Finance and Economics Discussion Series
Divisions of Research & Statistics and Monetary Affairs
Federal Reserve Board, Washington, D.C.

Taxes and the Fed: Theory and Evidence from Equities

Anthony M. Diercks and William Waller

2017-104

Please cite this paper as:
Diercks, Anthony M., and William Waller (2017). "Taxes and the Fed: Theory and Evidence from Equities," Finance and Economics Discussion Series 2017-104. Washington: Board of Governors of the Federal Reserve System, https://doi.org/10.17016/FEDS.2017.104.

Taxes and the Fed: Theory and Evidence from Equities

Anthony M. Diercks†, William Waller††

Abstract

We provide a critical theoretical and empirical analysis that suggests a key driver of fiscal effects on equity markets is the Federal Reserve. For the Post-1980 era, tax cuts lead to higher cash flow news and higher discount rates. The discount rate news tends to dominate such that tax cuts are associated with lower equity returns. This result is flipped for the Pre-1980 era. Our results are confirmed across multiple measures of tax shocks (narrative, SVAR, municipal bonds, etc.) at different frequencies (daily, quarterly, annual). We motivate our empirical findings with a standard New Keynesian model (in addition to the FRB/US model) that exhibits a shift in the aggressiveness of monetary policy. Moreover in our theoretical framework, downward nominal wage rigidities account for observed asymmetries in the response to tax cuts versus tax increases.

Keywords: fiscal policy, stock market, news decomposition
JEL Classification: E63, G12

This version: August 16, 2017
First draft: September 12, 2014

Helpful comments and suggestions provided by Anthony Diercks' advisor Max Croce, Geert Bekaert, John Cochrane, Thorsten Drautzburg, Yuriy Gorodnichenko, Urban Jermann, Arvind Krishnamurthy, Thomas Laubach, Martin Lettau, Karel Mertens, Virgiliu Midrigan, Glenn Rudebusch, Paul Tetlock, Annette Vissing-Jorgenson, Lu Zhang, and seminar participants from multiple conferences and institutions.

†Federal Reserve Board, Monetary and Financial Market Analysis 20th Street and Constitution Avenue N.W., Washington, D.C. 20551, Anthony.M.Diercks@frb.gov. http://www.anthonydiercks.com/ The analysis and conclusions set forth in this paper are those of the authors and do not indicate concurrence by other members of the research staff or the Board of Governors of the Federal Reserve System.
††Finance Area, Tepper Business School, Carnegie Mellon University, Pittsburgh, PA 15213, wwaller@andrew.cmu.edu.

1. Introduction

Following the 2016 presidential election, the stock market, the value of the dollar, and inflation compensation measures increased significantly. Some observers suggest these observations provide evidence that the promise of tax cuts substantially boost the stock market. Yet as of the end of the second quarter in 2017, the value of the dollar, inflation compensation, and the implied tax measures based on municipal bond spreads have all returned to their pre-election levels suggesting little effect of potential tax changes on financial markets. Despite these reversals, the stock market remains 18% above its level prior to the election. The lack of equity market reversion calls into question how important the promise of tax cuts were to the stock market. In the vein of previous studies exploring the relationship between policy and equity markets,[1] we provide a critical theoretical and empirical analysis that suggests that the Federal Reserve is a key driver of fiscal effects on equity markets. The Federal Reserve's reaction function plays a crucial role in determining the relative magnitudes of the effects of taxes on cash flow news and discount rate news in equity markets. With the Federal Reserve's more aggressive stance toward economic activity since 1980,[2] we find that tax cuts are associated with lower excess equity returns, despite our findings of positive effects on cash flow news.

The more aggressive monetary policy since 1980 has two primary effects: (1) monetary policy is raising rates to a greater extent in response to tax cuts, increasing the size of the discount rate channel and (2) the higher rates endogenously feed back negatively to economic activity in the form of less positive cash flow news in response to tax cuts. We conduct similar analysis for the Pre-1980 era and come to the opposite conclusion. With a less aggressive monetary policy, the cash flow news is larger than the discount rate news, and tax cuts are associated with higher equity returns. These empirical findings are motivated by a standard theoretical New Keynesian model that exhibits a shift in the aggressiveness of monetary policy.

