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Uncertainty and Fiscal Cliffs*

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Abstract

Large pending fiscal policy changes, such as in the United States in 2012 or in Japan with consumption taxes, often generate considerable uncertainty. “Fiscal cliff” episodes have several features: an announced possible future change, a skewed set of possible outcomes, the possibility that implementation may not actually occur, and a known resolution date. This paper develops a model capturing these features and studies their impact. Fiscal cliff uncertainty shocks have immediate impact, with a magnitude that depends on the probability of implementation, which generates economic volatility. The possibility of fiscal cliffs lowers economic activity even in periods of relative certainty.

JEL Classification: E20, E60, E62

Keywords: Fiscal Policy, Uncertainty, Distorting taxation

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1 INTRODUCTION

Fiscal policy changes frequently, but occasionally a large shift in policy appears on the horizon. This pending large change in policy can generate considerable uncertainty about the future path of policy, which can in turn affect the macroeconomy. These “fiscal cliffs” might arise due to a built-in expiration of old legislation, as was the case in the United States in 2012, or due to pre-announced new legislation, as in Japan several times in the 1990s and 2010s. In any event, fiscal cliffs represent an acute form of uncertainty about policy.

The uncertainty associated with fiscal cliffs has four particular aspects that make it unique and perhaps distinct from other types of policy uncertainty. First, the fiscal cliff uncertainty is triggered well in advance of possible changes in policy, with specific news about the possible implementation of reforms generating the uncertainty. Second, the uncertainty is over a skewed rather than symmetric set of outcomes. 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 fiscal cliff generates uncertainty because the ultimate implementation of proposed reforms remains in question until the changes take effect, and the proposed policy changes can be abandoned at any time. For example, tax provisions that are set to expire may be extended at any point up to the last minute, or a scheduled fiscal tightening may be postponed. Fourth, the fiscal cliff uncertainty has a known resolution date. 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. The first example is the United States, where a confluence of factors set up the potential for a sharp tightening of fiscal policy starting in 2013, an episode that popularized the term “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 2012. The second example is Japan, which gave pre-announced specific dates for increasing consumption tax rates, first in 1997 and again several times during the 2010s. The planned changes in consumption tax rates were also well understood, but whether or not the government would allow them to go into effect as announced remained in doubt. These two examples have all the features described above: an information flow about the possible tax changes well in

advance of possible changes, a skewed distribution over future tax rates, uncertainty regarding ultimate implementation, and a specific timeline for resolution.

This paper develops a model of fiscal cliff episodes that captures these four aspects and uses the framework to study the effects of the uncertainty that such episodes generate. Specifically, the model has fiscal cliff shocks that represent information about a possible future shift in 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 cliff 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 depends on the probability attached to a possible reform being implemented. If reform is viewed as 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 cliff 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 ultimately is adopted, the shift to a new fiscal regime is abrupt and induces a relatively volatile adjustment. Similarly, failing to enact a highly anticipated reform can induce substantial volatility as the economy moves towards a new fiscal regime that is ultimately not adopted, so decisions made upon the initial announcement must be unwound. Fourth, the probability attached to receiving a fiscal cliff uncertainty shock affects the level of the economy before uncertainty hits, even keeping the expected value of taxes the same. If there is a higher probability of going through fiscal cliff episodes in the future due to rising government debt projections, then the level of 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 literature studying the economic effects of uncertainty. Bloom (2009) shows that after an increase in uncertainty, firms pause in undertaking new hiring and investment, then overshoot in the future when the uncertainty is resolved. Basu and Bundick (2012), Bloom et al. (2012), and Leduc and Liu (2016) provide frameworks where uncertainty shocks are important drivers of fluctuations; Christiano, Motto, and Rostagno (2014) 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. (2015) show that time-varying volatility in fiscal policy generates negative movements in economic 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 (2015) or Richter and Throckmorton (2015), in which 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 a fiscal cliff shock, resembles a news shock. Rather than a noisy signal, as in Schmitt-Grohe and Uribe (2012) and Born, Peter, and Pfeifer (2013), a fiscal cliff shock can be interpreted as information about a potential change in the policy rule at some specified future date. In this way, the setup mimics Jaimovich and Rebelo (2009), where a news shock can be information that technology will be higher at a given point in the future with a certain probability. With fiscal cliffs, an added layer of informational complexity is that each period the pending implementation of tax changes can be abandoned, implying that uncertainty becomes more acute as the economy approaches the decision point. In the context of government spending shocks, Ramey (2011) highlights the importance of news about future reforms for assessing implications for the government spending multiplier.

Finally, a large body of research studies how uncertainty over discrete changes in future fiscal policy affects the economy in the short term. For example, Chung, Davig, and Leeper (2007), Bianchi (2012), and Bianchi and Melosi (2013) describe how the potential for switches in the fiscal policy rule matters for how the economy responds to shocks or how shifts in a contemporaneous policy rule affect 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 motivating examples of fiscal cliffs from the US and Japan. Section 3 discusses a model that captures elements of these episodes. Using this model, Section 4 shows the impact of fiscal cliff uncertainty. Section 5 highlights how expectations interact with fiscal cliffs and Section 6 concludes.

2 MOTIVATING EXAMPLES

Although examples of fiscal cliff-type episodes abound, two in particular stand out: the United States in 2012 and several repeated episodes in Japan during the 1990s and 2010s. This section reviews these two examples, drawing conclusions from the narrative.

2.1 US Fiscal Cliff of 2012

The first example of fiscal uncertainty is from the US and the fiscal cliff episode of 2012. The source of this uncertainty episode originates with income tax reductions originally passed in 2001 and 2003, which were originally 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, Bloom, and Davis (2016). 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 letting the tax provisions expire, however, in December 2010 Congress passed legislation that temporarily extended several of the provisions. In addition, the legislation also introduced additional temporary measures, including 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, 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 debate about 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 2011. 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 take effect at the start of 2013.

In sum, the Congressional Budget Office (2012) 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. On January 1, 2013 Congress passed legislation that was signed into law the following day. The legislation extended most of the tax cut 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 scheduled.

Uncertainty about the possible change in legislation was widely viewed as a drag on the econ-

omy during 2012. Federal Reserve Chairman Ben Bernanke sounded the warning to Congress on February 29, 2012, saying, “Under current law, on January 1, 2013, there’s going to be a massive fiscal cliff” according to reporting by Reuters (2012). Several months later, in November, he warned “Uncertainty about how the fiscal cliff, the raising of the debt limit, and the longer-term budget situation will be addressed appears already to be affecting private spending and investment decisions and may be contributing to an increased sense of caution in financial markets, with adverse effects on the economy. Continuing to push off difficult policy choices will only prolong and intensify these uncertainties” (Bernanke, 2012).

More broadly, 87% of respondents to the July 2012 survey by Blue Chip Economic Indicators (2012a) responded that they thought 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. In the August 2012 survey by Blue Chip Economic Indicators (2012b), 74% of respondents reported they viewed the fiscal cliff uncertainty as affecting capital spending more than other spending categories, compared to 26% that viewed consumer spending as more likely to be most affected.

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 of this uncertainty are most apparent in the US investment data. Figure 2 shows that as a share of GDP, nonresidential fixed investment was essentially unchanged in 2012, somewhat corroborating the views of both Bernanke and Blue Chip respondents.

2.2 Japanese Consumption Tax Cliffs

The second example of fiscal uncertainty is from Japan and repeated pre-announced changes to consumption taxes. On multiple occasions starting in the mid-1990s, the Japanese government declared intentions to raise the consumption tax, but in each case wavered in its commitment to implement the change before either abandoning the proposed change or ultimately enacting it.

During the first case, 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. Reforms in the package included a pre-announced increase in the consumption tax from 3% to 5% that was scheduled to take place starting in April 1997. In September 1996, however, the Finance Minister reported that there was a possibility that the tax increase could be delayed, but needed to see 1997 Q2 GDP statistics before making a final

decision. The tax increase was ultimately implemented, and Japan fell into recession shortly thereafter, although the recession was likely a confluence of several factors including the wider Asian crisis (Nakamichi, 2013).

Similarly, in 2012 the Japanese government announced plans to increase consumption taxes from 5% to 10% in two steps: the first increase to 8% would take place in April 2014, while the second increase to 10% would take place in October 2015. The first reform ultimately occurred despite doubts and a pre-implementation boom in consumption. Expectations of a repeat of the post-increase slowdown experienced in 1997 led government officials to cast doubt on whether the subsequent increase would actually be implemented, adopting a “wait-and-see” approach to determine how resilient the economy was to the first increase before adding a second (The Economist, 2014).

The economy was not viewed to have been resilient enough after the first increase, however, and Prime Minister Shinzo Abe announced a delay of the second tax increase in November 2014, almost a year before it was supposed to go into effect. The implementation was pushed back until April 2017, but this target date was not met either; in June 2016 Abe announced a further delay, this time to October 2019 (Japan Times, 2016).

As with the fiscal cliff in the United States, disentangling the effects of the fiscal uncertainty and the actual tax changes from other factors such as the Asian financial crisis in the 1990s is difficult. Many commentators pointed to a consumption boom prior to the implementation of the tax increase as one prominent economic outcome (for example, The Economist, 2014). Figure 3 compares consumption prior to the tax increases in 1997 and 2014. In both cases, anticipation of higher consumption tax rates sharply pulled forward consumption activity, but resulted in a decline immediately after implementation.

2.3 Discussion

The experiences of the US in 2012 and Japan in the 1990s and 2010s highlight the four features of fiscal cliff uncertainty already briefly discussed and suggest possible economic outcomes.

The first feature is that specific news about the possible implementation of reforms generated the uncertainty well before possible changes were to be made. In the US in 2010 and 2011, several different tax rates were legislated to change at the end of 2012. In Japan, specific legislation pinpointed a future date at which consumption taxes would increase.

The second feature is that the possible outcomes were relatively well defined and skewed toward either tax increases or no change if the reform was not implemented. In the US, the tax

rates would either reset to pre-specified values or a deal would be made to keep taxes unchanged, while in Japan either the legislated tax increase would take effect or legislation would stall or cancel the planned changes.

The third feature is that implementation remained in question until the changes took effect or were abandoned at some point. In the US, the implementation was avoided at the very last moment, but there was a chance for legislation earlier in 2012 that would have avoided the cliff. In Japan, consumption taxes increased on two occasions after some uncertainty about whether they would be carried out; the third planned increase, on the other hand, was delayed well before it would have been implemented. In other words, the future tax rates were potentially uncertain until the deadline, and while there was always the chance for early news that taxes would not change, there was never the chance of early news that taxes would change.

