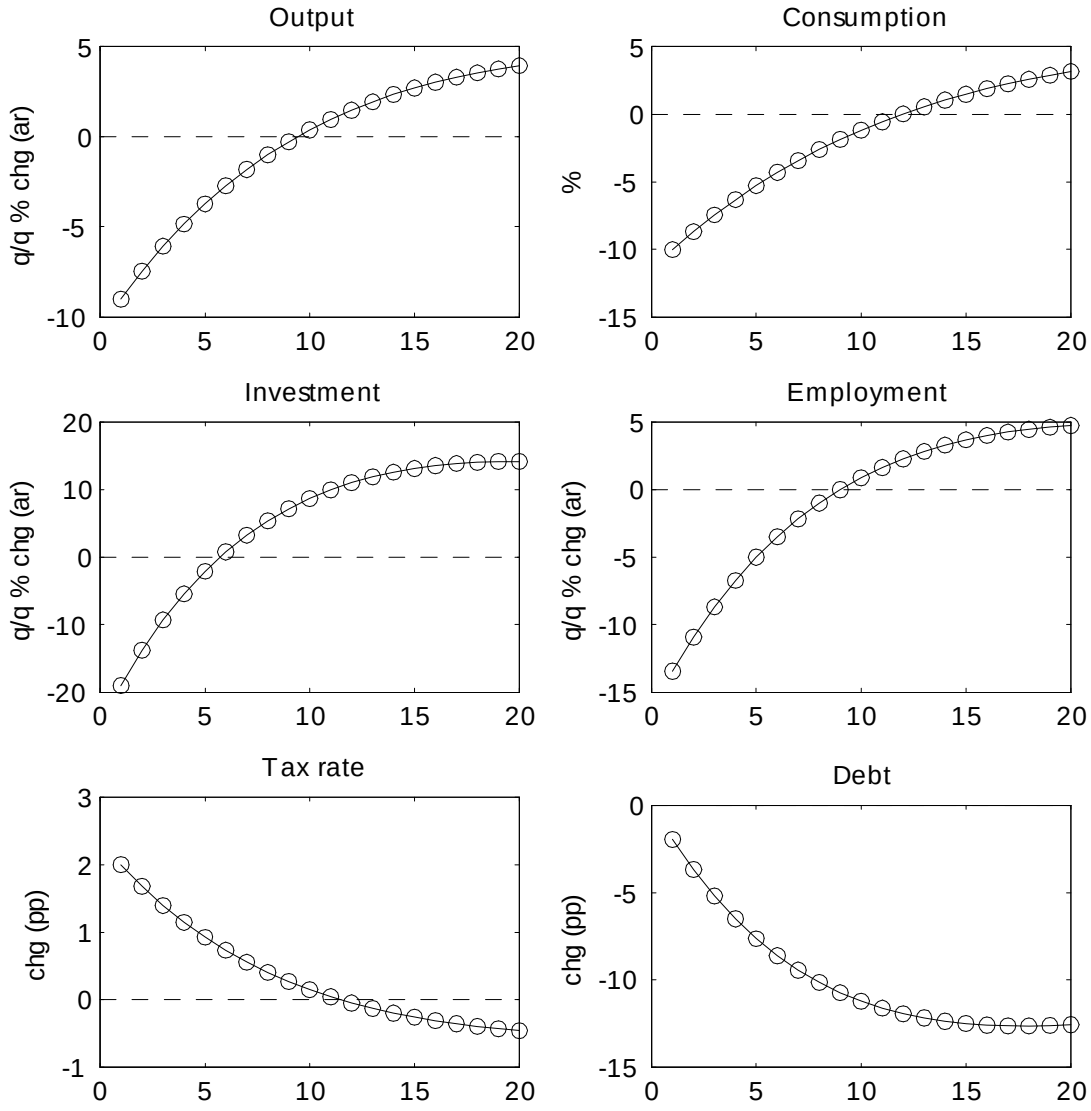
Due to the highly nonlinear nature of the model, local approximation methods may give an unsatisfactory solution to the model. Linearization methods such as Davig and Leeper (2007) and Farmer et al. (2008), or the peturbation method of Foerster et al. (2011) only remain valid in a neighborhood of the approximation point. Given the changing steady states associated with the regimes, and the response of taxes to debt, the economy may move far away from any approximation point. Consequently, this paper relies on the time-iteration method of Coleman (1991) to characterize the economy's solution.