Our results are not dependent upon any specific calibration and instead hold for a wide set of commonly used values, which we confirm across each of the parameters in the model. Moreover, the FRB/US model

[1]See Ai and Bansal (2016), Belo, Gala, and Li (2013), Croce, Kung, Nguyen, and Schmid (2012), Da, Warachka, and Yun (2016), Gallmeyer, Hollifield, and Zin (2005), Gomes, Michaelides, and Polkovnichenko (2012), among others discussed in more detail in our literature review.

[2]See Coibion and Gorodnichenko (2011); Bhattarai, Lee, and Park (2016); Clarida, Gali, and Gertler (2000); Lubik and Schorfheide (2004); Romer and Romer (2002); and Meltzer (2005).

used by the Federal Reserve predicts tax cuts being associated with lower returns.

We also document asymmetries with respect to tax changes. Specifically, we find that tax cuts have larger and more significant effects than tax increases. Again, this can be motivated by a nonlinear New Keynesian model that exhibits downward nominal wage rigidities. The basic intuition is that an income tax cut incentivizes households to work more causing wages to decline. However in the presence of downward nominal wage rigidities, wages do not fully adjust to this change in labor supply such that the increase in labor demanded is reduced. With not as much labor demanded, output and dividends increase less so that cash flow news is less positive. Combining the less positive cash flow news with the increase in interest rates, the overall effect is a larger negative effect on equity returns.

Moving to the empirics, we first use tax shocks based on Romer and Romer (2010) and incorporate them into a Campbell and Shiller (1988) news decomposition to back out the effects on cash flow and discount rate news. We take additional steps to ensure the exogeneity of these shocks by focusing also on the "surprise" shocks as outlined by Mertens and Ravn (2012), as well as the orthogonalized SVAR shocks also discussed in Mertens and Ravn (2014). Through ordered probit tests, we show that the shocks are not predictable based on financial market data, a concern raised by Leeper, Walker, and Yang (2013); Yang (2005); Mertens and Ravn (2013); and Kueng (2015).

In addition to results based on a time-varying parameter VAR, statistical tests suggest a structural break in our data in 1980. Splitting the sample at this date, we demonstrate that the relative magnitudes of the cash flow and discount rate channels shift, with discount rate news becoming larger Post-1980. The larger effect on discount rate news dominates, so that tax cuts are associated with lower returns, consistent with our theoretical motivation based on a more aggressive monetary policy.

We further empirically examine whether tax increases or tax cuts yield significant asymmetric effects on equity markets. We find that tax cuts are driving the significance and that when we isolate the effects of tax increases, the effects are smaller and less significant. This is consistent with Jones, Olson, and Wohar (2015) in terms of macro effects and also consistent with our nonlinear New Keynesian model with downwardly nominal wage rigidities.

Admittedly, the narrative shocks of Romer and Romer (2010) are quite heterogenous relative to the capital, labor, and income taxes in our model. To this end, we explore more narrowly defined personal tax shocks to ensure that our empirics mirror the channels operating in our theory. Our main results carry through when we shift our definition of tax shocks to the narrative personal tax shocks of Mertens and Ravn (2013) or to a definition of expected personal taxes based on municipal bond spreads as in Leeper, Walker, and Yang (2013) and Kueng (2015).

With the main empirical analysis conducted at the quarterly frequency, we show further robustness by using changes in expected future tax rates at higher frequencies based on municipal bond data. We continue to find a positive relationship between tax rates and equity excess returns based on event windows ranging from 1 week to 3 months.

Additionally, we replicate the results of Sialm (2009) using annual data and show that the effect of tax yields on equity returns flips signs if the sample is split in 1980 (rather than in 1960 as in Sialm (2009)). Using multiple robustness checks, we find that the effect of taxes on equity returns switches from negative to positive for the post-1980 period, which is consistent with both our theoretical and empirical analysis. Furthermore, we note that Sialm (2005, 2006) does not model monetary policy, leaving open the theoretical possibility for the positive relationship between dividend taxes and equity returns in a non-endowment economy. We confirm these findings in a Real Business Cycle model, and show that once we incorporate nominal rigidities and a monetary policy rule that aggressively responds to economic activity, the results flip.

