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**Abstract**

Fiscal uncertainty, such as that associated with the US "fiscal cliff" Japanese consumption tax increases, has several unique features: shifts in the policy landscape generate news, the possible outcomes are skewed, implementation is in question, and a known resolution date. This paper develops a model that captures these features and studies the impact of fiscal uncertainty. Arrival of new information affects decisions immediately, but the strength of adjustments depends on the probability attached to reforms being implemented, which in turn generates volatility in the economy. The possibility of uncertainty shocks drags on the economy even in periods of relative certainty.

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# 1 Introduction

Fiscal uncertainty comes in many forms, but often has four aspects that make it unique. First, specific news about the possible implementation of reforms generates the uncertainty, as possible shifts in the policy landscape are often discussed in public prior to implementation. Second, rather than having a symmetry of possible outcomes, uncertainty about future fiscal policy often has skewness. For example, a potential change in tax rates may leave them either higher or unchanged. More broadly, a government may debate the degree of austerity or stimulus measures, but is unlikely to seriously consider both at the same time. Third, the ultimate implementation of proposed reforms remains in question until the changes either take effect or are abandoned. For example, tax provisions may be extended at the last minute or a scheduled fiscal tightening may be postponed if economic performance deteriorates. Fourth, fiscal uncertainty often has a specific point in time for its resolution. For example, a provision ends, a tax increase is scheduled to take effect, or an election cycle may introduce a timeline for policy reforms. Even countries facing fiscal strains have such checkpoints, such as debt repayments, negotiating deadlines, and policy reforms that evolve according to a timeline and give households information about future policy.

Two examples motivate the framework behind these unique aspects of fiscal uncertainty. First, in the US, a confluence of factors setup up the potential for a sharp tightening of fiscal policy starting in 2013–the so-called "fiscal cliff." The details of the tightening were well understood, as they were encoded in existing law, but the likelihood that all the provisions would be adopted remained in question throughout much of 2012. This example had all the features described above, such as a skewed distribution over future tax rates, an information flow about the possible tax changes, a timeline for resolution, and uncertainty regarding ultimate implementation. A second example involves Japan's policy of pre-announcing specific dates for increasing consumption tax rates. Possible changes, however, are often subject to certain qualifications, so also have the same four aspects of fiscal uncertainty as the US fiscal cliff example.

This paper develops a model that captures these four aspects and uses the framework to study the effects of fiscal uncertainty. Specifically, the model has uncertainty shocks about either income or consumption taxes, the possible outcomes to policy are skewed and discrete, uncertainty about implementation of tax changes remains until the taxes changes either go into effect or do not, and this outcome will take place at a known resolution date.

Based on the modeling framework, a few themes emerge. First, the arrival of new information about future policy, called a fiscal uncertainty shock, affects decision making immediately, causing a partial adjustment in a manner consistent with the new fiscal regime. Second, the strength of any adjustments depend on the probability attached to a possible reform being implemented. If reform is certain, then a full adjustment towards the new regime begins immediately upon announcement. If reform is viewed as unlikely, adjustments will be modest. Third, the probability attached to implementation also matters for how fiscal uncertainty affects volatility. The arrival of news about a future policy reform may smooth the transition to a new policy regime if the probability of its adoption is relatively high and the reform is ultimately implemented. In contrast, if there is a low probability on a reform that ends up being adopted, the shift to a new fiscal regime is abrupt and induces a relatively volatile adjustment. Alternatively, failing to enact a highly anticipated reform can likewise induce substantially volatility as the economy moves towards a new fiscal regime that is ultimately not adopted, so must unwind decisions made upon the initial announcement. Fourth, the probability attached to receiving an uncertainty shock affects the level of the economy before uncertainty hits. If, for example, tax rates may be higher at some point in the future due to rising government debt projections, then the level economic activity and the capital stock will be lower even during periods of relative certainty. Thus, the framework has a mechanism to separate short-run uncertainty, which is the likelihood an announced fiscal reform will be implemented, from longer-run uncertainty, which is the likelihood that a possible fiscal reform will be put on the table.

This paper fits within the growing number of papers studying the economic effects of uncertainty. For example, Bloom (2009) shows that after an increase in uncertainty, firms pause in undertaking new hiring and investing, then overshoot in the future when the uncertainty is resolved. Basu and Bundick (2012), Bloom et al. (2012), and Leduc and Liu (2015) provide frameworks where uncertainty shocks are important drivers of fluctuations, Christiano et al. (2012) show how uncertainty can interact with financial frictions, and Fernández-Villaverde et al. (2011) show that higher volatility has large impacts in emerging economies. In addition, Fernández-Villaverde et al. (2011) show that time-varying volatility in fiscal policy generates negative movements in economy activity with magnitudes similar to the effects of monetary policy.

The information structure in this paper differs from other settings, such as Davig (2004), Hollmayr and Matthes (2013) or Richter and Throckmorton (2013), where agents in the economy learn about the fiscal policy rule currently in place. Instead, in this paper, contemporaneous policy rules may be left unchanged, but the arrival of information shifts expectations over future rules. In many respects, the arrival of information, or fiscal uncertainty shock, resembles a news shock. Rather than a perfectly known change, as in Jaimovich and Rebelo (2009), or a noisy signal, as in Schmitt-Grohe and Uribe (2012) and Born et al. (2013), a fiscal uncertainty shock can be interpreted as information about a potential change in the policy rule at some specified future date.

Finally, a large body of research studies how uncertainty over discrete changes in future fiscal policy affect the economy in the short term. For example, Chung et al. (2007), Bianchi (2012), and Bianchi and Melosi (2013) describe how the potential for switches in the fiscal policy rule matter for how the economy responds to shocks or how shifts in a contemporaneous policy rule affects economic activity. This paper expands on the switching literature by allowing for shocks that affect the probability distribution over future policy rules. As a result, households react to these news shocks, even though the contemporaneous policy rules are left unchanged.

The paper proceeds as follows. Section 2 reviews a few motivating examples of fiscal uncertainty from the US and Japan. Section 3 discusses a model that captures elements of these fiscal uncertainty episodes . Using this model, Section 4 shows the impact of fiscal uncertainty. Section 5 highlights how expectations interact with uncertainty and Section 6 concludes.

# 2 Motivating Examples

Although examples of fiscal policy uncertainty abound, two in particular stand out. The first is from the US and the so-called "fiscal cliff" episode of 2012. The source of this uncertainty episode originates with the income tax reductions originally passed in 2001 and 2003, which were set to expire at the end of 2010. Figure 1 highlights the extent of the rise regarding this aspect of fiscal policy uncertainty using the tax code expirations index from Baker et al. (2013). In particular, expiring tax provisions were rarely used prior to the tax reductions in 2001 and 2003, and they increased markedly in 2010 before peaking during 2012.

Instead of expiring, however, Congress passed in December 2010 legislation that temporarily extended several of the provisions. In addition, the legislation also introduced additional temporary measures, such as a one-year reduction in the payroll tax rate of 2 percentage points. As a result, the tax code expirations index increased at the end of 2011 when the temporary extension was set to expire. At the end of 2011, however, many of the provisions were again extended for another year. Throughout 2012, uncertainty persisted as to whether the tax provisions would again be extended, perhaps permanently.

In addition to the tax measures, a debate about the role of the debt ceiling, which sets a statutory limit on how much debt the federal government can issue, intensified in Congress in the middle of 2012. A compromise permitting a rise in the debt ceiling set in motion a series of events that ultimately resulted in mandatory cuts to non-discretionary federal government spending, which were to also take effect at the start of 2013.

In sum, the Congressional Budget Office estimated the combined amount of fiscal tightening would amount to about 4.0% of GDP and cause the economy to contract throughout the first half of the 2013 calendar year.[1] At the end of 2012, legislation was passed that extended most of the provisions, such as making the income tax rates put into effect in 2001 and 2003 permanent for lower and middle-income households, as well as indexing the Alternative Minimum Tax to inflation. On net, the legislation tightened fiscal policy, but by far less than was scheduled to occur.