The fourth and last feature is that there was a well-defined resolution date for the uncertainty. In the US, uncertainty grew until the end of 2012 when the economy reached the decision point. For Japan, the legislated dates represented known points at which, absent any delays, the tax rate would change. After these key resolution dates had passed, tax policy over the near term was relatively certain.

While the evidence for both the US and Japan during these times remains somewhat difficult to assess due to the limited set of dates, the data and commentary at least suggest that the uncertainty slowed economic activity, particularly depressing investment in the US. In addition, the consumption tax case in Japan strongly suggests an acceleration of consumption prior to the tax increase, followed by a drop upon implementation.

With these features in mind, the following section turns to presenting a model that captures the four features of uncertainty, and the following sections assess the model to show the economic implications.

3 NEW KEYNESIAN MODEL

This section describes a mostly prototypical New Keynesian model with a representative household, two types of firms, and a government that controls monetary and fiscal policy. The exposition of the household and firms will be brief since they are standard. More focus will be given to fiscal policy and the evolution of uncertainty. The section closes with a discussion of the parameterization used, as well as the effects of a standard shock to tax rates.

3.1 Representative Household

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

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

where $\beta \in (0, 1)$ denotes the discount factor, $\psi > 0$ governs the disutility of labor, and θ is the Frisch elasticity of labor supply. In general, they are subject to the budget constraint

$$(1 + \tau_{C,t}) C_t + X_t + \frac{B_t}{P_t} = (1 - \tau_{I,t}) (R_{k,t} K_{t-1} + W_t N_t) + R_{b,t-1} \frac{B_{t-1}}{P_t} + T_t, \quad (2)$$

where $R_{k,t}$ denotes the real rental rate on capital, W_t denotes the real wage rate, $R_{b,t}$ denotes the nominal interest rate, P_t denotes the price level, and T_t denotes transfers. Households may face either a distorting tax on wage and rental income $\tau_{I,t}$ or consumption $\tau_{C,t}$. For simplicity, the ensuing discussion takes a one-at-a-time approach, assuming the tax rate not being analyzed equals zero. Capital accumulates according to

$$K_t = (1 - \delta) K_{t-1} + X_t, \quad (3)$$

where δ denotes the depreciation rate.

3.2 Firms

There are two types of firms: final goods firms and intermediate goods firms.

A competitive final good producer combines a continuum of intermediate goods $Y_{j,t}$, $j \in [0, 1]$ to produce a final good Y_t according to

$$Y_t = \left(\int_0^1 Y_{j,t}^{\frac{\eta-1}{\eta}} dj \right)^{\frac{\eta}{\eta-1}}, \quad (4)$$

where η denotes the constant elasticity of substitution.

A continuum of intermediate goods producers are indexed by j and have production function

$$Y_{j,t} = K_{j,t-1}^\alpha N_{j,t}^{1-\alpha}. \quad (5)$$

These producers solve a two-stage problem. First, taking the wage W_t and rental rate $R_{k,t}$ as given, they choose their labor $N_{j,t}$ and capital $K_{j,t-1}$ to minimize costs subject to the fact that supply must meet demand at the posted price. Second, firms face a Calvo friction in the adjustment of prices, which implies it re-optimizes its price with probability $1 - \gamma$. A firm re-optimizing its price chooses $P_{j,t}$ to maximize

$$\mathbb{E}_t \sum_{\tau=0}^{\infty} (\beta\gamma)^\tau \frac{\lambda_{t+\tau}}{\lambda_t} \left\{ \left(\frac{P_{j,t+\tau}}{P_{t+\tau}} - mc_{t+\tau} \right) Y_{j,t+\tau} \right\}, \quad (6)$$

where mc_t denotes marginal cost, which is equal across firms.

3.3 Government

The government consists of a monetary authority and a fiscal authority. The monetary authority sets the nominal rate depending on inflation $\Pi_t = P_t/P_{t-1}$ according to

$$\frac{R_{b,t}}{R_{b,ss}} = \left(\frac{R_{b,t-1}}{R_{b,ss}} \right)^{\phi_r} \left(\frac{\Pi_t}{\Pi_{ss}} \right)^{\phi_\pi(1-\phi_r)} \quad (7)$$

where $R_{b,ss}$ denotes the steady state nominal rate, while ϕ_r and ϕ_π denote the degree of interest rate inertia and response to inflation, respectively.

The government runs a balanced budget, rebating all of its tax income back to the household via lump-sum transfers,

$$\tau_{C,t}C_t + \tau_{I,t}(R_{k,t}K_{t-1} + W_tN_t) = T_t. \quad (8)$$

The tax rule is given by

$$\tau_{j,t} = \mu_j(S_t) + \varepsilon_{j,t} \quad (9)$$

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

$$\varepsilon_{j,t} = \rho\varepsilon_{j,t-1} + \sigma u_{j,t} \quad (10)$$

with $u_{j,t} \sim N(0, 1)$ and $\mathbb{E}[u_{j,t}u_{j,s}] = 0$ for $s \neq t$. Innovations in $u_{j,t}$ represent intra-regime shocks and changes in S_t represent regime shifts. The intercept governing the regime-dependent average level of taxation takes one of two values, either high H or low L :

$$\mu_j(S_t) \in \{\mu_j^L, \mu_j^H\}. \quad (11)$$

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

3.4 Information Structure

Figure 4 illustrates the flow of information and how uncertainty is resolved. In the regime denoted $S_t = 0$, the average tax rate is set at μ_j^L , and households and firms understand that an adjustment in the tax rate in the future is possible, but view the exact timing as uncertain. With probability $1 - p$ the economy remains in this “status quo” regime and $S_t = 0$. On the other hand, with probability p the economy receives a fiscal cliff uncertainty shock that shifts it to regime $S_t = 1$, as there is new information indicating a new tax regime may be in place after N periods. In other words, the fiscal authority announces a plan to change the average tax rate to μ_j^H in N periods. This shock brings into focus the timing of a possible tax reform, although whether the reform is implemented or not remains uncertain. The regime change from $S_t = 0$ to $S_t = 1$ has the flavor of a news shock, as no fundamental policy parameters actually change, but provides a clear calendar regarding the timing of a possible adjustment to tax rates.

In the period after receiving the signal about a possible future tax change, the economy is in regime $S_t = 1$. With probability q there is no further information, and the economy transitions closer to the impending tax reform, with the new regime being $S_t = 2$. On the other hand, with probability $1 - q$ the fiscal authority announces a deal has been made to keep taxes at the current average rate for the foreseeable future, which is represented by a transition to regime $S_t = N + 1$. If a deal is not made, in subsequent periods the fiscal authority continues towards reform with probability q each period, and avoids reform with probability $1 - q$. In N periods after the initial signal, current legislation sunsets, requiring a deal to keep the status quo or an adjustment in average tax rates to μ_j^H actually occurs.

The timing outlined in Figure 4 has several implications for economic behavior. First, upon the first move from $S_t = 0$ to $S_t = 1$, households and firms understand tax reform is imminent, and so begin adjusting their behavior immediately upon receiving the information. Second, along the path of $S_t = 1, \dots, N$, each progression contains news that tax reform is becoming more likely. Specifically it occurs at the end of the path with probability q^{N-S_t+1} . Third, in each period with $S_t < N$, the tax rate in the immediate future is known, as there is no chance of tax reform prior to the known date, but there is the chance of a deal that avoids tax reform for the indefinite future.

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

the regime. For the parameterization considered below with $N = 4$, the transition matrix is

$$\mathbb{P} = \begin{bmatrix} 1-p & p & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & q & 0 & 0 & 1-q & 0 \\ 0 & 0 & 0 & q & 0 & 1-q & 0 \\ 0 & 0 & 0 & 0 & q & 1-q & 0 \\ 0 & 0 & 0 & 0 & 0 & 1-q & q \\ r & 0 & 0 & 0 & 0 & 1-r & 0 \\ r & 0 & 0 & 0 & 0 & 0 & 1-r \end{bmatrix}. \quad (12)$$

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.

3.5 Parameter Values and Model Solution

Table 1 displays the full set of parameter values assuming a unit of time equals a quarter. For preferences, the discount factor β implies a steady state real interest rate of 2 percent per year, the constant relative risk aversion and the Frisch elasticity of labor supply are both set to common values in the literature.¹ The capital share is set to be a third, and the depreciation rate implies roughly 10 percent depreciation per year. The Calvo parameter γ implies an average price duration of 3 quarters, while the elasticity of substitution implies a steady state markup of 11 percent. Lastly, the monetary policy parameters generate some persistence in the setting of the nominal rate as well as a more than one-for-one change with respect to inflation.

Turning to the parameters regarding fiscal cliffs and uncertainty, the two probabilities, p and q , control the likelihood of a fiscal cliff shock and an adjustment in the tax rate. The baseline parameterization has $p = 0.01$, capturing the unlikely nature of fiscal uncertainty episodes, and $q = 0.50$, meaning the economy progresses toward reform or avoids the cliff with equal probability. The parameter N dictates the length of uncertainty about future tax rates; a value of 4 implies a duration of one year. The choice of average income tax rates, $\mu_I^L = 0.18$ and $\mu_I^H = 0.20$, are roughly in line average taxes in the US (Leeper et al. (2010)), while the average consumption tax rates, $\mu_C^L = 0.05$ and $\mu_C^H = 0.07$ are in line with recent experience in Japan.² Note that, given the calibration of the tax rate shock $\sigma = 0.005$, the differences between the average tax rates in the high and low tax regimes are four 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. (2016), with a second-order approximation used to improve accuracy. Since the model has two sources of nonlinearity—regimes that affect the level of the economy and a second-order approximation—the responses to both intra-regime shocks and fiscal cliff episodes below are shown as deviations from the stochastic steady state of the status quo regime. In other words, zero deviation indicates the level had no shock occurred.

3.6 Intra-Regime Shock

Before discussing the impact of a fiscal cliff shock, first consider the impact of a temporary shock to the tax rate, $u_{j,t}$, without any uncertainty about future tax regimes. In this case, $p = 0$, so households expect μ_j^L 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 in turn lowers consumption as household income declines. With sticky prices, output is demand determined, so the drop in consumption and investment lower output. The magnitude of the drop in output is in line with the approximately 1.5 percent change in output from a 1 percentage point income tax shock found by Mertens and Ravn (2013).

The response to a consumption tax shock is rather different. Instead of changing the expected after-tax rate of return on investment, the shock 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. For any given real wage and level of consumption expenditures, a higher tax rate is consistent with a decline in the marginal utility of consumption 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 cause consumption, labor, and

output to decline. The relative allocation of resources towards 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 differing responses to each type of tax shock, fiscal cliff uncertainty shocks will generate similar movements in investment across taxes, as the next section shows.