The remainder of the paper proceeds as follows. Section 2 discusses the related literature. Section 3 provides the theoretical framework for our analysis. Section 4 presents our data and methodology. Section 5 discusses our main empirical results. Section 6 provides some additional tests and Section 7 concludes.

2. Related Literature

The extant literature, both theoretical and empirical, lacks consensus regarding the impact of tax changes on equity markets. In the time series, Tavares and Valkanov (2001) and Sialm (2006, 2009) find a negative relationship. However, studies that focus on a broader range of countries in addition to the United States tend to find no effect or in fact a positive relationship, as in Ardagna (2009); Afonso and Sousa (2011, 2012); and Agnello and Sousa (2013). Unlike our results, none of these studies examine the impact of monetary policy regime on the stock response to tax shocks.

Study	Sign of Tax Increase	Method	Type of Taxes
Ayers, Cloyd, and Robinson (2002)	Negative	Event Study of 1993 Tax Cut, Panel	Individual income (i.e. dividend tax rate)
Auerbach and Hassett (2005)	Negative	Event Study of 2003 Tax Cut, Panel	Cap Gains, Dividend
Lang and Shackelford (2000)	Negative	Event Study of 1997 Tax Cut, Panel	Capital Gains
McGrattan and Prescott (2005)	Negative	RBC model, Intangible Capital	Cons., Divs, Interest, Labor, Property, Corp. Income
Sialm (2009)	Negative	Time Series and Cross Section, Ann	Dividend, Cap Gain (SR, LR)
Sialm (2005)	Negative	Theoretical, Endow. Economy	Consumption Tax
Sialm (2006)	Negative	Theoretical, Endow. Economy	Dividend Tax
Tavares and Valkanov (2001)	Negative	SVAR, 1960-2000 US	Share of tax receipts (exluding transfers) in GDP
Dai, Maydew, Shackelford, and Zhang (2008)	Ambiguous/Negative	Event Study of 1997 Tax Cut, Panel	–
Arin, Mamun, and Purushothman (2009)	No Effect/Negative	SVAR, 1973-2005 Intl	Labor Tax, Indirect (Corporate Tax)
Amromin, Harrison, and Sharpe (2008)	No Effect	Event Study of 2003 Tax Cut, Panel	Dividend Tax
Ardagna (2009)	Positive	1960-2002 Intl, Ann	–
Afonso and Sousa (2011)	Positive (Small)	SVAR, 1970-2007 Intl, Qtrly	Govt. Revenue, NIPA Table 3.2, line 36
Afonso and Sousa (2012)	Positive (Small)	B-SVAR, 1970-2007 Intl, Qtrly	Govt. Revenue, NIPA Table 3.2, line 36
Agnello and Sousa (2013)	Positive (Temporary)	P-VAR, Intl	Primary Deficit Shocks
Hanlon and Heitzman (2010)	–	Literature Review	–

Theoretical implications in McGrattan and Prescott (2005) and Sialm (2005, 2006, 2009) predict negative stock returns in response to tax increases. In contrast to these theoretical models, we focus on a New Keynesian model that explicitly models monetary policy, which we find is a crucial modeling choice. Ayers, Cloyd, and Robinson (2002); Auerbach and Hassett (2005); Lang and Shackelford (2000); Dai, Maydew, Shackelford, and Zhang (2008); and Amromin, Harrison, and Sharpe (2008) run panel regressions and event studies around various tax cuts in 1993, 1997, and 2003. Their findings range from negative to no effect with respect to a tax increase. However, this approach controls, at least in part, for discount rate news that is an integral part to our story. To this end, we use a Campbell and Shiller (1988) news decomposition.

News decompositions consist of splitting the movements in unexpected stock market returns into two fundamental components – news about future discount rates and news about future cash flows. The news component of both channels reflect changes in investors' expectations, which can be proxied based on the methods of Campbell and Shiller (1988). While our focus is on which channels are influenced by tax shocks, our analysis speaks to the relative importance of discount rates versus cash flows, a central discussion of finance. Campbell and Shiller (1988); Campbell (1991); Campbell and Ammer (1993); Vuolteenaho (2002); Chen and Zhao (2009) among others focus on the volatility of asset prices being driven by volatility in discount rate news. Cash flow news as the primary driver of asset volatility is emphasized by Bansal and Yaron (2004); Bansal, Dittmar, and Lundblad (2005); Lettau and Ludvigson (2005); Santos and Veronesi (2010); Cohen, Polk, and Vuolteenaho (2009); Da (2009); Hansen, Heaton, and Li (2008).