## 3.6 Intra-Regime Shock

Before discussing the impact of fiscal uncertainty, first consider the impact of a shock to the tax rate $u_t$ without any uncertainty about future tax regimes. In this case, $p_1 = 0$, so households expect $\mu_0$ to be the relevant tax rate forever. Figure 5 illustrates the impact of a 2 percentage point increase in the tax rate. The increase in the tax rate has intuitive effects, as both investment declines due to the lower expected after-tax rate of return and employment falls.

The initial increase in the marginal tax rate causes debt to fall, which eventually leads to a lower tax rate, leading to a boom in output, consumption, investment, and employment that begins approximately 10 quarters after the intial shock. This basic shock shows how debt dynamics impact the tax rate in equation (9), and how the transition can take many quarters, since eventually debt and all variables return to their pre-shock levels.

Figure 5: Response to an Intra-Regime Tax Shock



# 4 A Fiscal Uncertainty Shock

This Section show the main results of the paper: the impact of a fiscal uncertainty shock. The next Subsection discusses the case of frictionless investment, and the following Subsection considers the impact of investment frictions. For both investment cases, the results depict a simulation of a fiscal-cliff scenario that ends without hitting the cliff, and then one where taxes change as the economy hits the cliff.

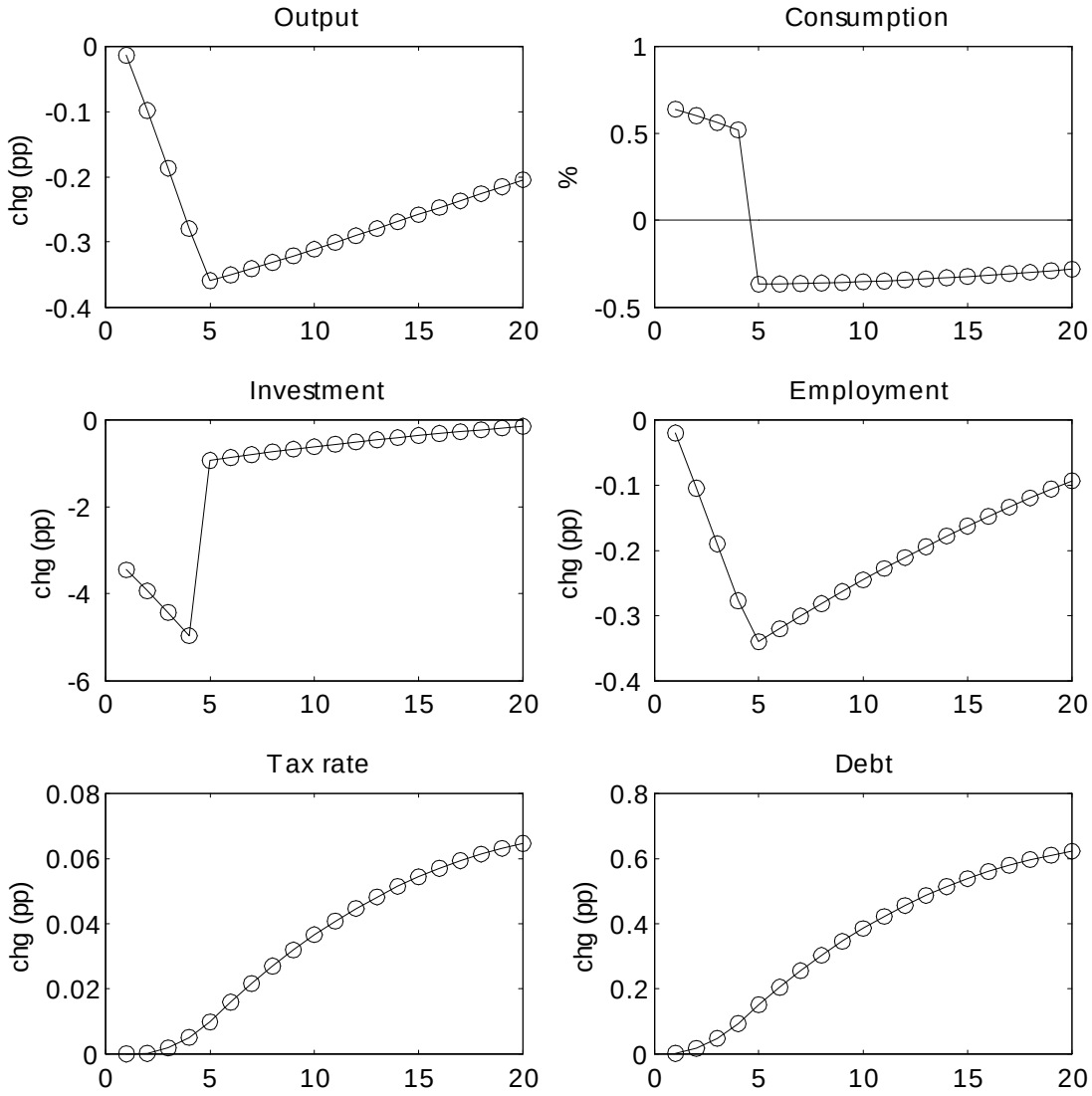
## 4.1 Frictionless Investment

### 4.1.1 Avoiding the Cliff

Figure 6 illustrates the implications of fiscal uncertainty with frictionless investment. A shift to the regime where household knows there is a possibility of tax rates moving higher in the future - in 5 periods in the Figure 6 - generates an immediate decline in both investment and employment. Investment falls sharply and even though total output declines, households shift towards consumption sufficiently to cause it to temporarily increase. Tax rates adjust only modestly and are driven by the increase in debt, which rises due to the decline in total output and income. In this example, tax rates are ultimately held at $\mu_0$, but the spectre of higher taxes on capital income in the future caused households to substitute away from investment and towards consumption.

In period $t = 5$, the economy avoids the cliff, so households and firms know that the tax rate remains at $\mu_0$ in the immediate future. Upon the resolution of uncertainty, investment immediately increases, while output and employment increase gradually back towards their steady-state values. The incentive to invest, now stronger becaues of lower tax rates, leads to a fall in consumption after the resolution of uncertainty, despite the fact that the economy experiences the positive outcome of averting the cliff. The slowdown in output increases the debt level, which produces a rise in marginal tax rates. In other words, the uncertainty generated by the fiscal cliff causes the need for higher taxes because of a slowdown in the economy and an increase in debt.