4 FISCAL CLIFF EPISODES

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

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

4.1 Evolution of Uncertainty

Prior to discussing the economic effects of a fiscal cliff uncertainty shock, Figure 6 highlights how uncertainty evolves after such a shock for the income tax case. At $t = 0$ the economy is in the status quo regime ($S_t = 0$), it experiences a fiscal cliff shock at $t = 1$, in $t = 2, 3, 4$ it remains along the uncertainty path, and in $t = 5$ the economy avoids the cliff, leaving the tax rate unchanged. The top panel of the figure shows the means of the conditional forecasts for τ_{t+h}^I for $h = 0, 1, 2, 3, 4$, while the bottom panel shows the standard deviations.

In the status quo regime, the expected value of future tax rates is μ_I^L at all horizons, and the standard deviation is low and only affected by the standard deviation of the shock ε_t . As the economy progresses towards the cliff, short term uncertainty remains low, but the distribution of possible tax rates at longer horizons increases in both mean and standard deviation. Ultimately at $t = 4$ the expected mean for one period ahead places equal weight on μ_I^H and μ_I^L , and the

standard deviation of the forecast peaks. When the cliff is ultimately avoided at $t = 5$ both the mean and standard deviation return to lower levels.

This simple exposition of uncertainty highlights two features of fiscal cliff episodes in the current framework. First, the regime switching structure generates both changes in expected value and also changes in standard deviations as the set of possible outcomes increases. The fiscal cliff uncertainty thus joins changes in expected values with the higher volatility of possible outcomes usually modelled as second-moment shocks, for example, by Bloom (2009) or Fernández-Villaverde et al. (2015).³ Second, these episodes generate a very specific term structure of uncertainty, with relative certainty governing the short term horizons, and then higher uncertainty starting at the final decision point at which taxes must adjust or remain unchanged. As the cliff approaches, the term structure of uncertainty becomes much steeper at close horizons.

4.2 Fiscal Noise

Figure 7 compares how the impact of a fiscal cliff uncertainty shock differs depending on whether it is about income or consumption tax increases. The figure shows similar timing to that in Figure 6, where the economy is in the status quo regime in period $t = 0$, experiences a fiscal cliff uncertainty shock at $t = 1$, progresses towards the cliff in $t = 2, 3, 4$, and in $t = 5$ the cliff is avoided and taxes are ultimately left unchanged.

Considering first the case of a possible rise in income tax rates, households and firms immediately begin the process of adjusting to a potential new tax regime upon the arrival of the fiscal cliff information. With the possibility of higher income taxes in the future, the after-tax return to capital declines, so the desired capital stock declines and investment falls. A similar channel operates for labor, with lower desired future labor supply producing a leisure-smoothing motive, which lowers the realized current labor supply. Consumption declines on net, as households substitute away from consumption to leisure. With output being demand-determined, output falls, as does inflation.

In each period following the fiscal cliff uncertainty shock, the economy progresses towards the cliff, and the effects of uncertainty about future tax rates become more acute, dampening the economic variables at an increasing rate as the cliff approaches. 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 μ_T^L . In period $t = 5$, tax rates are not adjusted, indicating to households and firms that the average tax rate will remain at μ_T^L 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 higher labor supply. In general equilibrium, consumption rises as well, as some of the additional labor income goes toward supporting consumption. Output and inflation surge with the higher investment and consumption.

In the case of the potential consumption tax increase shown in Figure 7, with the exception of consumption, the general pattern of responses are qualitatively similar to those of the income shock. The difference in the consumption responses is due to the magnitude of inter-temporal substitution towards current consumption. With the future marginal utility of the return to capital declining, households want to invest less and supply lower future labor, generating the same channels seen in the income tax case. However, in this case the motives that depress consumption under the income tax case are outweighed by a desire to lower the capital stock further, so consumption increases to facilitate a decumulation of capital.

Again, in this example, as the economy progresses toward the cliff, uncertainty becomes more acute, producing increasingly large effects as time progress. When the increase in consumption taxes fails to materialize it becomes known that average tax rates remain at μ_C^L at period $t = 5$ and beyond. Mimicking the income tax case, upon the resolution of uncertainty, both investment and labor increase. In a reverse of the allocation toward consumption and away from capital that occurred during the period of uncertainty, consumption now falls to make way for more investment. In other words, 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.

4.3 Full Fiscal Adjustment

Alternatively, policymakers may implement reforms after the N period horizon. Figure 8 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 into motion household decisions to complete the adjustment that began when the fiscal cliff uncertainty shock first hit. Investment, labor, consumption, and output drop sharply after the implementation of the new tax rate.

Figure 9 shows the effect of an actual adjustment in the consumption tax rate. The primary

difference between the income tax and consumption tax adjustment scenarios is that the consumption tax change increases the relative price of consumption goods, so households reallocate resources toward investment. Investment thus rises slightly relative to its level in the previous period, but remains depressed relative to the pre-uncertainty level. Overall, consumption, investment, and labor supply all decline when the actual tax adjustment happens and then transition to lower stochastic steady state values. Since consumption taxes are more targeted than income taxes, which discourage investment and labor rather than just consumption, the effects of adjustment are smaller in the consumption tax case than the income tax case.

4.4 Discussion

A comparison of the magnitudes in Figures 7, 8, and 9 with results in the literature is difficult because different shocks are considered. For example, while the fiscal cliff uncertainty shock developed in this paper affects both first and second moments, as highlighted in Figure 6, the fiscal volatility shocks in Fernández-Villaverde et al. (2015) affect only the second moments. Fernández-Villaverde et al. (2015) find VAR evidence that a two standard deviation shock to the volatility in capital taxes lowers output around 0.3 percent, while consumption falls to a lower extent and investment falls more significantly. These are slightly smaller estimates than the fiscal noise case shown in Figure 7, but follow a similar pattern. Meanwhile, estimates of the effects of income tax shocks tend to be lower than the full adjustment case in Figure 8. For example, Mertens and Ravn (2013) estimate that a 1 percentage point change in income taxes generates a 1.5 percent change in output, whereas the full adjustment case for income taxes has around a 2 percent change; this difference is partially due to the assumption that tax changes around fiscal cliffs are near-permanent events rather than mean-reverting shocks. In summary, while the magnitudes of the results for both the noise and adjustment scenarios do not align exactly with estimates from the literature, they appear consistent with those estimates, and they differ in reasonable ways.

Bringing direct empirical evidence to bear on these dynamics is not straightforward. First, the model is a way to analyze a particular event, rather than to capture general features of the data. For this reason, attempts at full scale estimation would be misguided. Second, Figures 2 and 3 suggest fiscal cliff episodes have effects on macroeconomic data, 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, both the data and model suggest the consumption tax reforms in Japan appear to have been quite powerful in pulling forward

consumption activity prior to implementation of the higher tax rate. 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 declining as the model suggests. In the US, investment dynamics appear to match the general contours predicted by the model, particularly in the period prior to implementation of reforms at the start of 2013. More broadly, the model highlights that fiscal cliff uncertainty can have meaningful effects well before implementation of policy, and as the next section highlights, the extent of any pre-implementation effects rests 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 a fiscal cliff 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 a fiscal cliff uncertainty shock. To illustrate the influence of these parameters, this section considers how variations in their values affect the response of the economy to a fiscal cliff uncertainty shock. The first subsection examines the effects of expectations on the uncertainty episode by repeating the fiscal noise scenario of Section 4.2 under different fiscal adjustment probabilities q . The second subsection analyzes how expectations of the likelihood of fiscal cliff uncertainty shocks p and the chance of ultimately adjusting taxes affects behavior and economic outcomes in the status quo regime $S_t = 0$.

5.1 Variations in the Likelihood of Implementation

When a fiscal cliff uncertainty shock hits, the magnitude of the adjustment during the N period horizon depends primarily on the probability q that households and firms attach to advancing towards the cliff. The baseline parameterization sets $q = 0.50$, so the economy only partially adjusts 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 and firms have complete knowledge about the future tax rate, so immediately begin to fully incorporate higher taxes after N periods into their decisions.

Figure 10 compares dynamics with $q = 0.25$ to dynamics with $q = 0.50$ in response to a fiscal cliff uncertainty shock about the future income tax rate. A lower q implies a smaller chance

of taxes ultimately shifting after N periods. As q decreases, expectations of future adjustment are lower, so the degree of slowing in economic activity is smaller. Of interest is the extent to which variables rebound, or get paid back, if the tax rule ultimately does not change. In each case, output, consumption, investment, and labor rebound, with the extent of the rebound being larger for higher values of q .

Figure 11 compares the effects of a fiscal cliff uncertainty shock about consumption taxes for $q = 0.25$ and $q = 0.50$. The results are analogous to the income tax case and highlight an important aspect of the information structure. If households and firms perceive an adjustment as likely, they begin to more aggressively respond 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 as a change is perceived as more likely to occur. If an uncertainty shock arrives, but households and firms perceive the probability of any change as quite low, then failing to implement a policy change introduces relatively modest additional volatility. However, these implications cut in both directions. After the arrival of an uncertainty shock in a setting with only a modest perceived 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 begun to adjust more forcefully during the period of uncertainty.

5.2 Long-Run Effects of Fiscal Cliff Uncertainty

A more pernicious implication of fiscal cliff episodes arises from their 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 higher probability of future uncertainty shocks persistently weighs on the level of investment and the capital stock. 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. Figure 12 illustrates the effects of higher levels of the probability of an uncertainty shock p , conditional on corresponding declines in q that leave the expected future taxes unchanged. The figure shows that the stochastic steady state levels of investment, employment, consumption and output in the status quo regime 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 have a negative impact on current conditions.

This framework provides a clear mechanism for how post-recession fiscal policy, which Figure 1 illustrates was often plagued by fiscal uncertainty, as well as longer-term fiscal uncertainty may weigh on activity. These aspects are also emphasized by Kydland and Zarazaga (2016). For example, projections from the Congressional Budget Office (2015) raise questions about the longer-run stability of debt dynamics over a multi-decade horizon. Such projections raise uncertainty regarding future taxes, which maps into the parameter p , and as a result, potentially weighs on capital formation and hence lowers economic activity.