Previous studies have used similar empirical methods to derive the effects of monetary policy on the stock market, but not fiscal policy. Patelis (1997); Bernanke and Kuttner (2005); and Maio (2014) have all found monetary policy imposing significant effects on the stock market using a news decomposition. For instance, Bernanke and Kuttner (2005) find that unexpected monetary policy shocks impact stock market returns predominantly through the future excess returns channel, whereas the effect on real interest rates and dividends are smaller and less significant.

These findings also add to a rich literature exploring the relationship between policy and equity returns, more broadly. Ai and Bansal (2016) explore the macro announcement premium in the context of uncertainty aversion. Belo and Yu (2013) look at the relationship between government investment and returns at the aggregate and firm level, while Belo, Gala, and Li (2013) focus on industry exposure to government spending and find predictable variation in cash flows and stock returns over political cycles. Croce, Kung, Nguyen, and Schmid (2012), Croce, Nguyen, Raymond, and Schmid (2017), and Croce, Nguyen, and Schmid (2012, 2013) study the link between debt, taxation, and returns in a general equilibrium RBC framework, while Da, Warachka, and Yun (2016) focus on state-level fiscal policies. Pastor and Veronesi (2012, 2013, 2017) study the link between stock prices and risk premia with an explicit focus on political uncertainty along with the political cycle. Gallmeyer, Hollifield, and Zin (2005) focuses on the relationship between various monetary policy rules and the term structure of interest rates, while Kung (2015) studies the equilibrium relationship between monetary policy and the term structure of interest rates in a model with endogenous growth. In contrast to the above studies, we document that a shift in monetary policy significantly changes the response of equity returns to fiscal policy within the context of tax shocks.

Finally, our paper is not the first to suggest that bad news (in our case, tax increases) can be associated with higher equity returns. Boyd, Hu, and Jagannathan (2005) find that bad news coming from unemployment data is usually good for stocks. Their empirical study suggests interest rate expectations fall on bad labor market news during expansions, which results in a positive effect on stock prices. Likewise, good news (in our case, tax cuts) can be associated with lower equity returns, as shown in McQueen and Roley (1993). They find that when the economy is strong, the stock market responds negatively to news about higher real economic activity and this is caused by a larger increase in discount rates relative to expected cash flows. In a separate and independent manuscript completed after our paper, Mumtaz and Theodoridis (2017) find that positive (negative) shocks to government spending (taxes) lead to a rise (fall) in stock prices in the US post-1980.[3] Additionally, Evans and Marshall (2009) show that an expansionary labor supply shock or a

[3] Our paper differs from this paper in several important ways. On the theoretical side, we move beyond a first-order approximation to allow for potentially non-linear asymmetric effects, which allows us to determine that tax cuts could potentially have larger effects in the presence of downward nominal wage rigidities. We show that our theoretical implications hold in the FRB/US model

preference/demand shock[4] leads to a positive response in profits, but a much bigger response of interest rates. The overall effect on the market return is negative, so that "good news is bad news" for the stock market. Blanchard (1981) and Orphanides (1992) also provide equilibrium and empirical support for the notion that good news can be bad for the stock market, depending on the state of the economy.

3. Model

3.1. Households

The economy is populated by a continuum of identical infinitely lived households. Each household has preferences defined for consumption, c_t, and labor hours, h_t. Preferences are based on the standard CRRA utility function

$$E_0 \sum_{t=0}^{\infty} \beta^t \frac{(c_t^{\iota}(1-h_t)^{1-\iota})^{1-\sigma}-1}{1-\sigma} \tag{1}$$

where E_t denotes the expectations operator conditional on information available at time t, $\beta \in (0,1)$ is the subjective discount factor, c_t is the consumption, and h_t is labor. The consumption good is assumed to be a composite good produced with a continuum of differentiated goods, c_{it}, $i \in [0,1]$, via the aggregator function