While disentangling the effects of uncertainty due to the fiscal cliff from other factors such as a hangover from the financial crisis is difficult due to the one-off nature of the event, the economic implications are most apparent in the US investment data. Figure 2 shows that as a share of GDP, nonresidential fixed investment was essentially

[1] See Congressional Budget Office (2012).

unchanged in 2012. More broadly, 87% of respondents to the July 2012 Blue Chip Survey responded that they viewed the fiscal cliff would depress GDP growth in the second half of 2012, which suggests the individual forecasts viewed uncertainty as weighing on economic activity since none of the fiscal tightening was slated to take effect until 2013.[2] In the August 2012 Blue Chip Survey, 74% of respondents reported they viewed the fiscal cliff uncertainty as having the largest effect on capital spending, compared to 26% that viewed consumer spending as more likely to be most affected.[3]

Japan provides another example of the type of fiscal uncertainty addressed in this paper. In response to rising fiscal deficits following the collapse of both Japanese equity and housing prices in the early 1990s, the government passed a package intended to stabilize the fiscal outlook. The reforms included a pre-announced increase in the consumption tax from 3% to 5% that was scheduled to tax place starting in April 1997. In September 1996, however, the Finance Minister reported that there was a possibility that the tax increased could be delayed, but needed first to see 1997 Q2 GDP statistics before making a final decision. The tax increase was ultimately implemented and had the most visible impact on consumption. Similarly, in 2012 the Japanese government announced plans to increase consumption taxes from 5% to 8% in 2014 Q2. The reform ultimately went through despite doubts and a pre-implementation boom in consumption. A similar pre-announced increase to 10%, originally scheduled to take effect in October 2015, was postponed until 2015 due to a weakened economy.[4] Figure 3 compares the episode in 1997 to that in 2014. In both cases, anticipation of higher consumption tax rates sharply pulled forward consumption activity, but resulted in a decline immediately after implementation.

# 3 Model Overview

This section describes the model, including the representative household and firm, and fiscal policy, followed by a discussion of the evolution of uncertainty, the parameterization, and the effects of a standard shock to tax rates.

[2]See Blue Chip Economic Indicators (2012a).

[3]See Blue Chip Economic Indicators (2012b).

[4]See, for example,The Economist (2014).

## 3.1 Representative Household and Firm

The representative household chooses sequences of consumption $C_t$, labor $N_t$, and investment $X_t$ to maximize preferences of the form

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left( \log(C_t) - \psi \frac{N_t^{1+\theta}}{1+\theta} \right), \tag{1}$$

where $\beta \in (0,1)$ denotes the discount factor, $\psi > 0$ governs the disutility of labor, and $\theta$ is the inverse of the Frisch elasticity of labor supply. Households may face either a distorting tax on income or consumption. In the case of the income tax, maximization is subject to the budget constraint

$$C_t + X_t \leq \left(1 - \tau_t^I\right) \left(U_t K_{t-1} + W_t N_t\right) + T_t, \tag{2}$$

where $U_t$ denotes the real rental rate on capital, $W_t$ denotes the real wage rate, $\tau_t^I$ the time-varying distortionary tax rate on income, and $T_t$ lump-sum transfers. In the case of a consumption tax, maximization is subject to

$$\left(1 + \tau_t^C\right) C_t + X_t \leq \left(U_t K_{t-1} + W_t N_t\right) + T_t. \tag{3}$$

where $\tau_t^C$ denotes the time-varying distortionary tax rate on consumption.

Capital accumulates according to

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

where $\delta$ denotes the depreciation rate.

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

$$Y_t = K_{t-1}^{\alpha} N_t^{1-\alpha}, \tag{5}$$

where $\alpha$ denotes the capital share. The firm makes production decisions by solving a series of one-period profit maximization problems, taking the rental rate $U_t$ and wage rate $W_t$ as given. Assuming an interior solution, firms maximize profits by equating marginal products with factor prices.

## 3.2 Fiscal Policy

To focus on the effects of changes in the tax rate, the government does not spend and simply rebates all tax revenue back to the household in the form of a lump-sum transfer. In the case of the income tax, transfers satisfy

$$T_t = \tau_t^I Y_t, \tag{6}$$

and for the consumption tax case

$$T_t = \tau_t^C C_t. \tag{7}$$

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

$$\tau_t^j = \mu_j \left(S_t\right) + \varepsilon_t, \tag{8}$$

where $j \in \{I, C\}$ and the error, $\varepsilon_t$, follows an auto-regressive process

$$\varepsilon_t = \rho\varepsilon_{t-1} + \sigma u_t \tag{9}$$

with $u_t \sim N\left(0, 1\right)$ and $\mathbb{E}\left[u_t u_s\right] = 0$ for $s \neq t$. Innovations in $u_t$ represent intra-regime shocks and changes in $S_t$ represent regime shifts. The intercept in (8) governs the regime-dependent average level of taxation, and takes one of two values

$$\mu_j \left(S_t\right) \in \left\{\mu_0^j, \mu_1^j\right\}. \tag{10}$$

The next subsection discusses how $\mu^j\left(S_t\right)$ evolves over time.

## 3.3 Information Structure

Figure 4 illustrates the flow of information and how uncertainty is resolved. In $S_t = 0$, the average tax rate is set at $\mu_0^j$. Households understand that a future adjustment in the tax rate is possible, but view the timing as uncertain. With probability $p$, households receive information indicating a new tax regime may be in place after $N$ periods. The arrival of such information brings into focus the timing of a possible tax reform, though households understand actual reform is uncertain. Given a low probability on the arrival of such information, the $S_t = 0$ regime reflects the "status quo."

With probability $p$ each period, the economy may receive information that moves it from $S_t = 0$ to $S_t = 1$. This regime change has the flavor of a news shock, as no fundamental policy parameters actually change. The shift, however, provides households with a clear calendar regarding the timing of a possible adjustment to tax rates. Households understand that after $N$ periods, the fiscal authority will keep the existing average tax rate $\mu_0^j$ with probability $1 - q$ or adjust average taxes to $\mu_1^j$ with probability $q$. Since households understand tax rates could change after the $N$ period horizon, they begin adjusting their behavior immediately upon receiving the information. In the case considered below $N = 4$, so uncertainty about the future tax regime lasts for four quarters.

A Markov-switching framework captures the timing and resolution of uncertainty within this information structure. In total, there are $N + 3$ regimes, where $S_t \in \{0, 1, ..., N + 2\}$ indicates the regime. For the case of $N = 4$, the transition matrix is

$$\Pi = \begin{bmatrix} 1-p & p & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 1 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1-q & q \\ r & 0 & 0 & 0 & 0 & 1-r & 0 \\ r & 0 & 0 & 0 & 0 & 0 & 1-r \end{bmatrix}. \tag{11}$$

The probability $r$ allows the economy to cycle back to the original status quo regime, which ensures an ergodic distribution across regimes. However, given that this probability is set to be very small, it does not meaningfully factor into the analysis.