An important caveat to this analysis is that while the parsimonious modeling of fiscal policy as simple distortionary taxes rebated via lump-sum transfers helps to illuminate the effects of fiscal cliff episodes, other aspects of policy not considered may have benefits in practice. For example, the parameter p might in part reflect the frequency of elections, transparency of fiscal policy deliberations, or use of automatic sunset clauses to prevent regulations or policy from becoming too stale and outdated. These mechanisms provide possible reasons for prevalence of fiscal cliff episodes to be beneficial, despite generating uncertainty.

6 CONCLUSION

This paper considers the effects of fiscal cliff uncertainty, such as that in the US in 2012 or those in Japan in the 1990s and 2010s. The model developed captures four main features of fiscal cliff episodes: uncertainty is generated by news that policy may shift in the future, tax outcomes are often skewed, proposed reforms may not actually occur, and a known resolution date exists. The framework highlights how the arrival of news about future policy, referred to as a fiscal cliff uncertainty shock, can cause an immediate response in the economy. It also highlights 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 provide motivation for considering income and consumption tax increases, the general framework developed in this paper can easily be extended to consider a multitude of fiscal policy issues including tax cuts, changes in government spending, and management of debt levels. Despite the relatively rare occurrence of fiscal uncertainty episodes, many 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.

APPENDIX A: ROBUSTNESS EXERCISES

This Appendix considers two robustness exercises to complement the analysis in the main text. The first examines the implications of choices of different parameters governing preferences, and the second considers a possible decrease in taxes. For brevity, both robustness experiments focus on the case of income taxes.

A.1 Preferences

The first robustness exercise revisits the main result on fiscal cliff uncertainty shocks shown in Figure 4 with different calibration of the preferences, which may be key parameters in generating the results. In particular, under the baseline calibration the coefficient of relative risk aversion is $\omega = 2$ and the Frisch elasticity of labor supply is $\theta = 2$. Figure A1 focuses on the income tax case, and shows the results for the baseline calibration, compared with a higher $\omega = 5$ and a lower Frisch $\theta = 0.5$. To see why these parameters may matter for the effects of fiscal uncertainty, note that the household's optimality conditions imply an Euler equation for consumption

$$1 = \beta \mathbb{E}_t \left(\frac{C_{t+1}}{C_t} \right)^{-\omega} \frac{(1 + \tau_t^C)}{(1 + \tau_{t+1}^C)} \left((1 - \tau_{t+1}^I) R_{k,t+1} + 1 - \delta \right), \quad (13)$$

and one in terms of labor

$$1 = \beta \mathbb{E}_t \left(\frac{N_{t+1}}{N_t} \right)^{1/\theta} \frac{(1 - \tau_t^I) W_t}{(1 - \tau_{t+1}^I) W_{t+1}} \left((1 - \tau_{t+1}^I) R_{k,t+1} + 1 - \delta \right). \quad (14)$$

The higher value of ω serves to decrease the intertemporal elasticity of substitution of consumption, making households less willing to substitute consumption across periods. Similarly, a lower value of the Frisch elasticity makes households less willing to substitute labor or leisure across periods.

Figure A1 then shows that changes in ω do not have a major impact on the baseline calibration results, as all variables move in a similar manner under both $\omega = 5$ and $\omega = 2$. The lower intertemporal elasticity associated with $\omega = 5$ generates a slightly more pronounced consumption smoothing motive, which causes investment to fall slightly less. On the other hand, a lower Frisch of $\theta = 0.5$ makes households less willing to pull forward leisure due to the possibility of higher income taxes in the future. As a result, labor declines to a lesser extent and consumption rises to offset the lower leisure. However, investment still declines, and as a result output falls

but by a lesser extent. Therefore, the elasticity of labor supply plays a critical role in generating declines in consumption as presented in the main text.

A.2 Negative Tax Changes

The second robustness exercise considers the effects of negative tax changes for the results shown in Figure 4. Throughout the analysis, any possible tax changes from the initial value are always increases, as this scenario reflects the experiences of the United States and Japan in the motivating examples in Section 2. However, it is possible that a future tax decrease is announced, and this announcement has all the features of fiscal cliffs described. Figure A2 compares the baseline result originally presented in Figure 4 with the case where $\mu_I^H = 0.16$; for comparison sake, the tax decrease case is presented with the sign reversed. Despite the fact that both scenarios involve possible 2 percentage point changes in the income tax, the tax increase case leads to slightly larger movements in output, consumption, investment, and labor. That is, the decreases in these variables are larger for possibly higher taxes than the increases in the variables for possibly lower taxes.

The reason for the differences in magnitudes is the curvature of household's utility function, which makes tax increases a more substantial concern than the possible benefits of tax decreases. The risk associated with possibly a positive tax cliff leads to lower consumption and investment, which in turn lowers labor and output. A negative tax cliff leads to a consumption and investment boom, but the incentive to increase both of these is diminished due to risk aversion, as households are more concerned about the possibility that taxes actually remain unchanged. The main conclusion from this robustness exercise is that the fiscal cliff mechanism can be applied to tax decreases, although the exact movements in economic variables depend on the set of fiscal outcomes and not necessarily in a perfectly symmetric manner.

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Notes

¹The Appendix shows robustness exercises for the risk aversion and labor supply elasticity parameters. In particular, Frisch elasticities below unity can generate opposite movements in consumption dynamics from the baseline scenario.

²Following the motivating examples, the baseline results consider possible outcomes that are skewed in that average tax rates remain unchanged or increase. The Appendix includes analysis of the opposite case where taxes may remain unchanged or decrease; the results are qualitatively similar but are not exactly symmetric.

³By considering a shock that affects both first and second moments simultaneously, the analysis of fiscal cliffs here slightly resembles Schaal (2017), which considers aggregate first moment shocks and idiosyncratic second moment shocks for technology.

Table 1: Parameterization of the New Keynesian model

Parameter	Description	Value
β	Discount factor	0.995
ω	Coefficient of relative risk aversion	2
θ	Frisch elasticity of labor	2
N_{ss}	Steady state labor	0.33
α	Capital share	0.33
δ	Depreciation rate	0.025
γ	Probability of not re-optimizing prices	0.66
η	Elasticity of substitution	10
ϕ_r	Monetary policy: smoothing	0.6
ϕ_π	Monetary policy: inflation response	1.5
ρ	Serial correlation of shock to tax rate	0.9
σ	Standard deviation of tax rate shock	0.005
p	Probability of fiscal cliff shock	0.01
q	Probability of continuing on path	0.50
r	Probability of returning to original regime	0.0001
N	Length of fiscal uncertainty	4
μ_I^L	Average income tax, low tax regime	0.18
μ_I^H	Average income tax, high tax regime	0.20
μ_C^L	Average consumption tax, low tax regime	0.05
μ_C^H	Average consumption tax, high tax regime	0.07