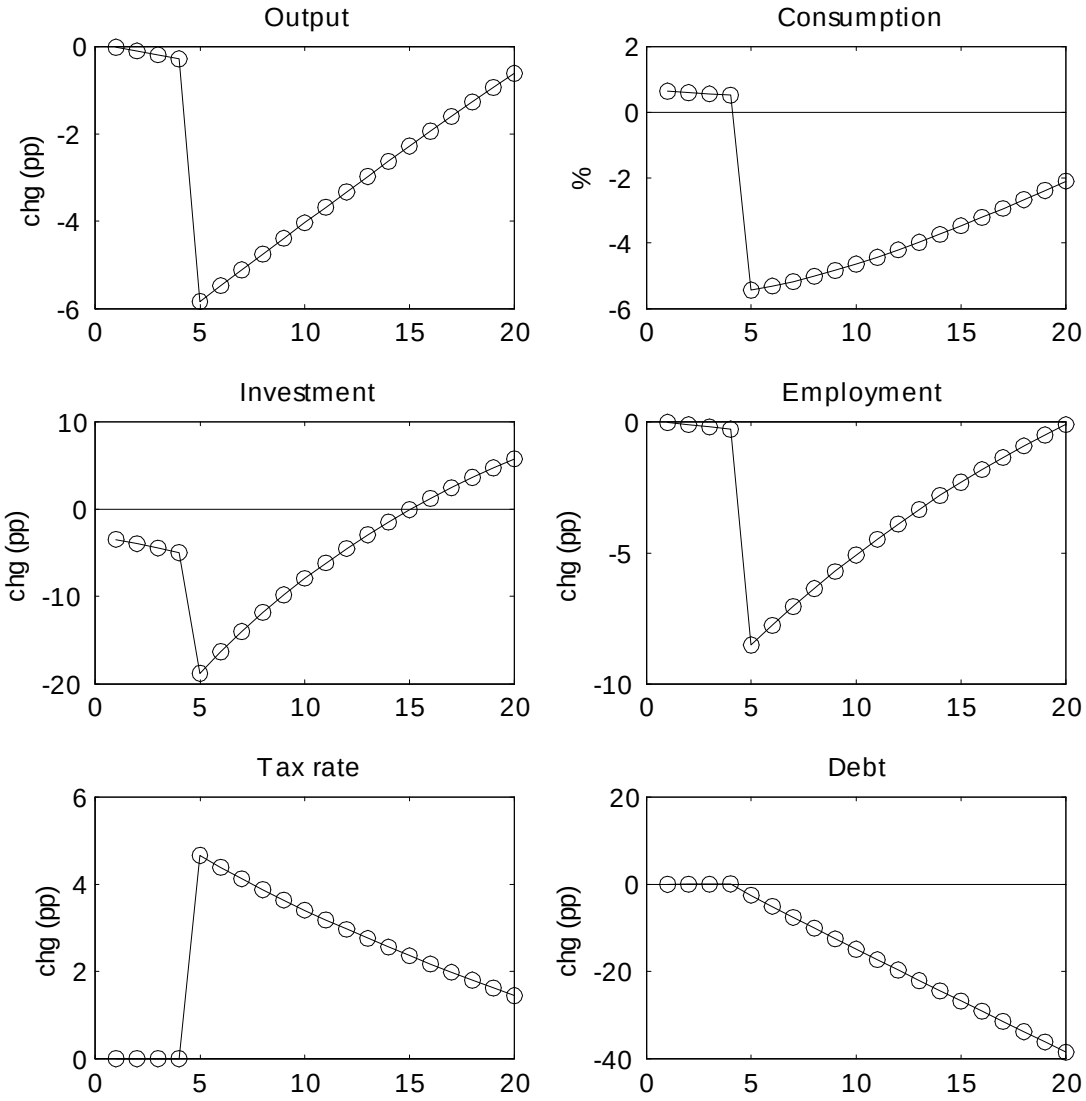
Figure 6: Response to an Uncertainty Shock




### 4.1.2 Going Over the Cliff

Figure 7 illustrates the effects of a fiscal cliff episode where tax rates adjust in period $t = 5$. Prior to hitting the cliff, agents in the economy remain uncertain about future tax rates, producing the same responses in the early periods as shown in Figure 6.

Figure 7: Response to Uncertainty Shock, Going over Cliff




The difference in the outcomes from hitting the cliff begin in $t = 5$, when tax rates increase sharply as the tax rule switches from an average tax rate of $\mu_0$ to the higher $\mu_1$ level. The higher tax rates lower debt, which act as a countervailing force against the rise in the intecept term of equation (9), but taxes still rise approximately 5 percentage points before decreasing. The larger tax rates slows the economy significantly, with output, consumption, investment, and

employment falling far below their levels had the economy avoided the cliff. After 20 quarters, the economy nearly rebounds, bouyed by the fact that lower debt leads to lower taxes. These lower taxes yield an investment boom, but output and consumption remain below their intial levels.