$$c_t = \left[\int_0^1 c_{it}^{1-1/\eta} di\right]^{1/(1-1/\eta)} \tag{2}$$

where the parameter $\eta > 1$ denotes the intratemporal elasticity of substitution across different varieties of consumption goods. For any given level of consumption of the composite good, purchases of each variety i in period t must solve the dual problem of minimizing total expenditure, $\int_0^1 P_{it} c_{it} di$ subject to the aggregation constraint above, where P_{it} denotes the nominal price of a good of variety i at time t. Upon solving this

demonstrating that neither the relatively small scale of our model nor the specific form of our Taylor Rule is necessary to drive our results. On the empirical side, we provide evidence using a variety of alternate specifications and identification strategies, such as higher frequency results using municipal bond data, results using valuation ratios rather than returns as in Sialm (2009), and cross-sectional results.

[4]Note, Mulligan (2002) interprets this shock as a labor market distortion, such as a change in tax rates.

problem, the optimal level of c_{it} is given by $c_{it} = \left(\frac{P_{it}}{P_t}\right)^{-\eta} c_t$ and P_t is a nominal price index given by $P_t \equiv \left[\int_0^1 P_{it}^{1-\eta} di\right]^{1/(1-\eta)}$. This price index has the property that the minimum cost of a bundle of intermediate goods yielding c_t units of the composite good is given by $P_t c_t$.

Households are assumed to have access to a complete set of nominal contingent claims. The household's budget constraint is given by

$$E_t d_{t,s} \frac{x_{t+1}}{P_t} + c_t + i_t + \tau_t = \frac{x_t}{P_t} + (1 - \tau_t^D) \cdot (w_t h_t + u_t k_t) + \delta q_t \tau_t^D k_t + \phi_t \tag{3}$$

where $d_{t,s}$ is the stochastic discount factor, defined such that $E_t d_{t,s} x_s$ is the nominal value in period t of a random nominal payment x_s in period $s \geq t$. The variable i_t denotes investment, τ_t is the lump sum tax, τ_t^D is the distortionary income tax rate, w_t is the real wage, u_t is the rental rate of capital, k_t denotes capital, and q_t denotes the market price of one unit of installed capital. The term $\delta \tau_t^D q_t k_t$ denotes deprecation allowance for tax purposes and ϕ_t denotes profits received from ownership of firms net of income taxes.

The evolution of capital is given by

$$k_{t+1} = (1 - \delta) k_t + i_t \Psi_t \left(\frac{i_t}{i_{t-1}}\right) \tag{4}$$

where the function Ψ represents investment adjustment costs that take the form $\Psi(x) = 1 - \frac{\psi}{2}(x - 1)^2$ and $\psi \geq 0$. Without adjustment costs on investment, the price of capital would never change because the supply would be perfectly elastic and always equal to one. We show in the robustness section that our results do not depend on this parameter and for parsimony, set $\psi = 0$. Households are assumed to be subject to a borrowing limit that prevents them from engaging in Ponzi schemes.

3.1.1. Wages and Labor

Households are assumed to have differentiated job skills that provide them monopolistically competitive power over the labor supply. They choose their wage and labor supply taking the firms' demand for their labor type. Following Kim and Ruge-Murcia (2009), labor market frictions create adjustment costs in nominal wages and take the form of the linex function

$$\Phi_t^n = \Phi(W_t^n / W_{t-1}^n) = \phi \left(\frac{exp(-\phi(W_t^n / W_{t-1}^n - 1)) + \phi(W_t^n / W_{t-1}^n) - 1}{\phi^2} \right) \tag{5}$$

where W_t^n is the nominal wage and ϕ and ψ are cost parameters. This function allows for the costs associated with wage decreases to rise exponentially, while costs associated with wage increases to rise linearly. This creates an asymmetry that is consistent with the notion of downward nominal wage rigidities.