### 3.4 Parameter Values and Model Solution

Table 1 displays the full set of parameter values assuming a unit of time equals a quarter. The parameters governing preferences and production follow standard values from the literature. The two probabilities, $p$ and $q$, control the likelihood of an uncertainty shock and adjustment in the tax rate. The baseline parameterization has $p = 0.01$, capturing the unlikely nature of fiscal uncertainty episodes, and $q = 0.25$, meaning the tax rate changes in one-quarter of fiscal uncertainty episodes. The

Table 1: Parameterization

| Parameter | Description | Value |
|---|---|---|
| $\beta$ | Discount Factor | 0.995 |
| $\theta$ | Inverse of Frisch Elasticity of Labor | 1 |
| $N_{ss}$ | Steady State Labor | 0.33 |
| $\alpha$ | Capital Share | 0.33 |
| $\delta$ | Depreciation Rate | 0.025 |
| $\rho$ | Serial Correlation of Shock to Tax Rate | 0.9 |
| $\sigma$ | Standard Deviation of Tax Rate Shock | 0.01 |
| $p$ | Probability of Uncertainty Shock | 0.01 |
| $q$ | Probability that Taxes Adjust | 0.25 |
| $r$ | Probability of Returning to Original Regime | 0.0001 |
| $N$ | Length of Fiscal Uncertainty | 4 |
| $\mu_0^I$ | Average Income Tax, Low Tax Regime | 0.18 |
| $\mu_1^I$ | Average Income Tax, High Tax Regime | 0.20 |
| $\mu_0^C$ | Average Consumption Tax, Low Tax Regime | 0.05 |
| $\mu_1^C$ | Average Consumption Tax, High Tax Regime | 0.07 |

parameter $N$ dictates the length of uncertainty about future tax rates, so a value of 4 implies a duration of one year. Finally, the choice of average income tax rates, $\mu_0^I = 0.18$ and $\mu_1^I = 0.20$, are roughly in line average taxes in the US (Leeper et al. (2010)), while the average consumption tax rates, $\mu_0^C = 0.05$ and $\mu_1^C = 0.07$ are in line with recent experience in Japan. Note that given the calibration of the tax rate shock $\sigma = 0.01$, the differences between the average tax rates in the high and low tax regimes are two standard deviations for both types of taxes, which helps compare relative magnitudes.

Given that the model is a Markov-switching DSGE model with changes that affect the steady state, linearized solution methods that account for the regime switching such as Davig and Leeper (2007) and Farmer et al. (2008) may prove insufficient. The following results use the perturbation method for Markov-switching DSGE models of Foerster et al. (2011), with a second-order approximation used to improve accuracy.

## 3.5 Intra-Regime Shock

Before discussing the impact of a fiscal uncertainty shock, first consider the impact of a temporary shock to the tax rate, $u_t$, without any uncertainty about future tax regimes. In this case, $p = 0$, so households expect $\mu_0^j$ to govern the steady-state tax rate forever. Figure 5 compares the effects of a temporary, though persistent, 1 percentage point increase in the consumption and income tax rate.

Turning first to the income tax case, the increase has intuitive effects. The increase reduces the expected after-tax rate of return on investment, causing investment to decline in the period the higher rate is first put into place. Employment also declines on impact due to the lower after-tax real wage, which pulls output lower. Investment falls more sharply than the decline in output, so consumption rises initially before declining as the capital stock declines further.

The response to a consumption tax is rather different. Instead of changing the expected after-tax rate of return on investment, it changes the relative price between consumption and investment. A higher tax rate increases the relative price of consumption, so effectively acts as a negative shock to households' marginal utility of consumption. To illustrate, the first-order conditions are given by

$$\lambda_t = \frac{1}{\left(1+\tau_t^C\right) C_t}, \tag{12}$$

$$\psi N_t^{\theta} = \lambda_t W_t, \tag{13}$$

and

$$\lambda_t = \beta E_t \left[\lambda_{t+1} U_{t+1} + 1 - \delta\right], \tag{14}$$

where $\lambda_t$ is the Lagrange multiplier on the budget constraint. For any given real wage and level of consumption, a higher tax rate is consistent with a decline in the multiplier and less labor supply. In equilibrium, consumption and labor supply both fall. Consumption declines by more than the decrease in output, so investment and capital rise as households shift resources towards the future in anticipation of lower consumption tax rates as the shock dissipates.

In general, higher tax rates on either consumption or income causes labor supply and output to decline. The relative use of resources towards either consumption or investment, however, is different. Households reallocate resources toward investment in the case of a consumption tax increase, but away from investment in response to a higher income tax rate. Despite the different responses to each type of tax shock, fiscal uncertainty shocks will generate similar movements across taxes, as the next section shows.

# 4 A Fiscal Uncertainty Shock

This section reports baseline results from the model incorporating the information structure from Figure 4. A fiscal uncertainty shock is the arrival of news that tax rates may change at some point in the future, which triggers an immediate response from households. As an example, this framework can capture a situation where a given average tax rate may be scheduled to change at some point in the future, though households understand there is a possibility that tax rates will actually be left unchanged.

The following results focus on two aspects: how the arrival of new information affects the economy leading up to the period when uncertainty is resolved, as well as the response after resolution. If the average tax rate is ultimately left unchanged, then the fiscal uncertainty shock amounts to noise that nonetheless temporarily induces changes to household decisions. If the average tax rate does change, then households must complete the adjustment to the new steady state that only partially began upon the arrival of the initial information.

## 4.1 Fiscal Noise

Figure 6 compares how the impact of a fiscal uncertainty shock differs depending on whether it is about income or consumption tax rates. In contrast to the intra-regime shock, where investment either increased or decreased on impact depending on whether consumption or income taxes increased, the responses of all the endogenous variables to the fiscal uncertainty shock are qualitatively similar. In each case, a shift to the regime where households know there is a possibility of tax rates moving higher in the future with probability $q = 0.25$ generates an immediate decline in investment, employment and output, whereas consumption increases.

Considering first the case of a possible rise in income tax rates, households immediately begin the process of partially adjusting to a potentially new tax regime upon the arrival of the information. The expected after-tax rate of return on investment declines, so households reallocate resources towards consumption. As a result, the marginal utility of consumption declines, reducing the utility value of wage income and leading to a decline in labor supply. Tax rates on wage income are expected to rise in the future, which could cause households to want to work more in response to temporarily high after-tax wage income. However, under the baseline parameterization, labor supply is sufficiently inelastic and the size of potential tax increase, combined with the probability of it actually occurring, do not cause households to intertemporally substitute labor toward the period of the shock. As a result, labor supply and output both decline. Overall, the distorting effects of future income taxes induce households to consume more and provide less labor upon arrival of the new information, a reallocation pattern similar to McGrattan (2012).

In this example, the shock amounts to a false or unrealized news shock, since the average tax rate ultimately does not change and is held at $\mu_0^I$. In period $t = 5$, tax rates do not adjust, indicating to households and firms that the tax rate intercept will remain at $\mu_0^I$ indefinitely. Upon the resolution of uncertainty, investment immediately increases. The incentive to invest, now stronger because of an expectation that tax rates will remain lower in the future along with the need to offset the relative under-investment during the period of uncertainty, leads to a reallocation away from consumption towards investment starting in the period when the uncertainty is resolved. The reallocation back towards investment causes consumption to decline and labor to increase.

In the case of the potential consumption tax increase shown in Figure 6, the general pattern of responses are qualitatively similar to those of the income shock. Upon receiving an uncertainty shock, the possible rise in consumption taxes induces a stronger substitution toward current consumption than in the income tax case, so consumption rises more significantly. In particular, the marginal utility of consumption declines, which induces a lower labor supply, while at the same time lowering the expected future marginal utility of the return to capital, which produces a simultaneous decline in investment. While the intra-regime shock led to an increase in investment and capital as households delayed consumption, the uncertainty shock leads to a pulling-forward of consumption that ends up moving consumption labor, output, and investment in the same direction as in the income tax case.

Again, in this example the increase in consumption taxes fails to materialize, meaning that average tax rates remain at $\mu_0^C$ at period $t = 5$. Mimicking the income tax case, upon the resolution of uncertainty both investment and labor increase. In this case, consumption also declines even though an expected consumption tax increase fails to materialize. This result is due to the fact that, while pulling future consumption forward prior to the period of uncertainty, households have lowered their capital holdings, so upon resolution of uncertainty they increase labor and decrease consumption in order to invest and rebuild capital stock.

## 4.2 Full Fiscal Adjustment

Alternatively, policymakers may implement reforms after the $N$ period horizon. In this case, Figure 7 illustrates how the economy responds to an uncertainty episode that is followed by a change in the income tax regime relative to the case of fiscal noise, where no fiscal adjustment occurred. The differences in the two paths begin in period five, which is the period when uncertainty is resolved.

The shift sets in motion household decisions to complete the adjustment that began when the uncertainty shock first hit. Investment, employment and output drop sharply after the implementation of the new tax rate. The decline in output is not as deep as in investment, so consumption temporarily rises reflecting the desire to disinvest.