## 4.2 Time-to-Build

### 4.2.1 Avoiding the Cliff

Figure 8 shows how fiscal uncertainty impacts the economy with investment frictions. In this setup, only a fraction of new investment goes into the capital stock each period. The responses mimic those in the frictionless case, but with a smaller drop in investment With the resolution of uncertainty, none of the variables rebound as quickly as the frictionless case, reflecting the inertia that investment frictions create.

### 4.2.2 Going Over the Cliff

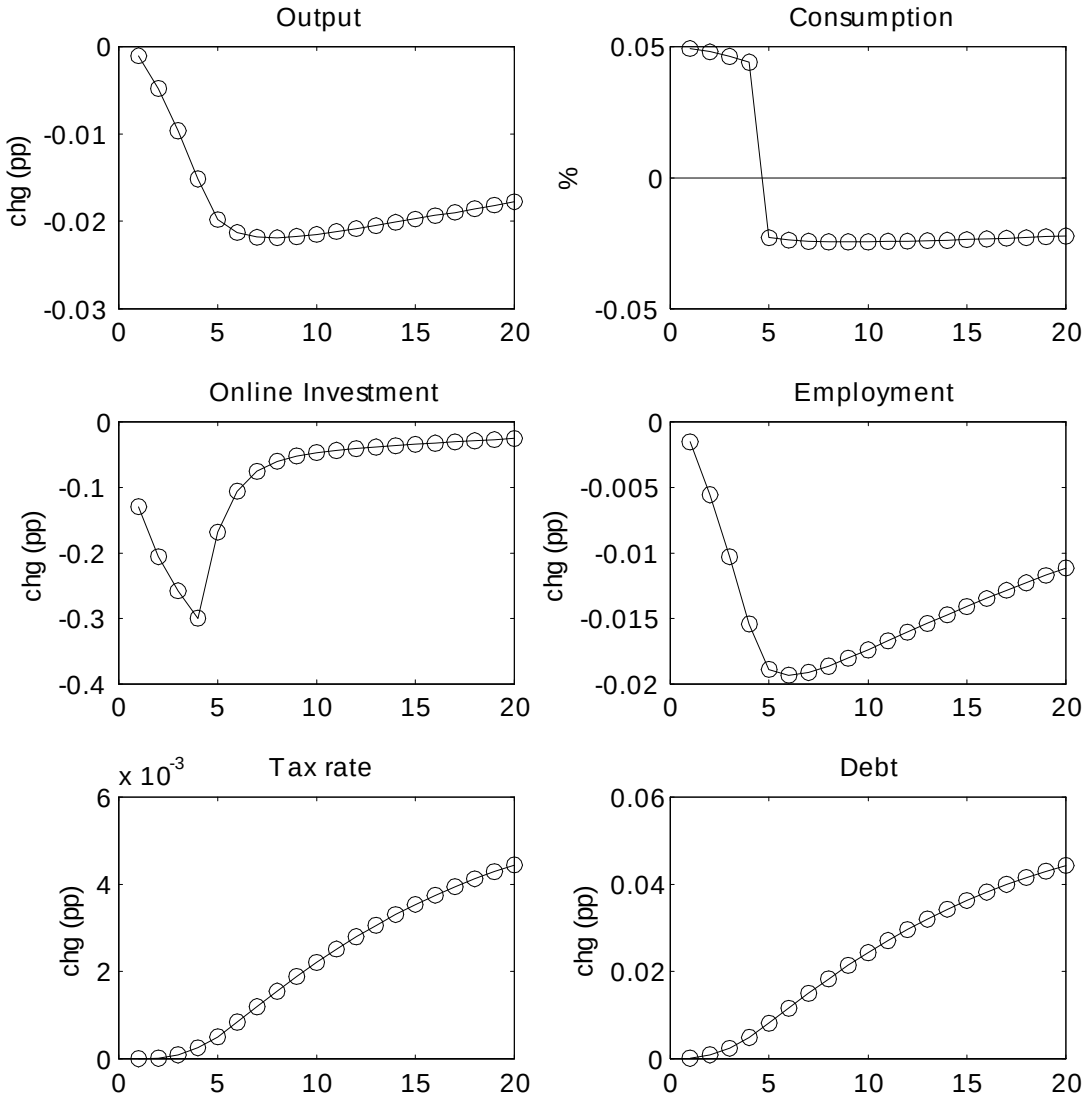
Figure 9 shows the effects of going over the fiscal cliff with investment frictions. Investment doesn't decline by the same magnitude as in the frictionless case, but the drop in employment, output, and consumption is significantly more, as the frictional investment creates a sharper drop in the capital stock.