Figure 1: Baker, Bloom, and Davis (2016) Tax Code Expirations Index

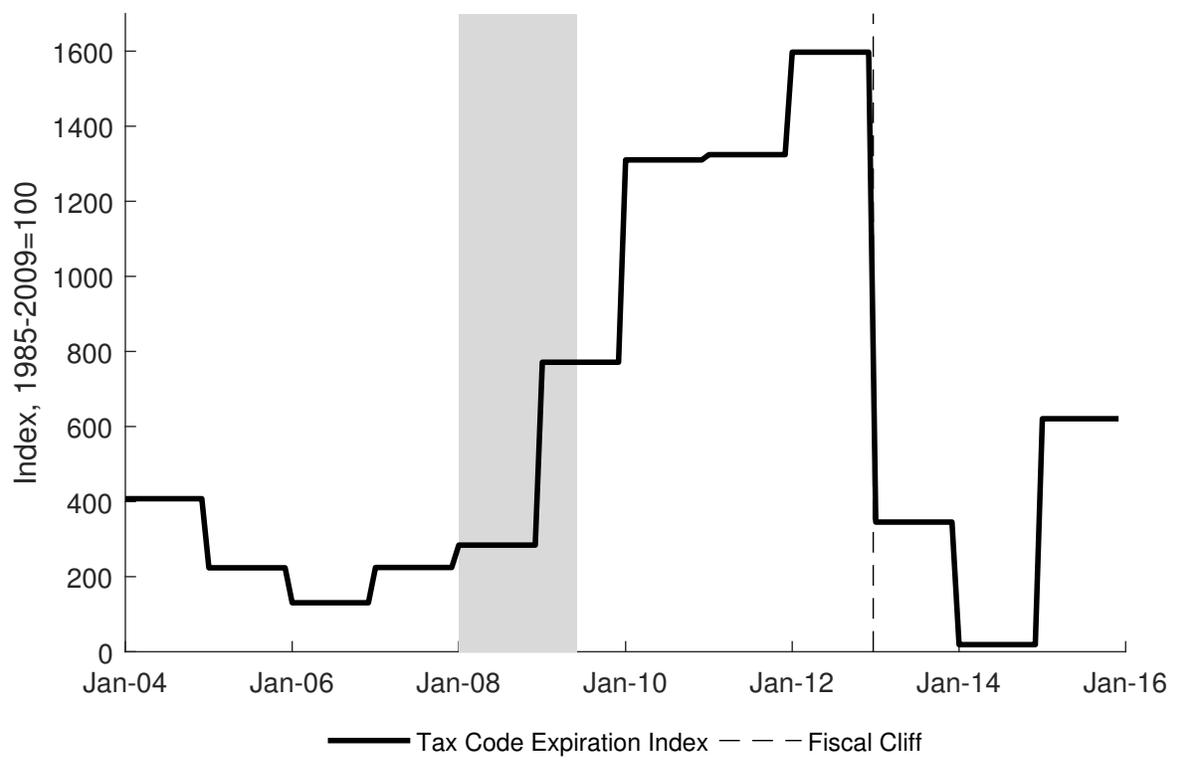


Figure 2: US nonresidential fixed investment as a share of GDP

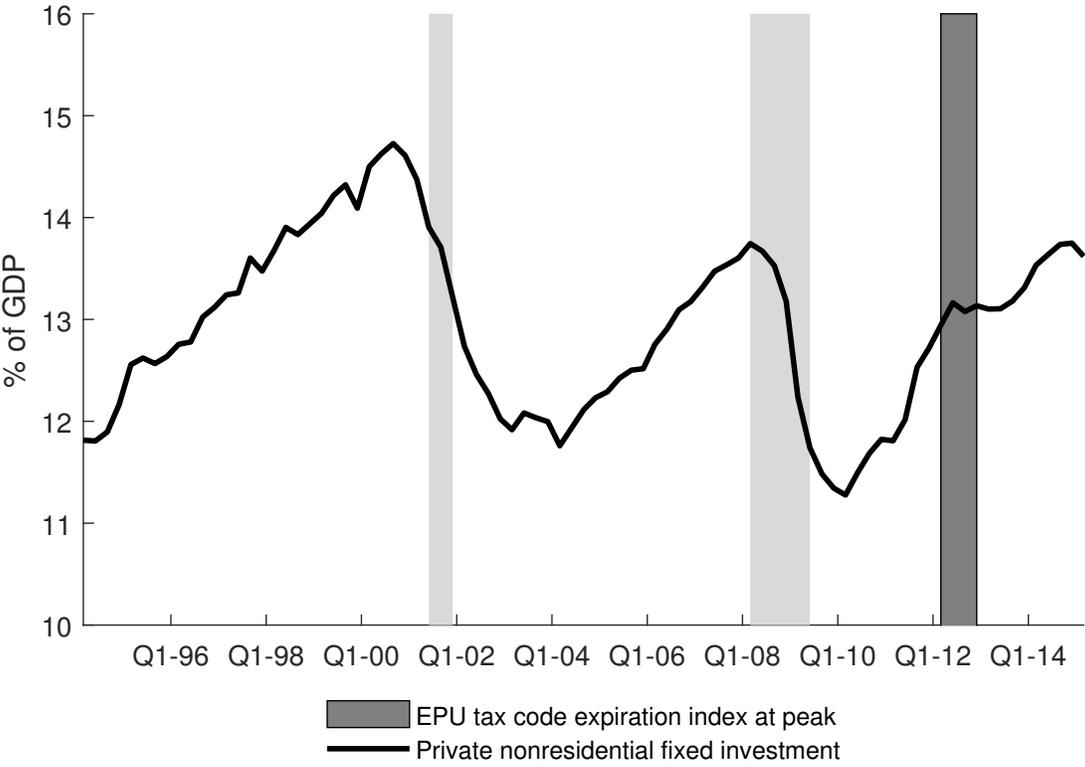


Figure 3: Japanese consumption prior to the implementation of increases in the consumption tax rate