Figure 8 shows the effect of an actual adjustment in the consumption tax rate. Labor supply and output both fall, but by not as much as the case of a change to the income tax rate. The primary difference between the scenarios is the consumption response upon resolution of uncertainty. The realization of the higher consumption tax rate increases the relative price of consumption goods, so households reallocate resources toward investment. Investment still falls because the decline in labor supply reduces the total amount of available resources, but the reallocation towards investment mitigates the extent of its decline. Overall, consumption, investment and labor supply have positive comovement. They all decline when the actual adjustment begins and transition to lower stochastic steady state values. In the case of an income tax adjustment, transitions for all these variables are also to lower stochastic steady state levels, but the initial disinvestment is more aggressive. As a result, consumption and investment have negative comovement the period the full adjustment begins.

Bringing direct empirical evidence to bear on these dynamics is not straightforward. First, the model represents a way to analyze a particular event, rather than to capture general features of the data. For this reason, attempts at a full scale estimation would be misguided. Second, fiscal cliff episodes have effects on macroeconomic data, as Figure 2 and 3 suggest, but the variety of other shocks and changes in monetary policy do not make for a clean event-study type mapping from the data to the dynamics generated by the model. For example, the consumption tax reforms in Japan appear to be quite powerful in pulling forward consumption activity prior to implementation of the higher tax rate, as both the data and model suggest. In other respects, however, the model does less well at matching movements in particular series. Investment increased prior to the reforms in Japan in 1997 and 2014, rather than declined as the model suggests. In the US, investment dynamics appear to match the general contours the model predicts, particularly in the period prior to implementation of the reforms at the start of 2013. More broadly, the model highlights that fiscal uncertainty can have meaningful effects well before implementation of policy and as the next section highlights, the extent of any pre-implementation effects rest with the probability households attach to the actual implementation of any reforms.

# 5 Expectations and the Effects of Uncertainty

Households and firms understand the probability of receiving an uncertainty shock, $p$, and the probability that the tax rate adjusts, $q$. As a result, different values for these parameters amount to altering the expectations structure and influence economic outcomes before and after an uncertainty shock. To illustrate the influence of these parameters, this section considers variations in their values and how they effect the response of the economy to an uncertainty shock. The first section examines the effects of expectations on the uncertainty episode by repeating the fiscal noise scenario of

Section 4.1 under different fiscal adjustment probabilities $q$. The second section analyzes how expectations of the likelihood of uncertainty shocks $p$ affects behavior and economic outcomes in the status quo regime $S_t = 0$.

## 5.1 Variations in the Likelihood of Implementation

When a fiscal uncertainty shock hits, the magnitude of the adjustment during the $N$ period horizon depends primarily on the probability $q$ that households attach to the higher tax rate. The baseline parameterization sets $q = 0.25$, so households only partially adjust to a potential change in the tax rule over the $N$ period horizon. If $q = 1.0$, for example, then the uncertainty shock becomes a news shock, and households have complete knowledge about the future tax rate, so would begin fully incorporating higher taxes after $N$ periods into their decisions.

Figure 9 compares dynamics across different values of $q$ in response to a fiscal uncertainty shock about the future income tax rate. The higher $q$, the greater households attached to the rule shifting after $N$ periods. As $q$ rises, the adjustment to an uncertainty shock is more heavily front loaded and therefore, the impact of the shock is larger. In contrast, if $q$ is lower, households place a low probability on a future adjustment so only modestly adjust their behavior when the uncertainty shock hits.

One aspect of the dynamics of interest is the extent of payback, or the rebound, if the tax rule ultimately does not change. In each case, labor rebounds modestly, but not enough to pull up output unless $q$ is relatively high. Instead, the lower capital stock weighs on output after uncertainty is resolved, so households reduce consumption to rebuild the capital stock.

Figure 10 compares the effects of an uncertainty shock about consumption taxes for different values of $q$. The results are analogous to the income tax case and highlight an important aspect of the information structure. If households perceive an adjustment as likely, they begin more aggressively responding the moment the news arrives. If ultimately the tax rate is left unchanged, the impact of the original uncertainty shock injects more volatility into the economy if household perceive a change is likely to occur. If an uncertainty shock arrives, but households perceive the probability of any change as quite low, then failing to implement a policy change introduces only modest additional volatility. However, these implications cut in both directions. After the arrival of an uncertainty shock in a setting where household perceive only a modest chance tax rates will be changed, but they do actually end up adjusting, then households are caught by surprise and undertake larger adjustments. A highly anticipated reform that is ultimately implemented will have a smoother transition, though households would have began the adjustment more forcefully upon the arrival of the uncertainty shock.

## 5.2 Long-Run Effects of Fiscal Uncertainty

A more pernicious implication of fiscal uncertainty arises from the impact on the distributions of variables before an uncertainty shock occurs. As households make decisions in the initial, or status-quo, regime ($S_t = 0$), the probability of higher future tax rates persistently weighs on the level of investment and the capital stock. While $q$ was a key parameter in governing the transitional dynamics following a fiscal uncertainty shock, $p$ is more relevant in affecting the stochastic steady-state levels conditional on the status-quo regime. One interpretation of the parameter $p$ is that it conveys the general level of fiscal uncertainty in the economy. If $p$ is relatively high, households are more likely to face a fiscal uncertainty shock that may result in higher taxes. As Figure 11 illustrates, the stochastic steady-state levels of investment, employment, consumption and output decline as uncertainty about future fiscal regimes increases above the baseline case of $p = 0.01$. These highlight how, even during periods of low uncertainty about tax rates in the next few periods, uncertainty about fiscal policy at longer horizons can still have a negative impact on current conditions.

The framework provides a clear mechanism for how post-recession fiscal policy, which Figure 1 illustrates was often plagued by fiscal uncertainty, as well as how longer-term fiscal uncertainty may weigh on activity, aspects also emphasized by Kydland and Zarazaga (2015). For example, projections from the Congressional Budget Office raise questions about the longer-run stability of debt dynamics over a multi-decade horizon.[5] Such projections raise uncertainty regarding future taxes, which map into the parameter $p$, and as a result, potentially weigh on capital formation.

[5] See Congressional Budget Office (2015)

## 6 Conclusion

This paper considers the effects fiscal uncertainty, such as the fiscal cliff episode in the US and consumption tax policy in Japan. The model developed captures four main features of fiscal policy: uncertainty is generated by news that policy may shift in the future, that tax outcomes are often skewed, that proposed reforms may not actually occur, and that a known resolution date exists. The framework highlights how the arrival of news about future policy, referred to as an uncertainty shock, can cause an immediate response in the economy and that the probability of adopting a new tax regime matters for the initial adjustment, as well as how the economy responds to resolution of uncertainty.

While the US and Japan provided motivation for considering income and consumption tax increases, the general framework developed in this paper can easily be extended to a multitude of issues in fiscal policy including tax cuts, changes in government spending, and managing debt levels. And despite the relatively rare occurrence of fiscal uncertainty episodes, both countries have fiscal policies that set up the potential for future uncertainty episodes, primarily due to projections of rising debt levels. As the framework in this paper suggests, uncertainty about the longer-run can affect the economy even in periods when fiscal uncertainty is low by reducing output and the capital stock.

# 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.

Bianchi, F. (2012). Evolving Monetary/Fiscal Policy Mix in the United States. *American Economic Review 102*(3), 167–172.

Bianchi, F. and L. Melosi (2013). Dormant Shocks and Fiscal Virture. *NBER Macroeconomics Annual 2013 28*, 1–46.

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.

Blue Chip Economic Indicators (2012a). Vol. 37, No. 7.

Blue Chip Economic Indicators (2012b). Vol. 37, No. 8.

Born, B., A. Peter, and J. Pfeifer (2013). Fiscal news and macroeconomic volatility. *Journal of Economic Dynamics and Control 37*(12), 2582–2601.