## 4.3 Comparison of Investment

Having discussed the effects of uncertainty, and the resolution of uncertainty on the full economy, Figure 10 shows the responses of investment across the two models when tax rates do not change. The two responses show that, in the presence of investment frictions, investment doesn't decline by the same magnitude, barely responding to the uncertainty relative to the frictionless case, which shows a rapid drop and recovery.

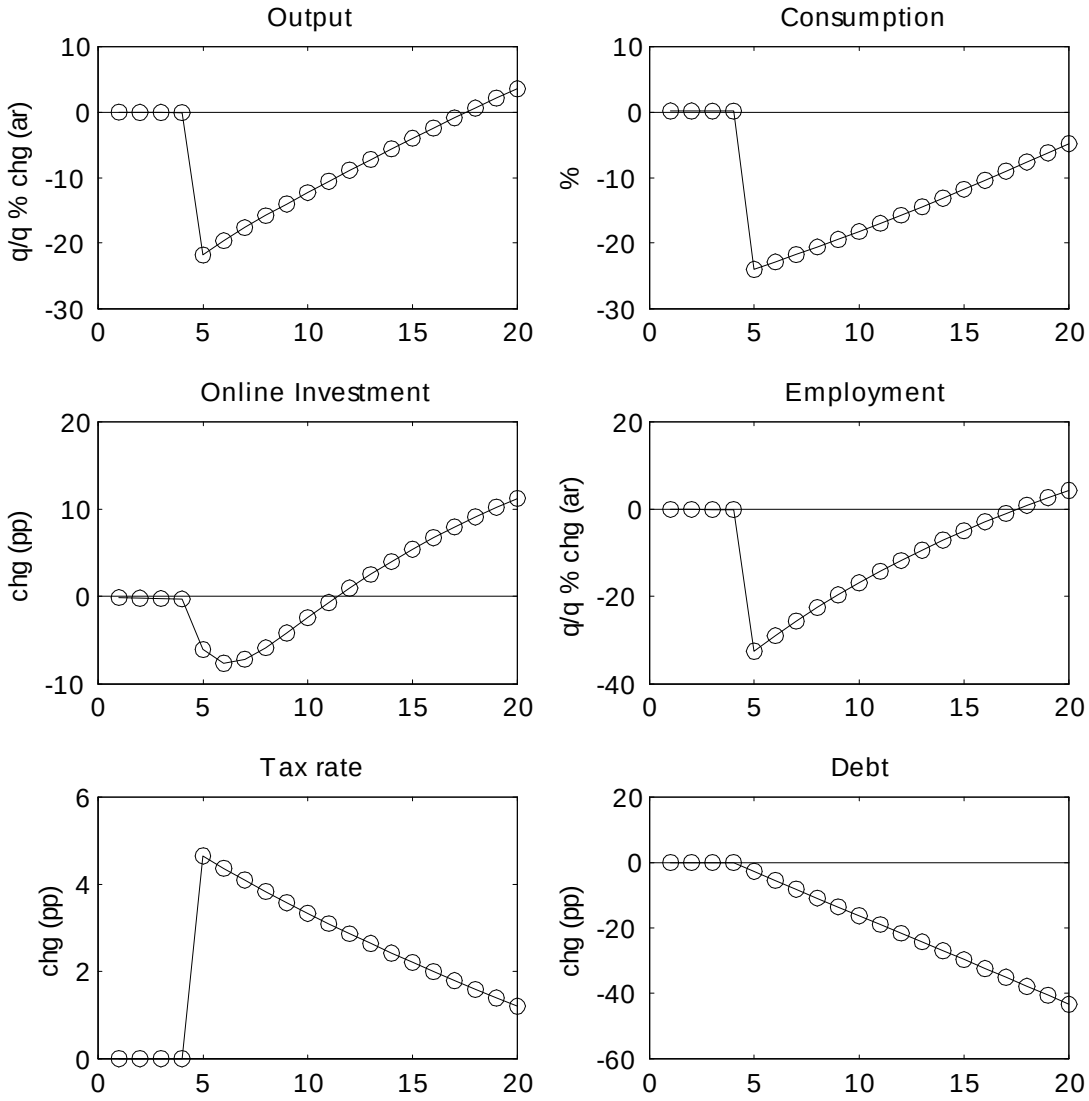
As demonstrated in Figure 3, investment in Equipment and Software declined and recovered rapidly to an uncertainty shock, whereas investment in Structures had a small, slow moving