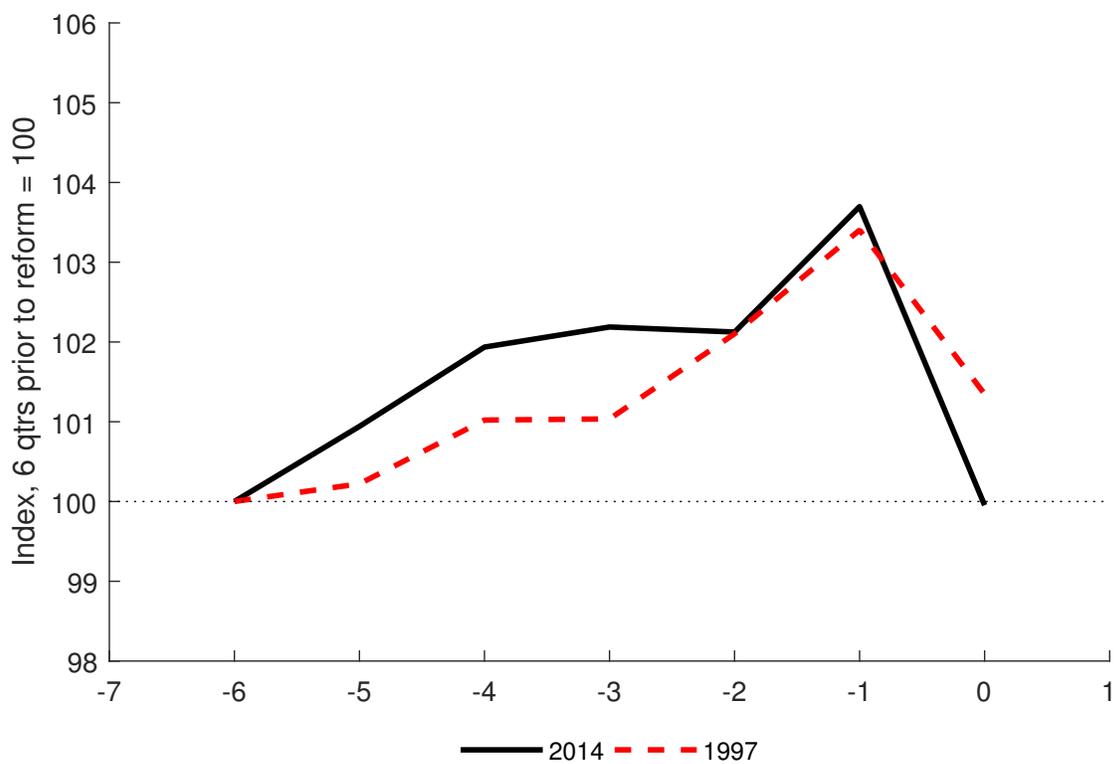


Figure 4: The progression of fiscal uncertainty

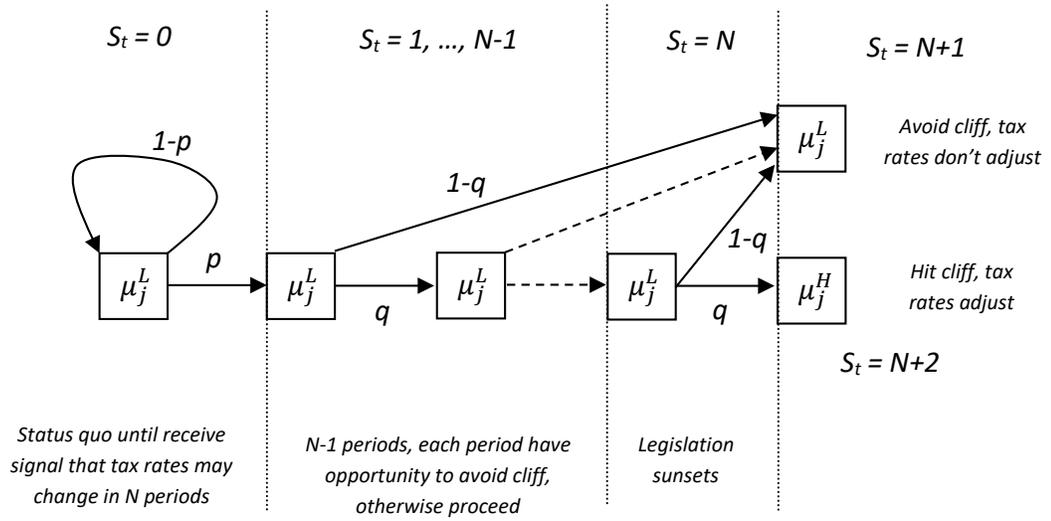


Figure 5: Responses to an intra-regime income and consumption tax shock

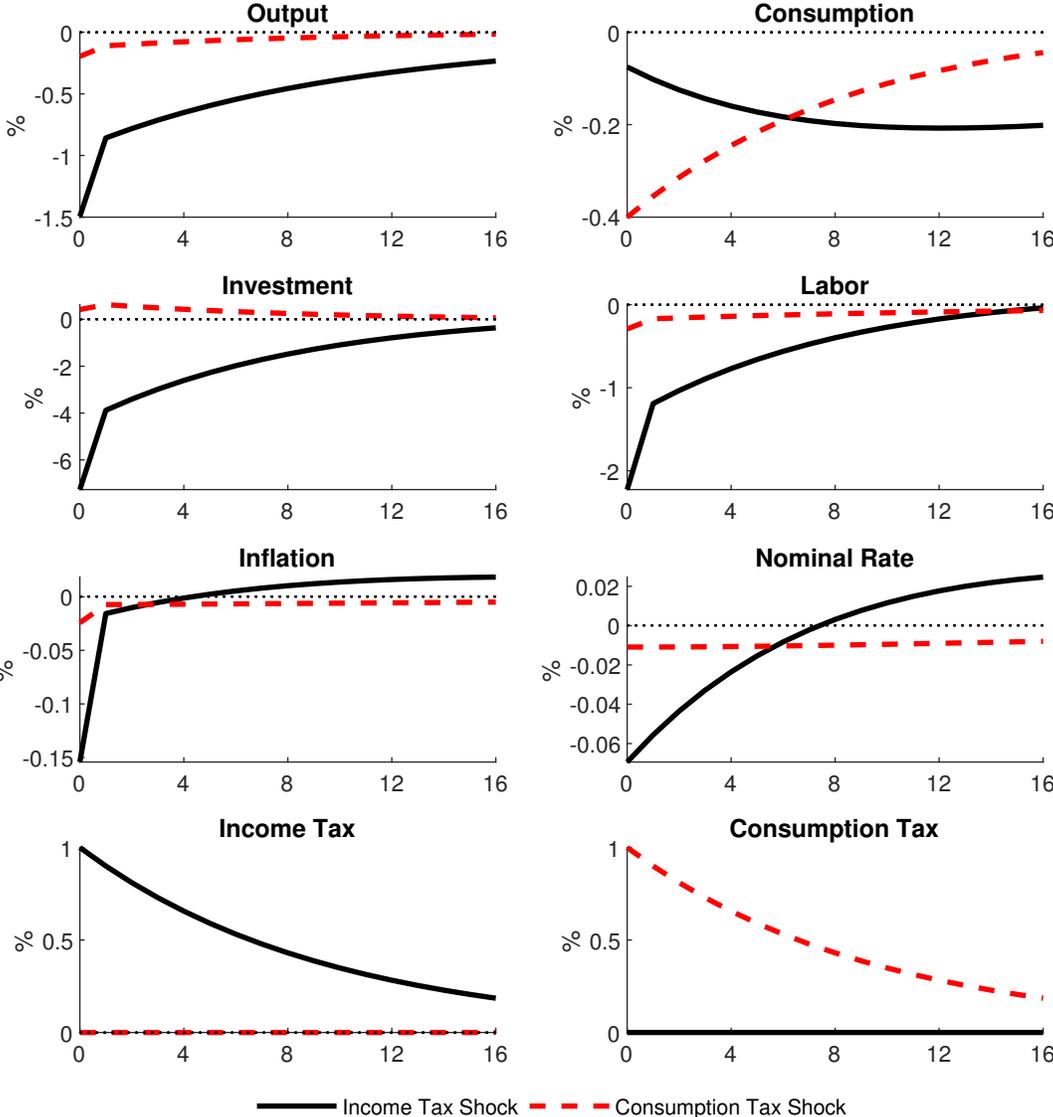


Figure 6: Evolution of uncertainty during a fiscal cliff episode

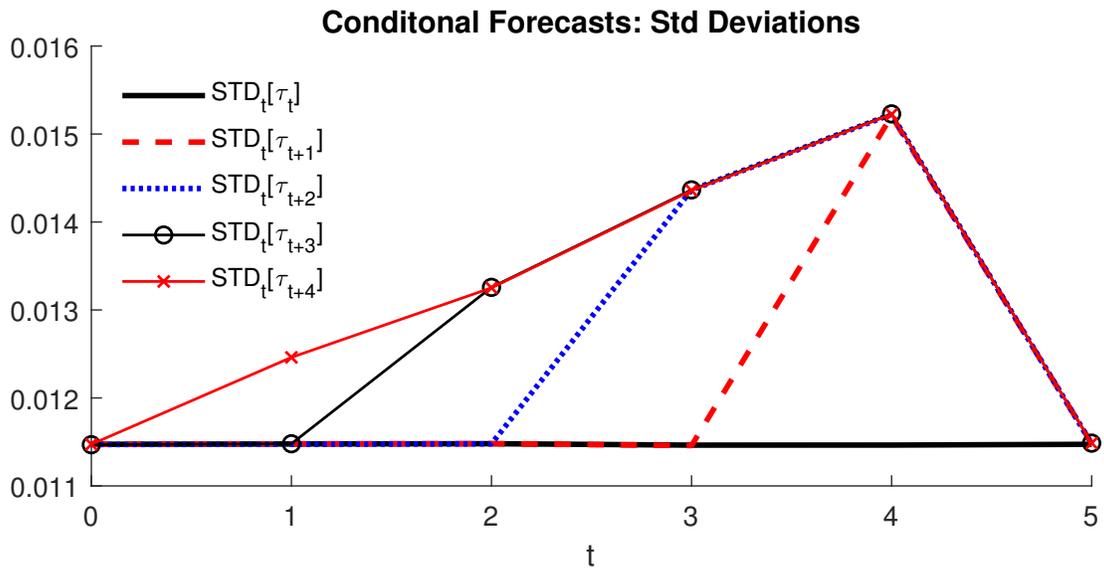
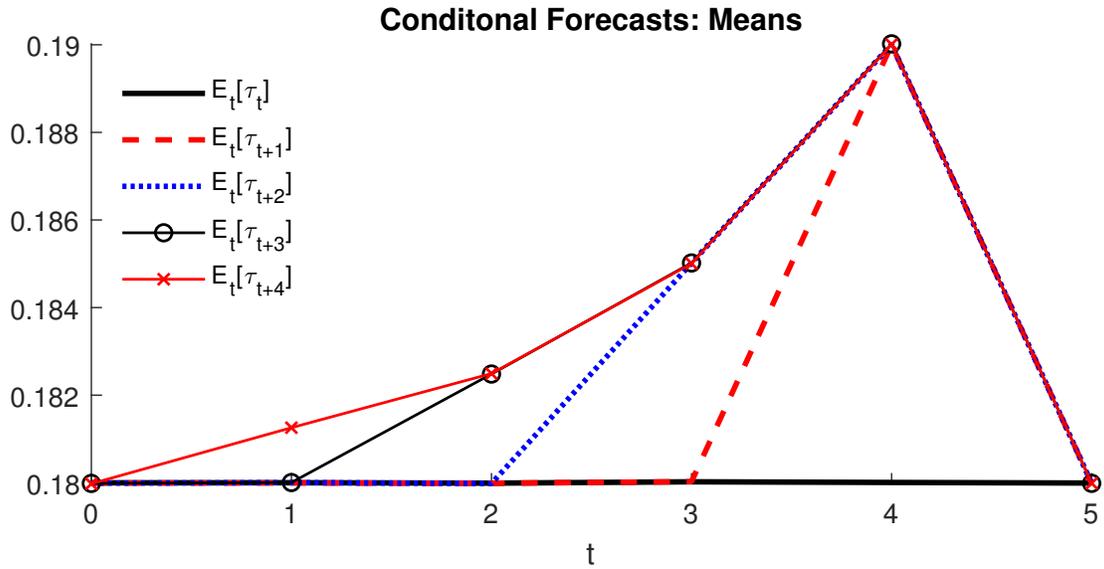


Figure 7: Comparison of fiscal cliff episodes for income and consumption tax rates

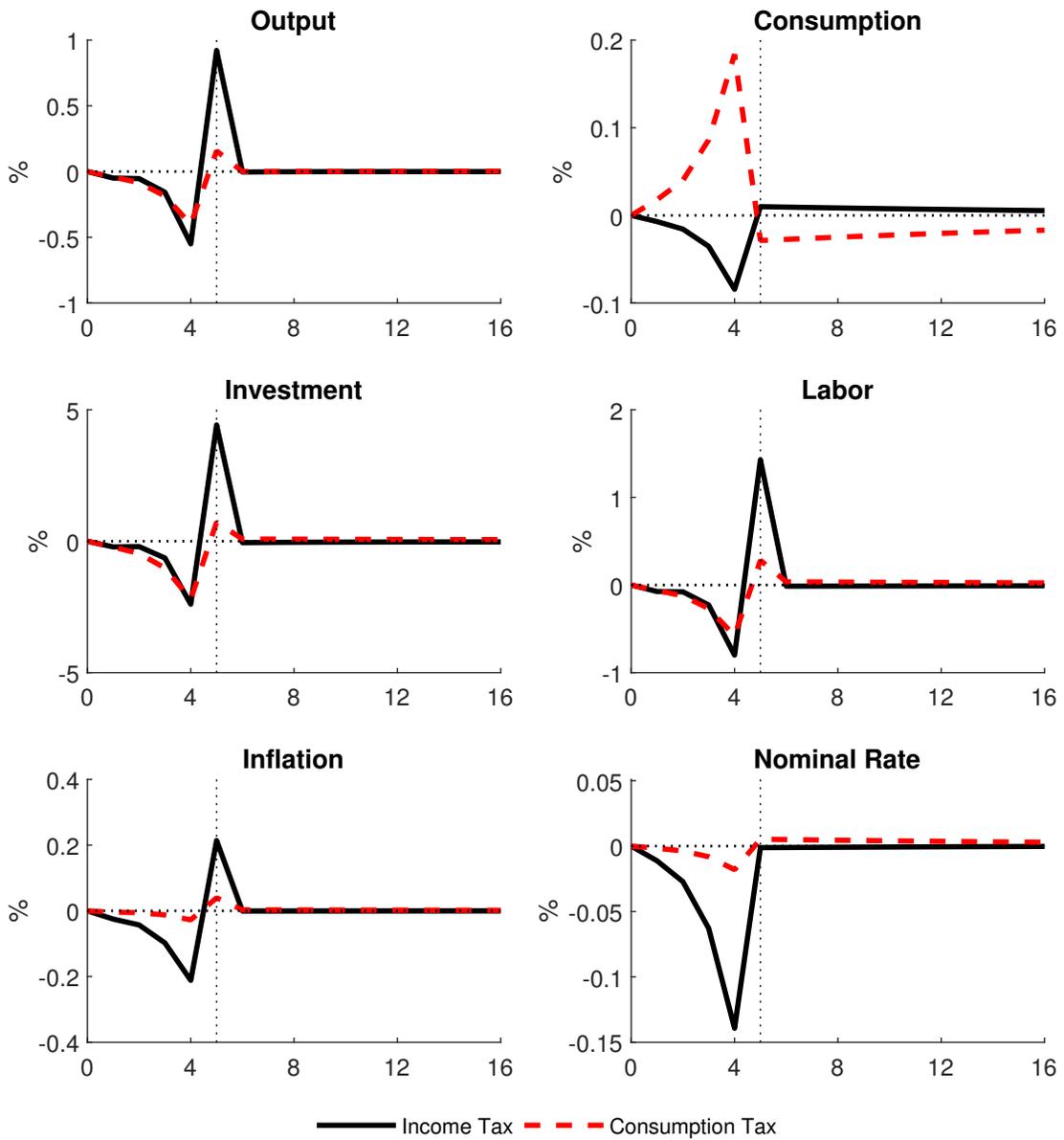


Figure 8: Responses to a fiscal cliff episode that ends in noise versus adjustment in the income tax rate

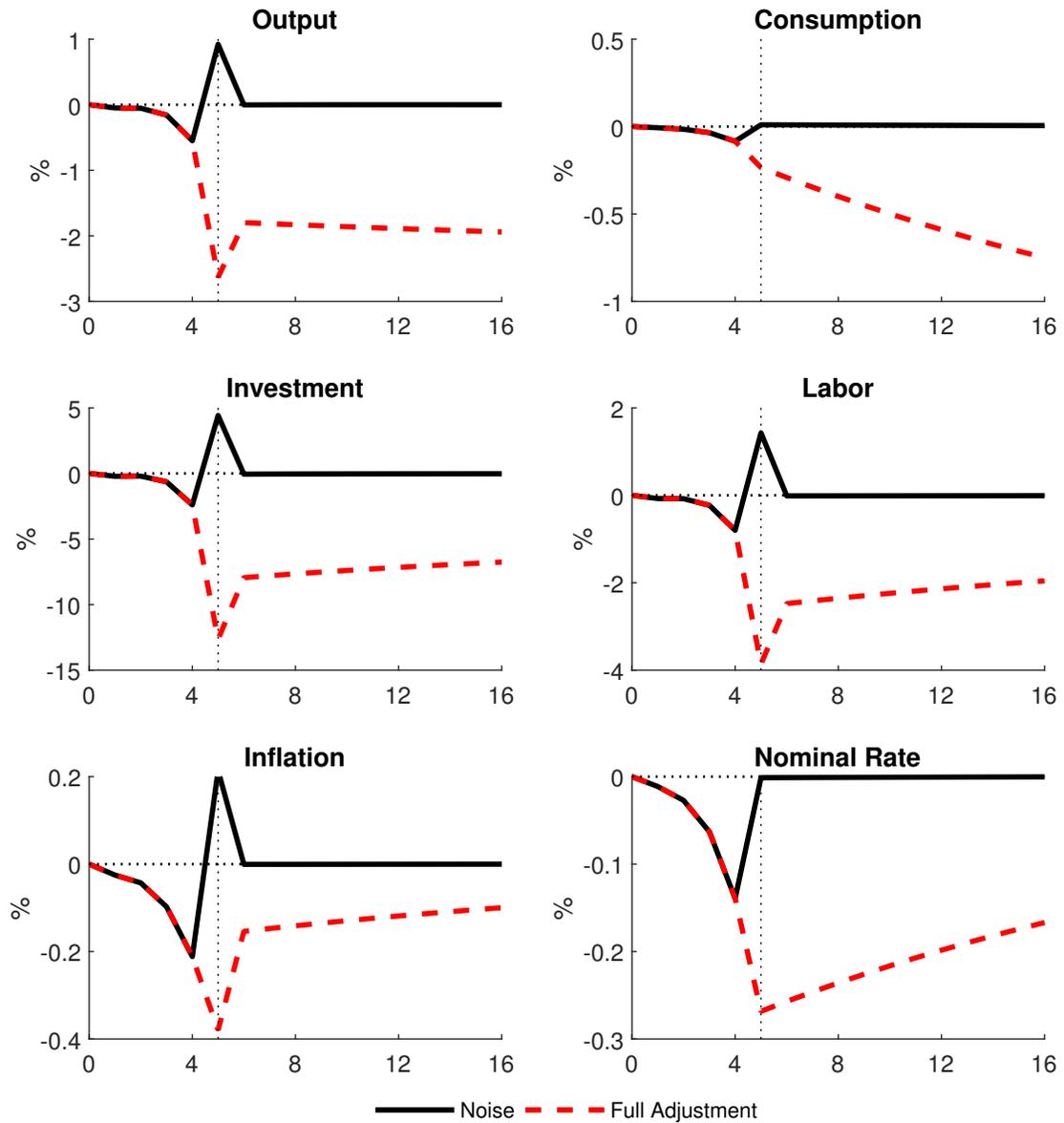


Figure 9: Responses to a fiscal cliff episode that ends in noise versus adjustment in the consumption tax rate