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

Chung, H., T. Davig, and E. Leeper (2007). Monetary and Fiscal Policy Switching. *Journal of Money, Credit and Banking 39*(4).

Congressional Budget Office (2012). Economic Effects of Reducing the Fiscal Restraint That is Scheduled to Occur in 2013.

Congressional Budget Office (2015). Long-Term Budget Projections.

Davig, T. (2004). Regime-Switching Debt and Taxation. *Journal of Monetary Economics 51*(4), 837–859.

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

Fernández-Villaverde, J., P. A. Guerrón-Quintana, K. Kuester, and J. Rubio-Ramírez (2011). Fiscal Volatility Shocks and Economic Activity. Working papers, NBER.

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.

Hollmayr, J. and C. Matthes (2013). Learning about fiscal policy and the effects of policy uncertainty. Working Paper 13-15, Federal Reserve Bank of Richmond.

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

Kydland, F. E. and C. E. Zarazaga (2015). Fiscal Sentiment and the Weak Recovery from the Great Recession: A Quantitative Exploration. Working Paper.

Leduc, S. and Z. Liu (2015). Uncertainty Shocks are Aggregate Demand Shocks. Federal Reserve Bank of San Francisco Working Paper 2012-10.

Leeper, E. M., M. Plante, and N. Traum (2010). Dynamics of Fiscal Financing in the United States. *Journal of Econometrics 156*, 304–321.

McGrattan, E. (2012). Capital Taxation During the U.S. Great Depression. *The Quarterly Journal of Economics 127*(3), 1515–1550.

Richter, A. and N. Throckmorton (2013, October). The Consequences of Uncertain Debt Targets.

Schmitt-Grohe, S. and M. Uribe (2012, November). What's News in Business Cycles. *Econometrica 80*(6), 2733–2764.

The Economist (2014). Groundhog Day? Japan's Consumption Tax Hike. April 5.

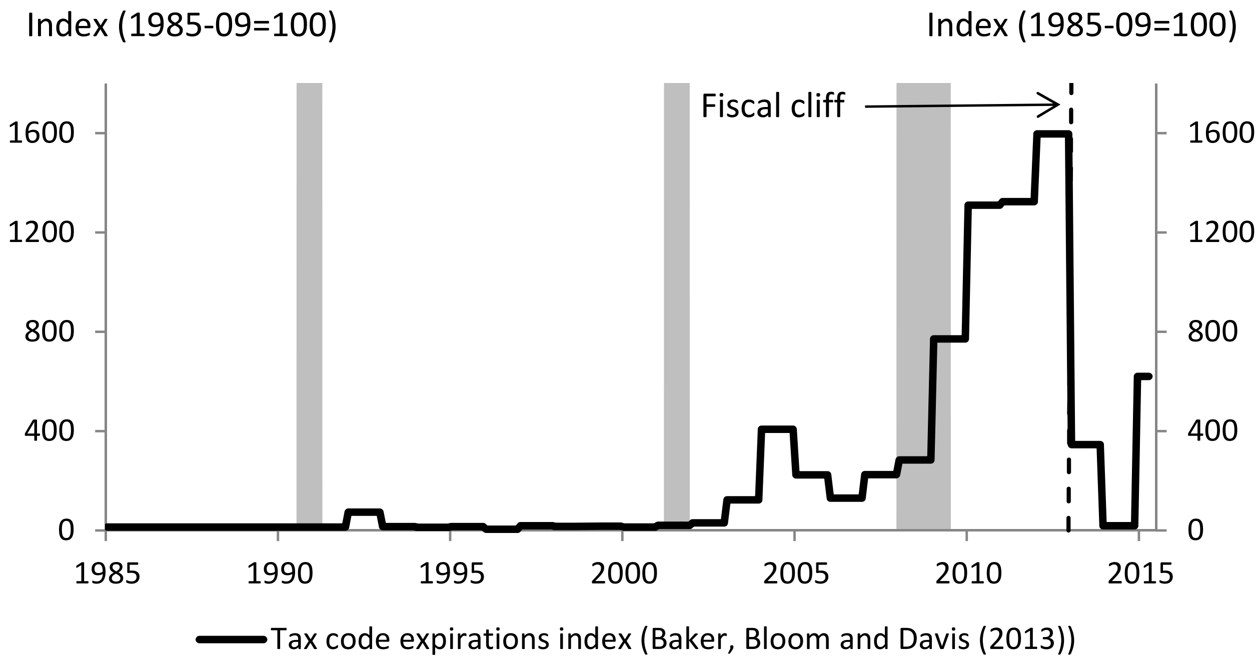


Figure 1: Tax code expirations index

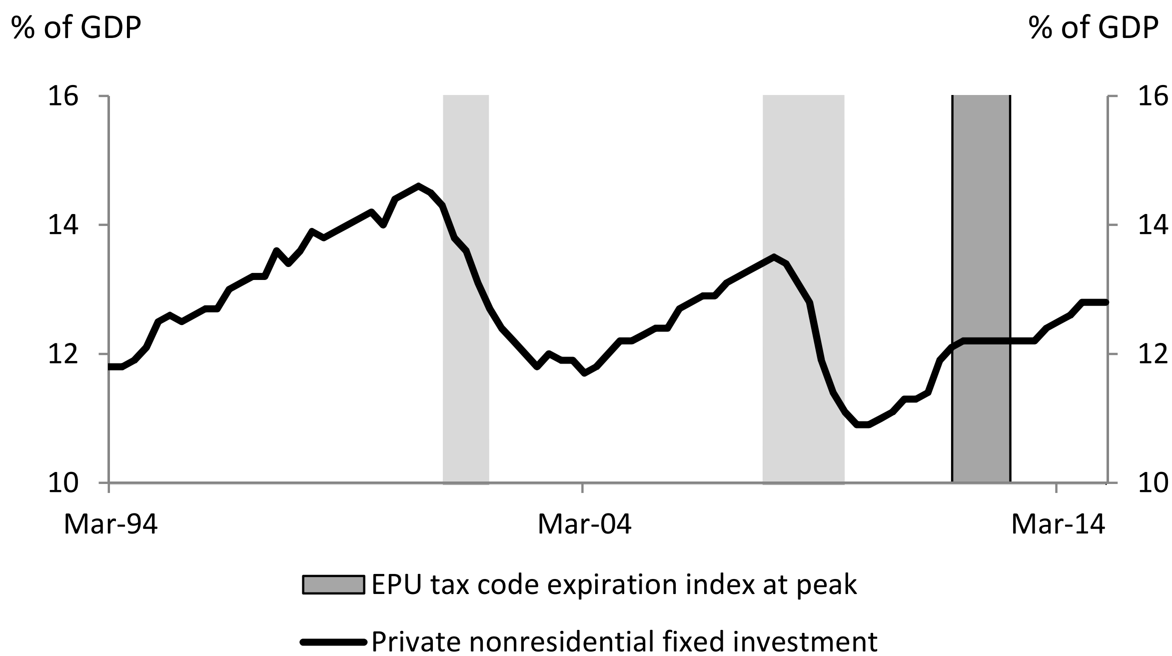


Figure 2: US nonresidential fixed investment, as a share of GDP, was flat when the EPU tax code expiration index was at its peak.