Figure 8: Response to Uncertainty Shock, Time-to-Build




response. Since investment in structures tends to be slow-moving, the frictional investment model applies, whereas the frictionless case applies to equipment and software.

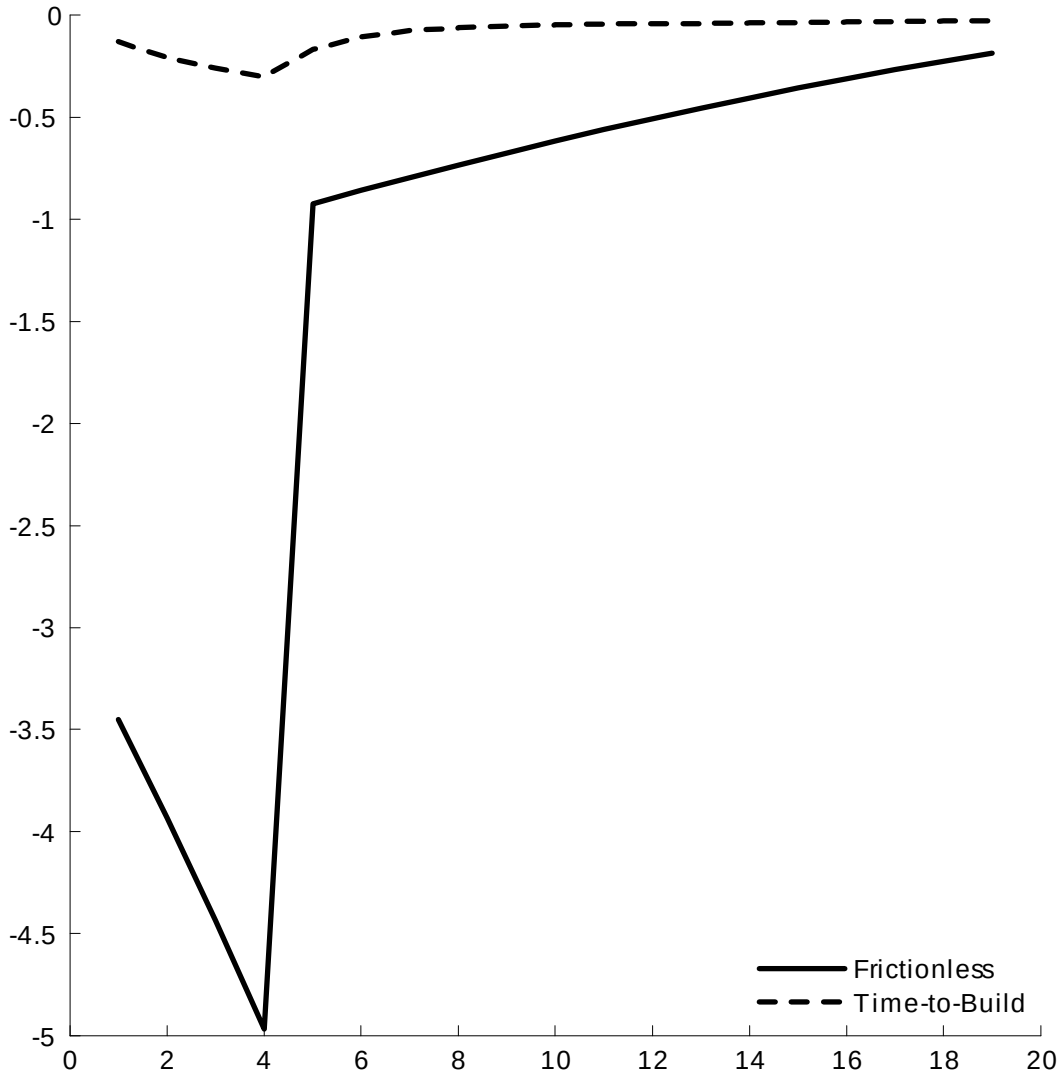
Figure 9: Response to Uncertainty Shock, Going over Cliff, Time-to-Build