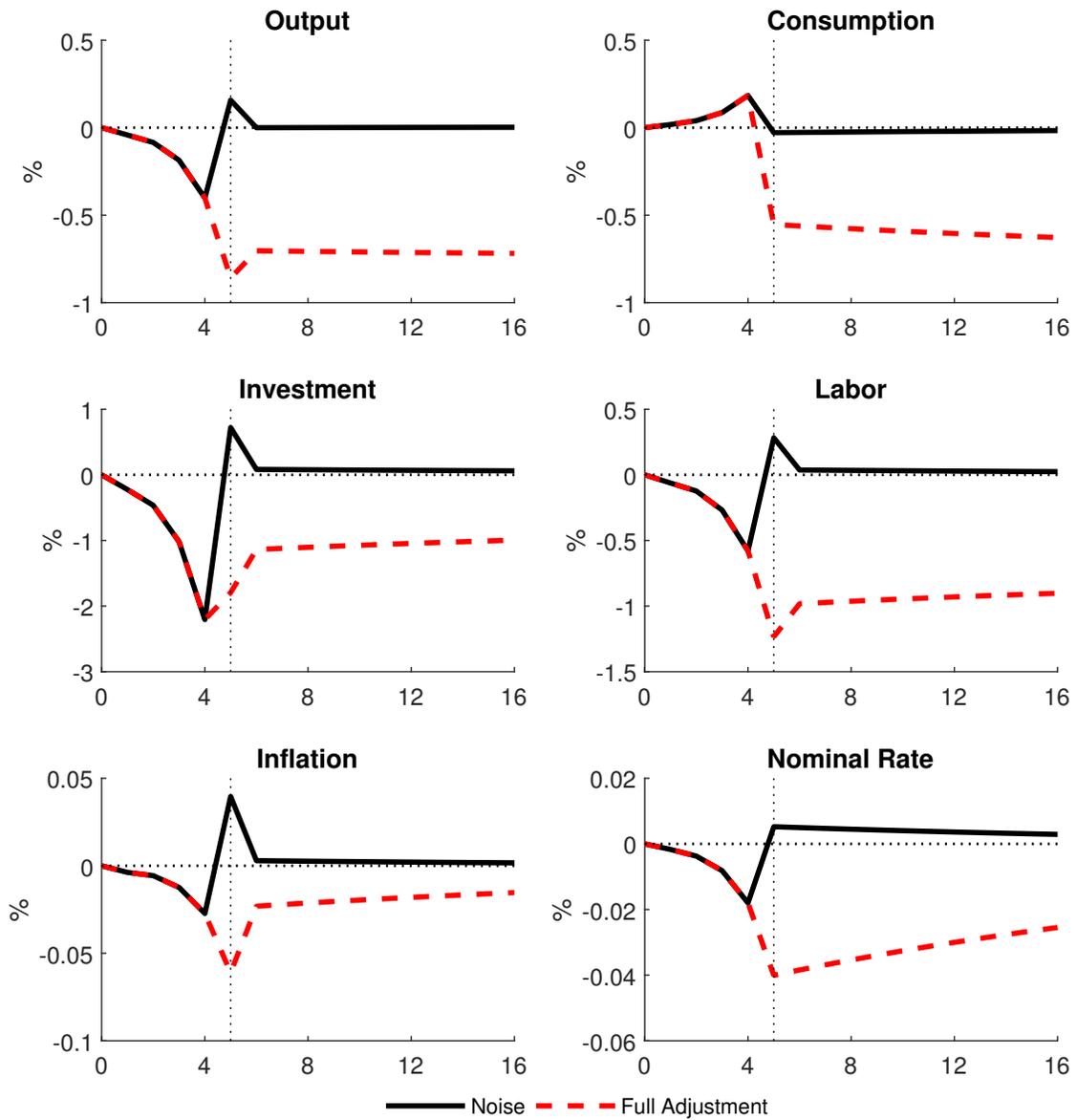


Figure 10: Responses to fiscal cliff episodes for different likelihoods for implementation in the income tax case

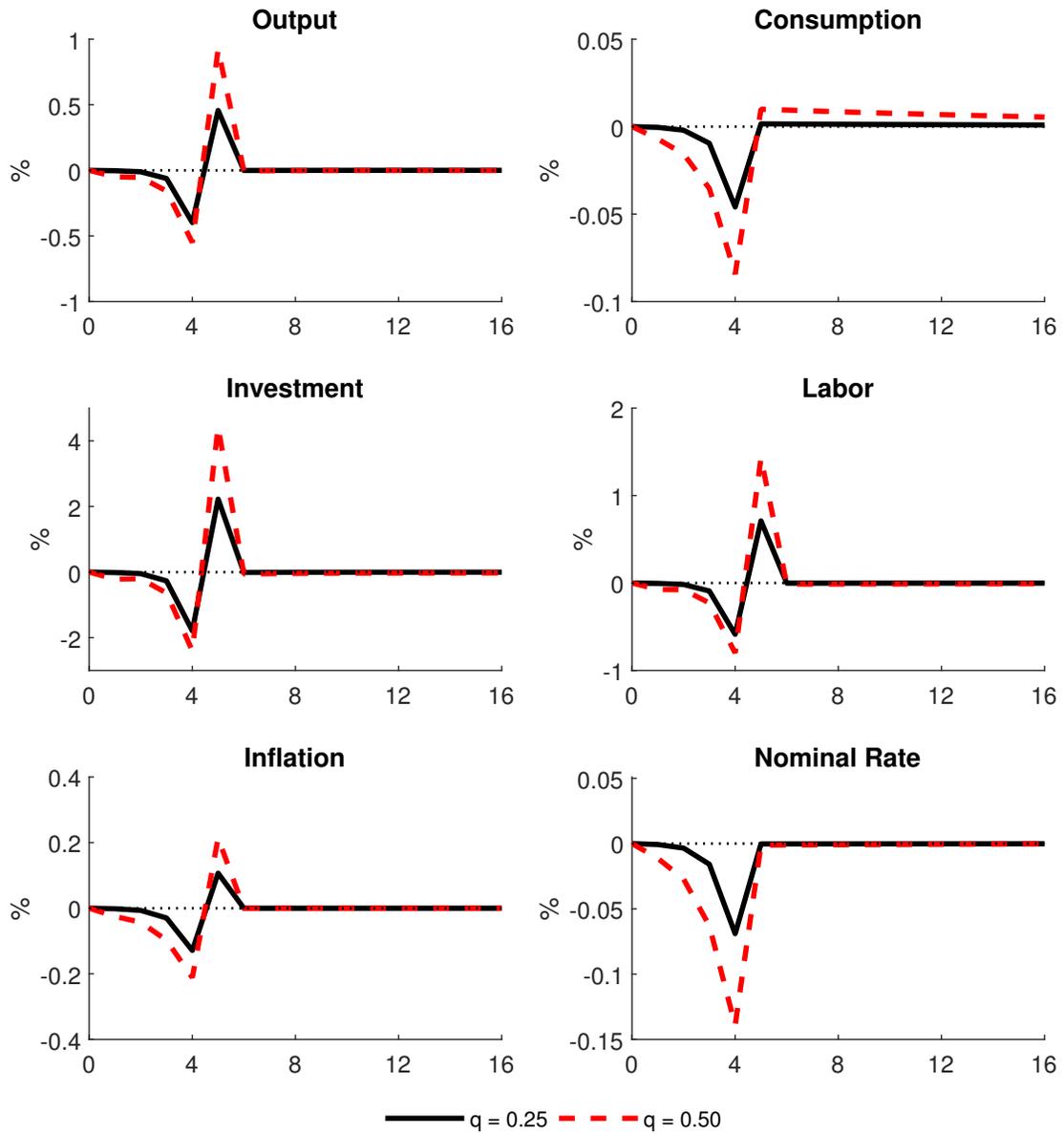


Figure 11: Responses to fiscal cliff episodes for different likelihoods for implementation in the consumption tax case