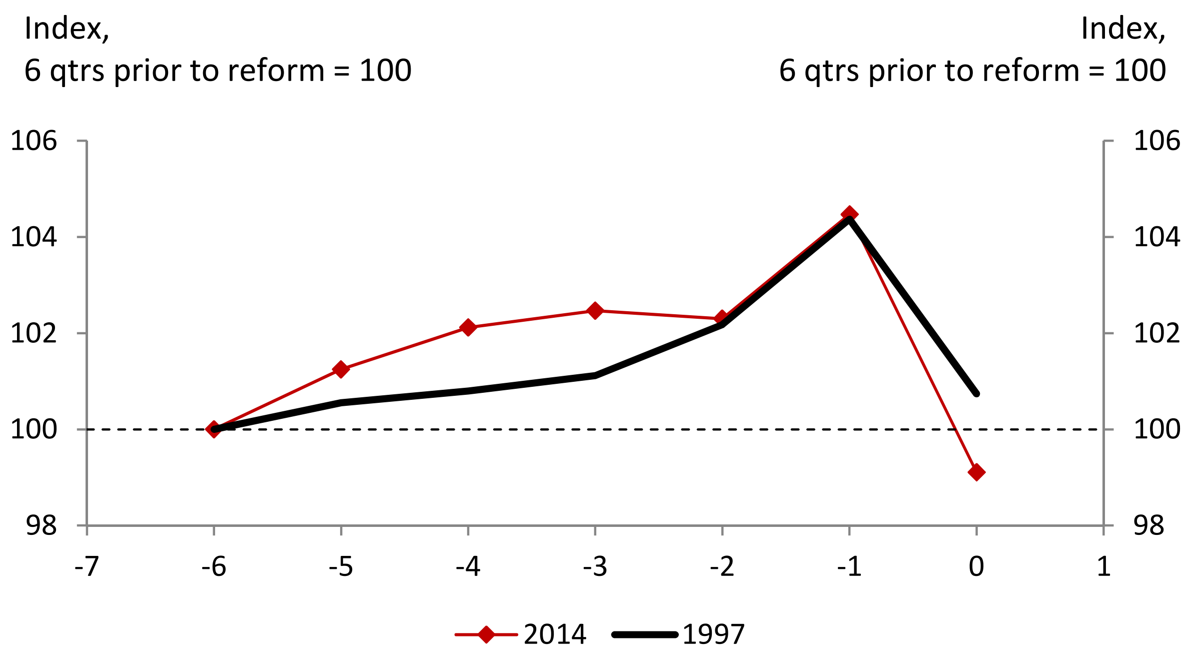


Figure 3: Japanese consumption prior to the implementation of increases in the consumption tax rate.

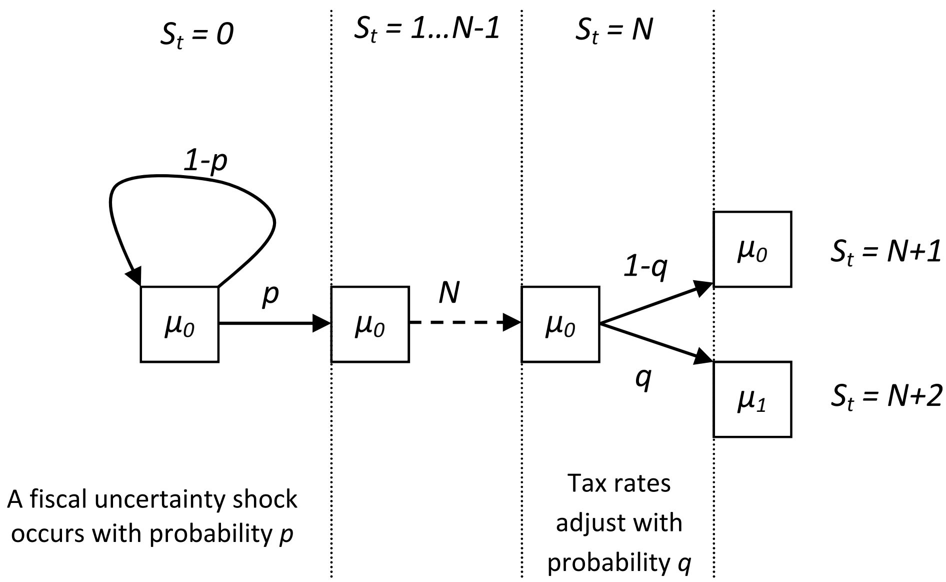


Figure 4: The progression of fiscal uncertainty.

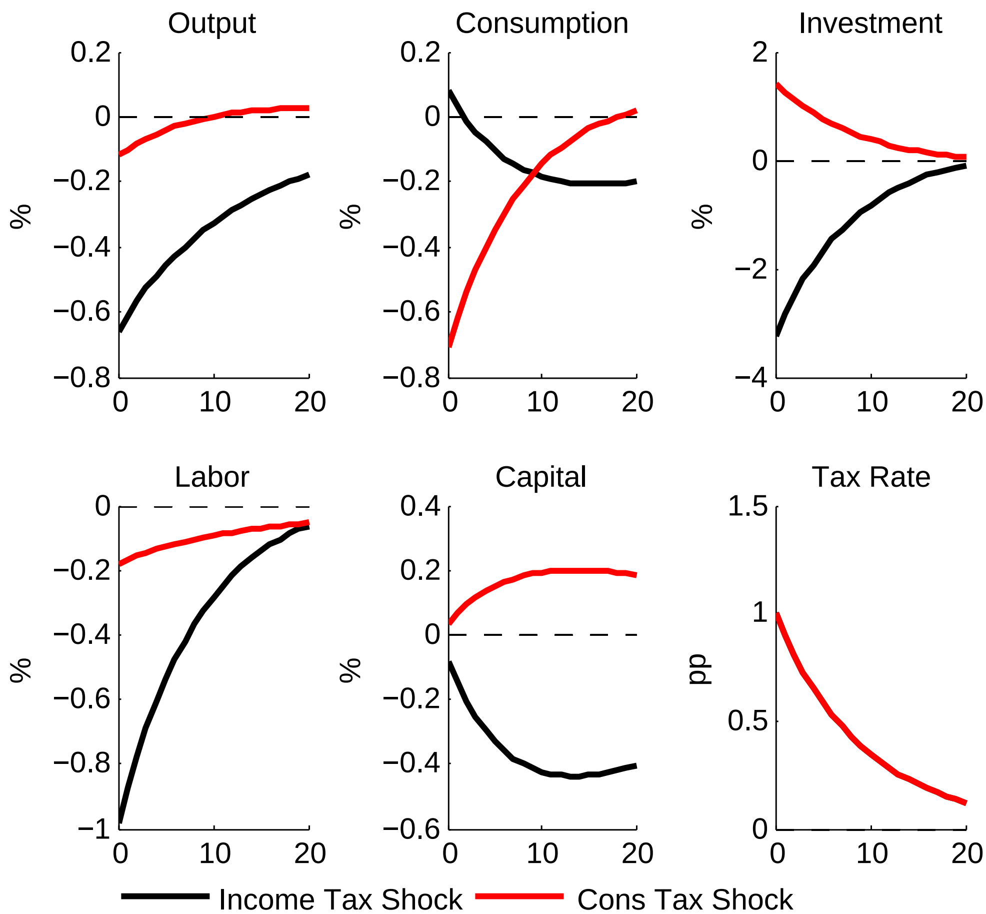


Figure 5: Responses to an intra-regime income and consumption tax shock.