When households choose W_t^n, they equate the marginal costs and benefits of increasing W_t^n, as shown below

$$\omega_t \Phi' = \theta \frac{1-\iota}{\iota} \frac{c_t}{leis_t} \frac{1}{w_t(1-\tau_t^d)} - (\theta - 1)(1 - \Phi) + E_t \left[m_{t,t+1} \frac{h_{t+1}}{h_t} \Delta w_{t+1} \omega_{t+1} \Phi'_{t+1} \right] \tag{6}$$

where $\omega_t = W_t^n / W_{t-1}^n$. As noted by Kim and Ruge-Murcia (2009), the costs decrease in hours worked as firms substitute away from more expensive labor input and the wage adjustment cost. The benefits are the increase in labor income per hour worked, the increase in leisure time as firms reduce their demand for labor of type-n, and the reduction of future expected wage adjustment costs.

3.2. The Government

The government issues one-period nominal risk-free bonds, B_t, collects tax revenues $P_t \tau_t$, and spends an exogenous amount each period, g_t. In real terms, the government's budget constraint is

$$b_t = \frac{R_{t-1}}{\pi_t} b_{t-1} + g_t - \tau_t \tag{7}$$

where lower case letters denote real values, $\pi_t \equiv P_t / P_{t-1}$ denotes gross consumer price inflation, R_t denotes the gross one-period risk free nominal interest rate in period t.

Total tax revenues are $\tau_t = \tau_t^D y_t + \tau_t^L$. The fiscal rule is defined so that tax revenues must rise with debt

$$\tau_t = \tau^* + \gamma_1 (R_{t-1} b_{t-1} - R^* b^*) \tag{8}$$

where γ_1 denotes how fast taxes are paid back, τ^* and B^* denote the deterministic steady state values of τ_t and B_t respectively. To isolate the effects of the tax rate, we allow lump sum taxes to adjust in order to balance the budget. Note that if we did not setup taxes in this way, any distortionary tax rate change would be followed by an opposite reaction in the following periods, coming from the above rule as debt changes.[5]

To analyze the effect of tax shocks, a normal, mean zero shock is appended to the distortionary tax rate such that

$$\tau_t^D = \tau^{D,*} + u_t^{tax}. \tag{9}$$

$$u_t^{tax} = \rho^\tau u_{t-1}^{tax} + \epsilon_t^{tax} \tag{10}$$

The standard deviation is set to match the standard deviation of the tax shocks coming from Romer and Romer (2010) and the persistence is set to a high value to be consistent with the empirical analysis. We show in the robustness section that our main results do not depend on these parameters.

The monetary authority sets the short-term nominal interest rate according to a simple feedback rule.

$$\ln(R_t/R^*) = \alpha_r \ln(R_{t-1}/R^*) + (1-\alpha_r)\left[\alpha_\pi \ln(\pi_t/\pi^*) + \alpha_y \ln(\Delta y_t/\Delta y^*)\right] \tag{11}$$

where Δy^* denotes the deterministic steady state of output growth.[6]

3.3. Firms

Each variety $i \in [0,1]$ is produced by a single firm in a monopolistically competitive environment. The production technology is given by $z_t k_{it}^\theta h_{it}^{1-\theta}$ where z_t denotes an exogenous, aggregate productivity shock.

Aggregate demand for good i is denoted by $a_{it} = c_{it} + i_{it} + g_{it} = (P_{it}/P_t)^{-\eta} a_t$ given the aggregation

[5] Isolating the effects of tax rate changes in this way is also consistent with Sims and Wolff (2016).

[6] We focus on output growth rather than the output gap for multiple reasons: (1) Output growth is observable whereas the output gap is a function of two unobserved variables, the natural rate of unemployment and the potential level of output; (2) Real-time output gaps tend to significantly differ from ex-post output gaps (Belke and Klose, 2011); (3) Smets and Wouters (2007), Orphanides (2004), and Campbell, Pflueger, and Viceira (2017) find no significance on the output gap for Post-Volcker. In contrast, Smets and Wouters (2007) do find significance on output growth for Post-Volcker. In addition, our own estimates based on Greenbook Data find significance for output growth but not the output gap for the Post-Volcker time period. Furthermore, Coibion and Gorodnichenko (2015) find significant changes to the output growth variable across the Pre and Post-Volcker regimes whereas they find no significant difference in the output gap level. Moreover, including an output gap level does not change our analysis so we exclude it for parsimony.

constraint. It is assumed that the firm must satisfy demand at the posted price so that firms maximize expected profits subject to the following constraint

$$z_t k_{it}^{\theta} h_{it}^{1-\theta} \geq \left(\frac{P_{it}}{P_t}\right)^{-\eta} a_t \tag{12}$$