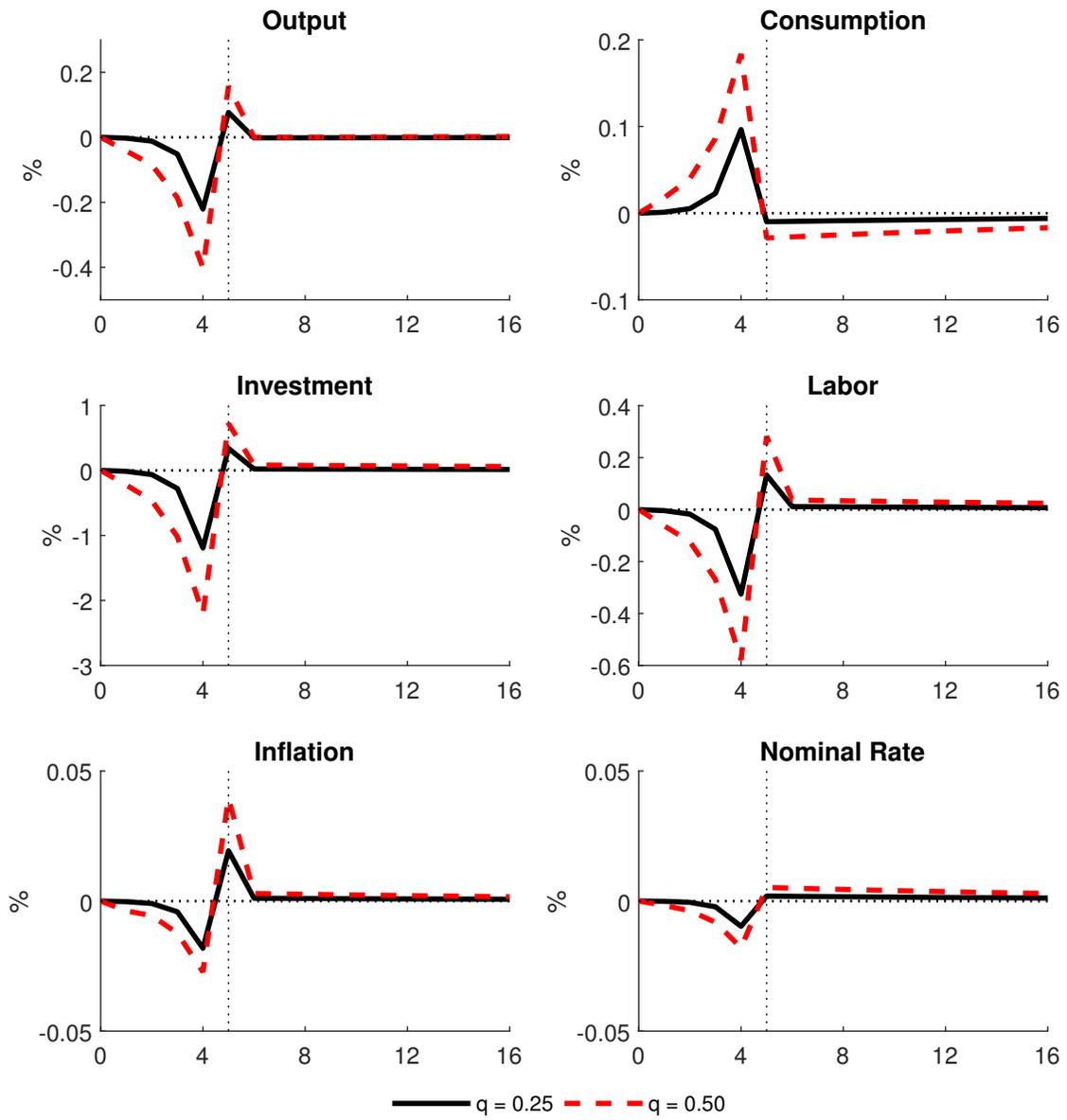


Figure 12: The stochastic stochastic steady state in the status quo regime relative to the baseline case with $p = 0.01$

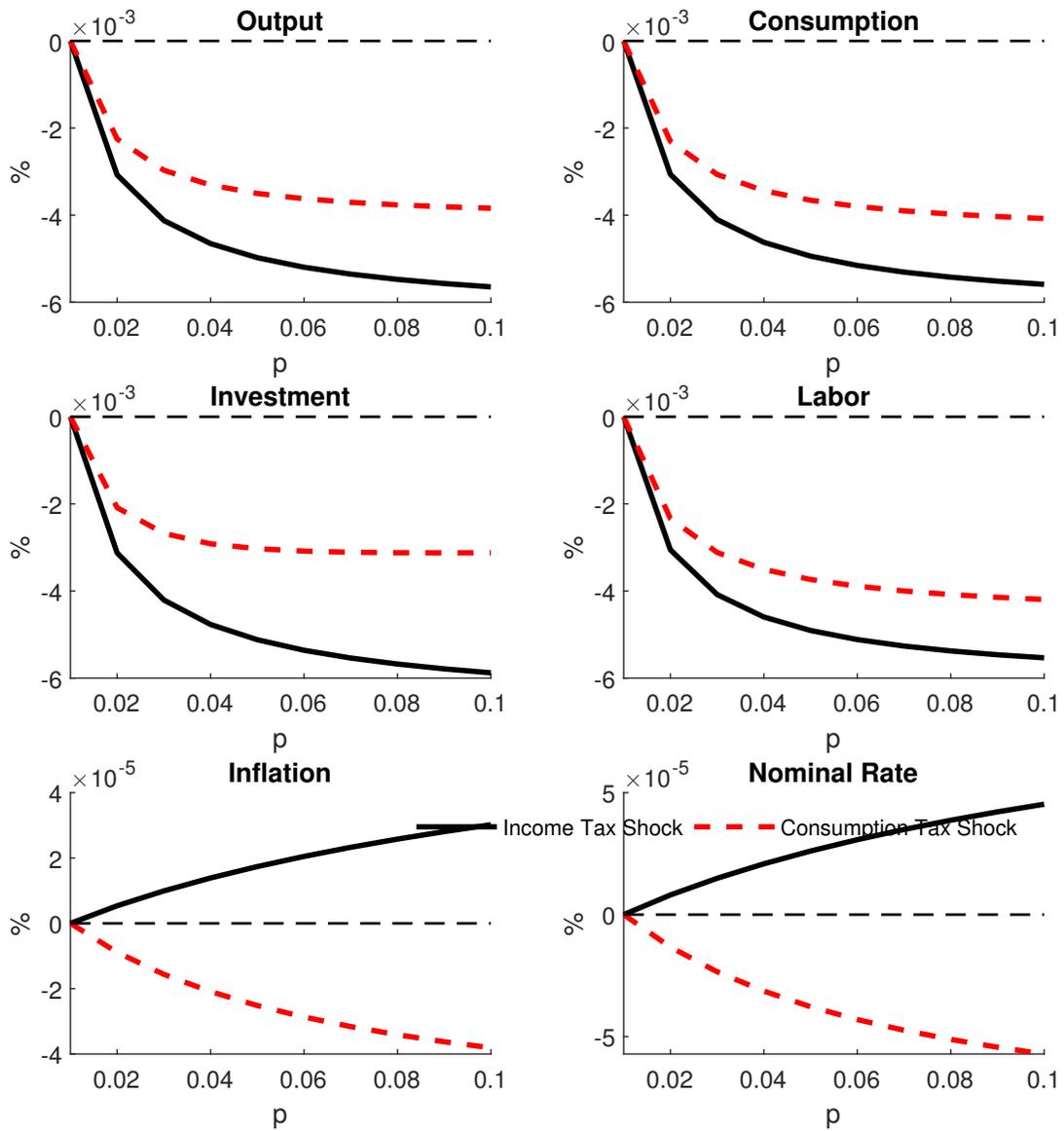


Figure A1: Robustness of the responses to a fiscal cliff episode to different parameterizations

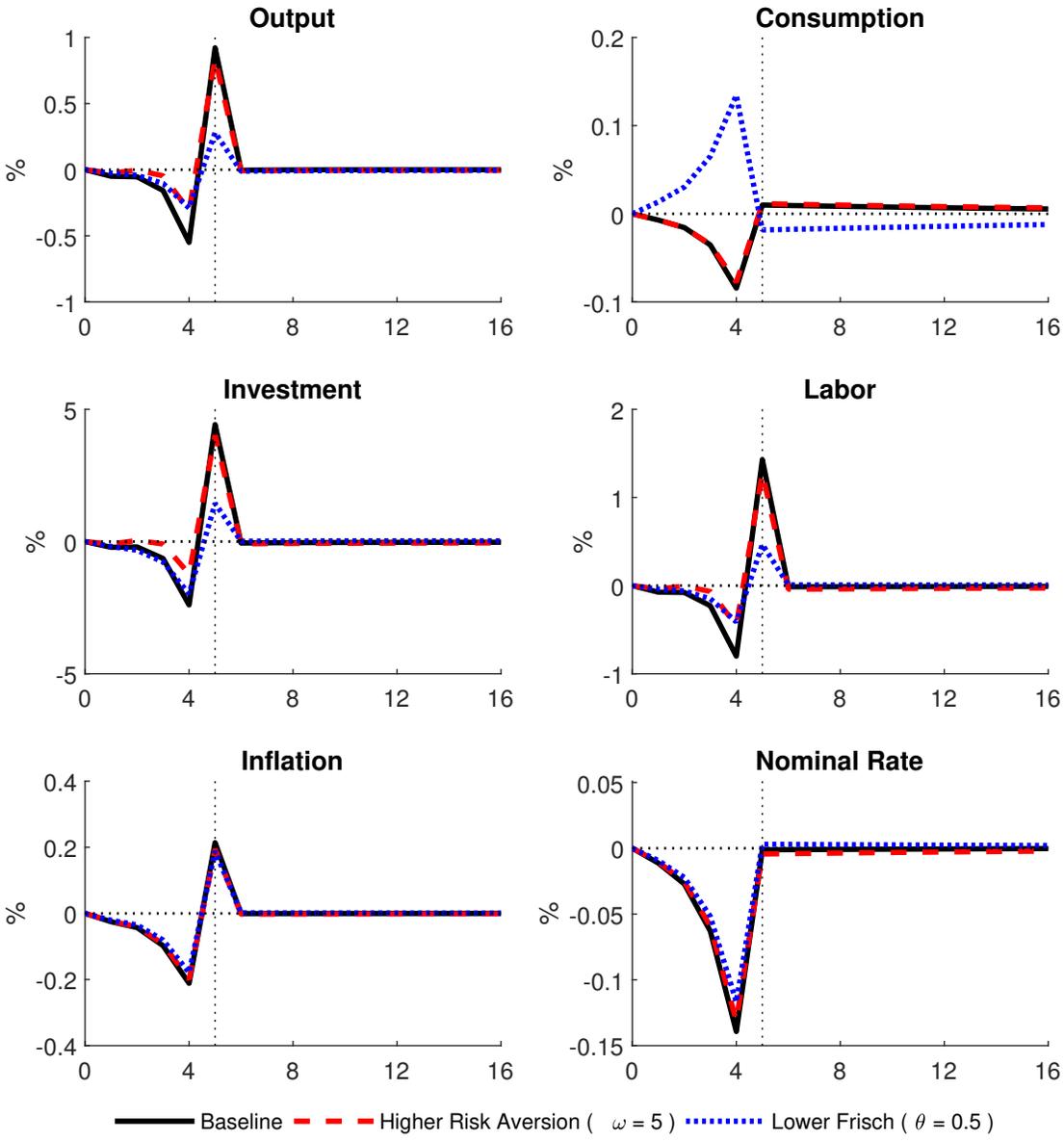


Figure A2: Robustness of the responses to fiscal cliff episodes for positive versus negative income shocks