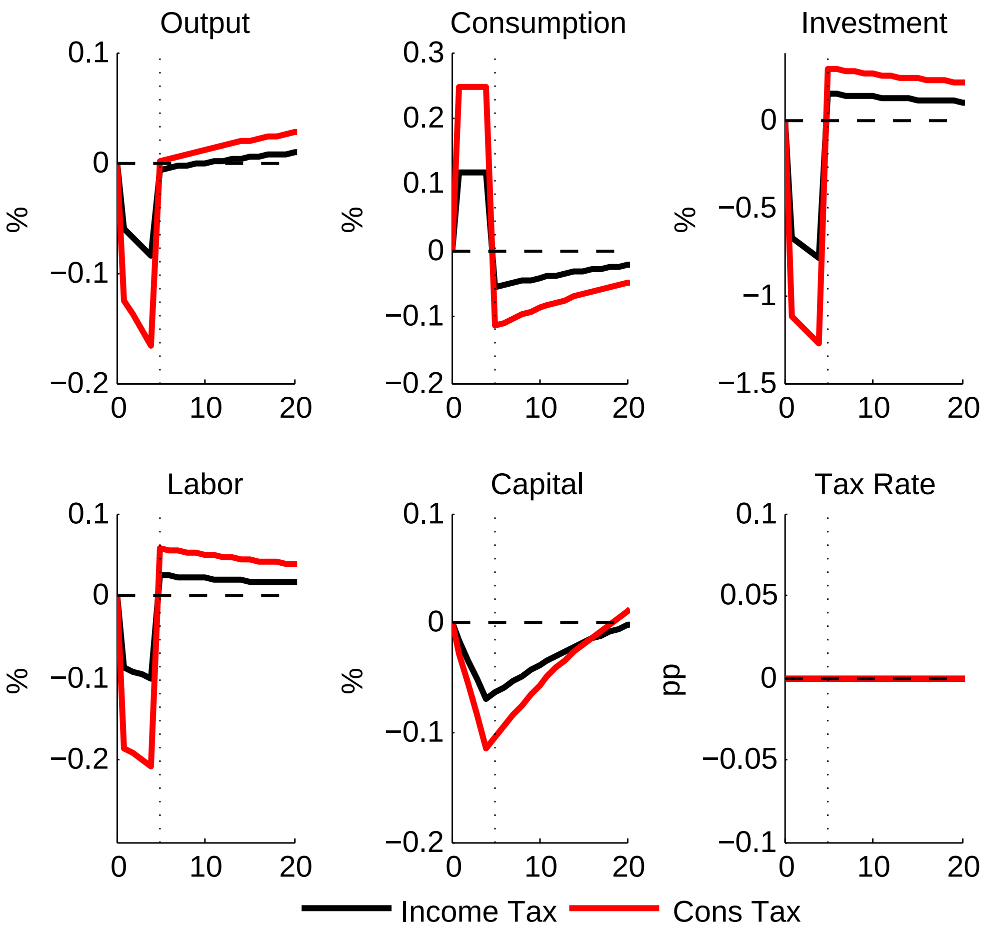


Figure 6: Comparison of a fiscal uncertainty shock about the future income tax rate with the consumption tax rate.

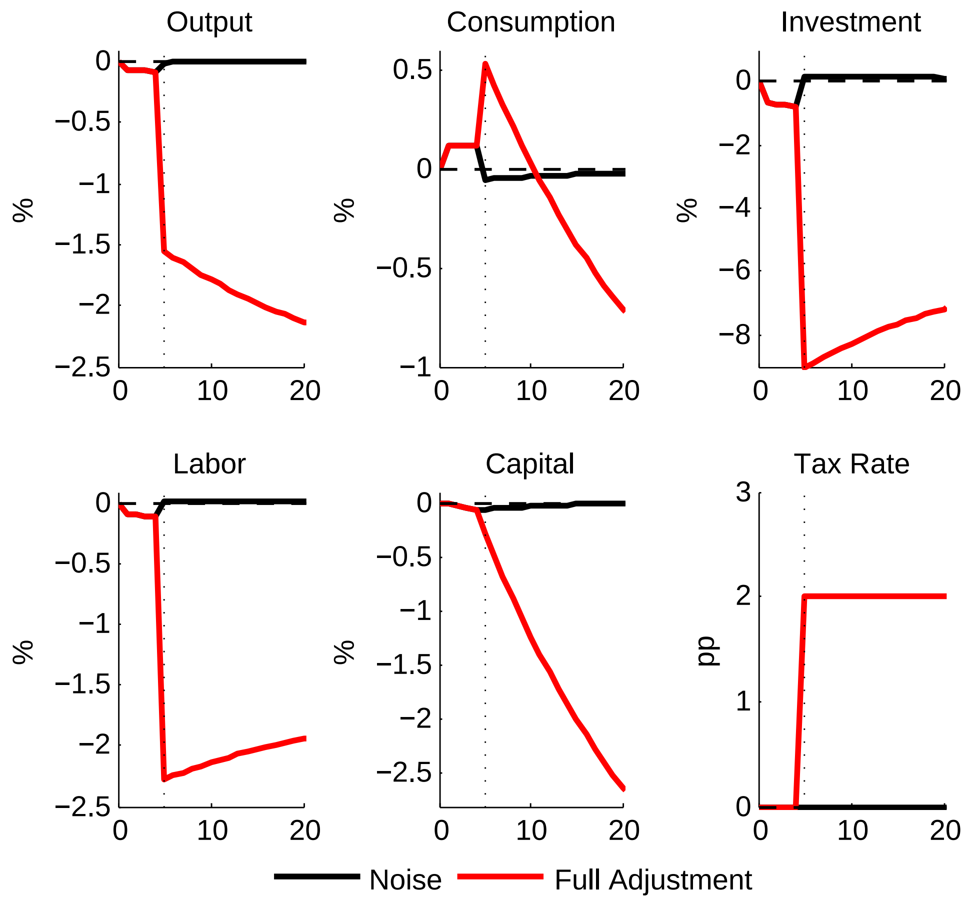


Figure 7: Responses to a fiscal uncertainty shock compared to a full fiscal adjustment in the income tax rate.

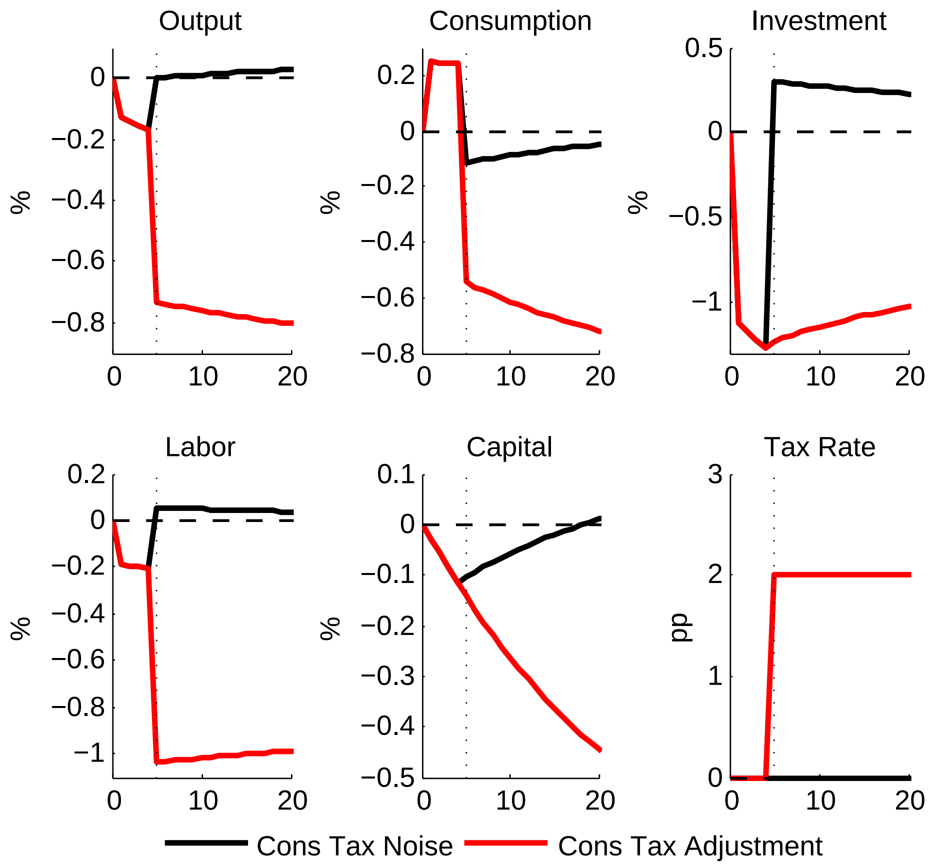


Figure 8: Responses to a fiscal uncertainty shock compared to a full fiscal adjustment in the consumption tax rate.