# 5 Conclusion

This paper considered the effects of expiring tax provisions such as the recent Fiscal Cliff in the US. Empirically, a rise in economic policy uncertainty lowers employment and investment, and produces a rapid decline in equipment and software and a slow decline in structures investment.

Figure 10: Comparison of Investment Response to Uncertainty Shock




In the model developed, an uncertainty shock pushes the economy towards a date when the tax rate may change. This uncertainty generates declines in investment, employment, and output; frictional invesment mutes the response of investment, similar to the empirical response of investment in structures.

# References


Baker, S. R., N. Bloom, and S. J. Davis (2013). Measuring Economic Policy Uncertainty. Working Paper.

Basu, S. and B. Bundick (2012). Uncertainty Shocks in a Model of Effective Demand. Working Paper 774, Boston College.

Bloom, N. (2009, May). The Impact of Uncertainty Shocks. *Econometrica 77*(3), 623–685.

Bloom, N., M. Floetto, N. Jaimovich, I. Saporta-Eksten, and S. J. Terry (2012). Really Uncertainty Business Cycles. Working Paper 182545, NBER.

Christiano, L., R. Motto, and M. Rostagno (2012). Risk Shocks. Working Paper.

Coleman, W. (1991). Equilibrium in a Production Economy with an Income Tax. *Econometrica 59*(4), 1091–1104.

Davig, T. and E. Leeper (2007). Generalizing the Taylor Principle. *American Economic Review 97*(3), 607–635.

Farmer, R., D. Waggoner, and T. Zha (2008). Minimal State Variable Solutions to Markov-Switching Rational Expectations Models. *Journal of Economic Dynamics and Control 35*(12), 2150–2166.

Fernández-Villaverde, J., P. Guerrón, K. Kuester, and J. F. Rubio-Ramírez (2012). Fiscal Volatility Shocks and Economic Activity. Working Paper.

Fernández-Villaverde, J., P. Guerrón, J. F. Rubio-Ramírez, and M. Uribe (2011). Risk Matters: The Real Effects of Volatility Shocks. *American Economic Review 101*, 2530–61.

Foerster, A., J. Rubio-Ramirez, D. Waggoner, and T. Zha (2011). Perturbation Methods for Markov Switching DSGE Models. Working Paper 13-01, Federal Reserve Bank of Kansas City.

Greenwood, J., Z. Hercowitz, and G. Huffman (1988). Investment, Capacity Utilization, and the Real Business Cycle. *American Economic Review 78*(3), 402–417.

Jaimovich, N. and S. Rebelo (2009). Can News about the Future Drive the Business Cycle. *American Economic Review 99*(4), 1097–1118.

King, R. G., C. I. Plosser, and S. Rebelo (1988). Production, Growth, and Business Cycles: I. The Basic Neoclassical Growth Model. *Journal of Monetary Economics 21*(2-3), 195–232.