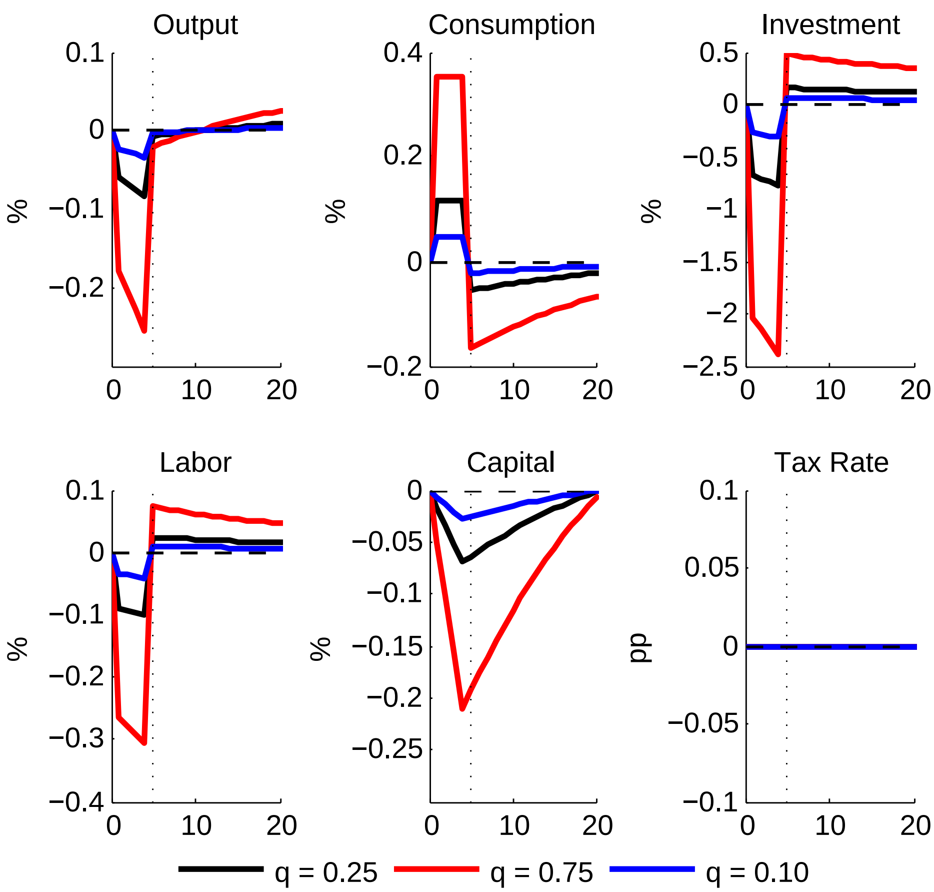


Figure 9: Responses to a fiscal uncertainty shock about the future income tax rate for different likelihoods for implementation.

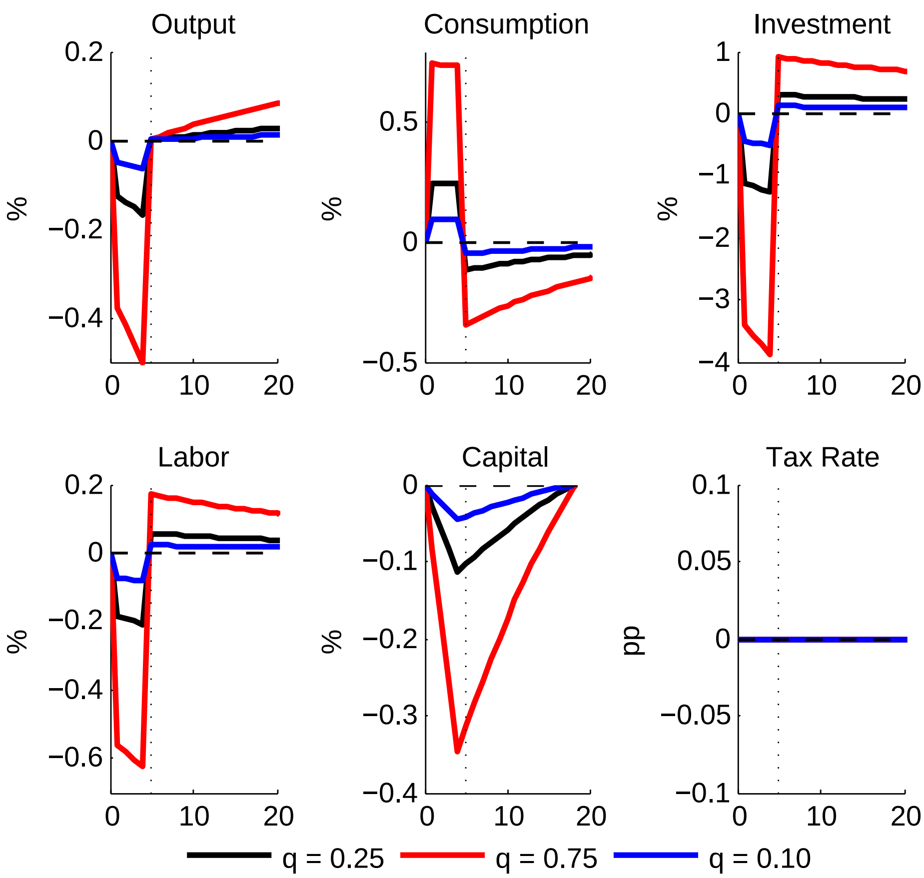


Figure 10: Responses to a fiscal uncertainty shock about the future consumption tax rate for different likelihoods for implementation.

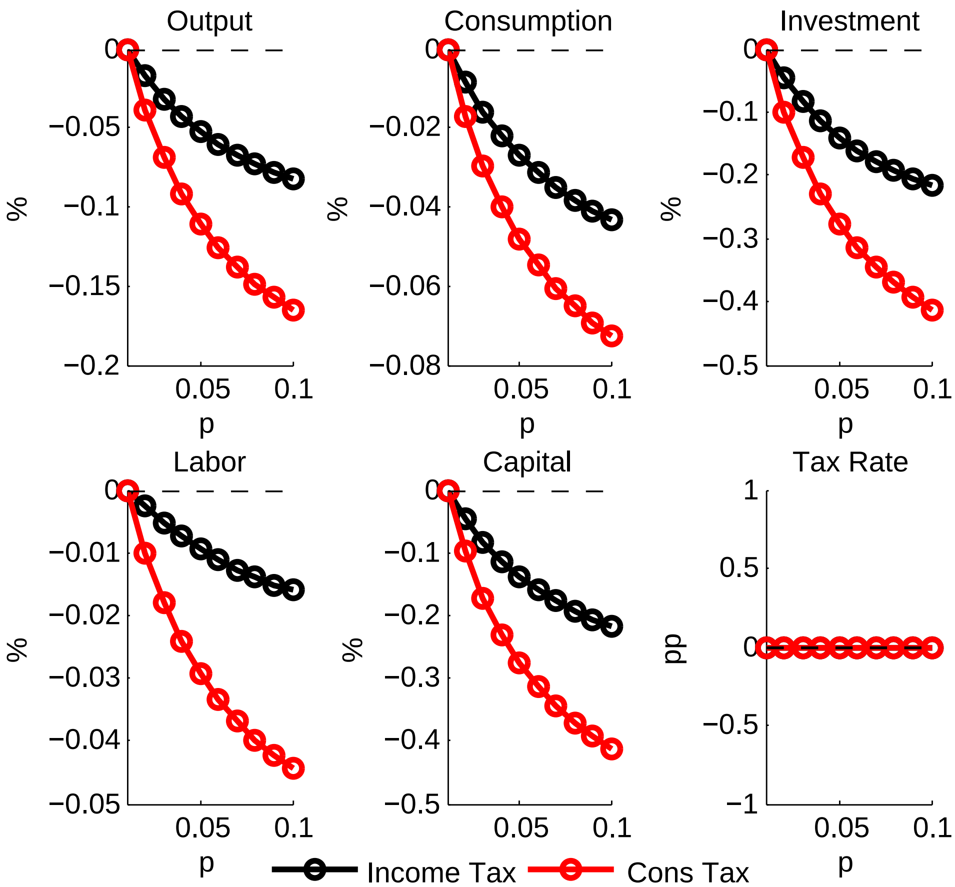


Figure 11: The stochastic stochastic steady state in the status quo regime relative to the baseline case with $p = 0.01$.