Firms are assumed to face a quadratic cost of adjusting nominal prices as in Rotemberg (1982), with the cost being measured in terms of the final good and given by

$$\frac{\phi}{2}\left(\frac{\pi_t}{\pi_{ss}}-1\right)^2 Y_t$$

where ϕ captures the degree of nominal rigidity. The problem for firm j is then to maximize the discounted value of nominal profits

$$\max_{P_t(j)_{t=0}^{\infty}} E_t \sum_{s=0}^{\infty} Q_{t,t+s} \Xi_{t+s}$$

where nominal profits are defined as

$$\Xi_t = P_t(j)Y_t(j) - mc_t Y_t(j) P_t - \frac{\phi}{2}\left(\frac{\pi_t}{\pi_{ss}}-1\right)^2 Y_t P_t$$

Firms can change their price in each period subject to the adjustment costs. Therefore, all firms face the fame problem and will choose the same price and same quantity. This yields a symmetric equilibrium, $P_t(j) = P_t$ and $Y_t(j) = Y_t$ for any j, and the first-order condition is

$$(1-\eta)+\eta mc_t-\phi\frac{\pi_t}{\pi_{ss}}\left(\frac{\pi_t}{\pi_{ss}}-1\right)+\phi\beta E_t\left[\left(\frac{c_{t+1}}{c_t}\right)^{\iota(1-\frac{1}{\psi})-1}\left(\frac{1-h_{t+1}}{1-h_t}\right)^{(1-\iota)(1-\frac{1}{\psi})}\frac{y_{t+1}}{y_t}\frac{\pi_{t+1}}{\pi_{ss}}\left(\frac{\pi_{t+1}}{\pi_{ss}}-1\right)\right]=0$$

This is the non-linear Phillips curve that relates current inflation to future expected inflation and to the level of output.

Rounding out the model, the resource constraint for the entire economy is

$$y_t = c_t + i_t + g_t + \Gamma_t y_t + w_t h_t \Phi_t \tag{13}$$

where Γ captures the price adjustment costs and Φ_t captures wage adjustment costs.

3.4. Return

We follow standard theory and define the return in our theoretical model as follows

$$R_{t+1}^{DIV} = \frac{P_{t+1} + D_{t+1}}{P_t} \tag{14}$$

where $P_t = E_t \left[M_{t+1} R_{t+1}^{DIV} \right]$ and $D_t = Y_t - w_t L_t - I_t$.[7] Typically, dividends are defined as a levered claim to consumption in the finance literature. This is because consumption based asset pricing models are frequently modeled as endowment economies where consumption and dividends are exogenous. In contrast, our setup is a richer and more fully specified framework that defines dividends as a function of endogenous production and investment decisions.

For the sake of our theoretical income tax experiments, we modify the cash flow in the return equation such that

$$D_t^* = \left(1 - \tau_{D,t}^*\right) D_t \tag{15}$$

where $\tau_{D,t}^* = \gamma \tau_t^D$ is the dividend tax rate and is proportional to the income tax rate. On one extreme, $\gamma = 0$, and this assumes that 0% of equity is held by taxable investors. On the other extreme, $\gamma = 1$, which assumes that 100% is held by taxable investors. Instead, we follow Sialm (2009) and use data from the FED2004 Flow of Funds that suggests $\gamma = 0.55$, or 55% of equity is held by taxable investors.

3.5. Calibration

Many of the deep structural parameters have been set to the values in Schmitt-Grohé and Uribe (2007). For completeness, we check the robustness of our results with respect to each parameter in Section 1 of the Appendix. Since the goal of Schmitt-Grohé and Uribe (2007) was to determine optimal policy and not necessarily to match empirical moments when specifying fiscal and monetary policy, we turn to prior literature to set the remaining parameters in our model. The four parameters that we are unable to obtain

[7] Alternatively, we can define dividends as $D_t = C_t + G_t + (1 - \Phi_t) W_t H_t$.

from Schmitt-Grohé and Uribe (2007) are γ_1, the speed of tax repayment, α_π, the inflation coefficient, α_y, the output growth coefficient, and α_R, the inertia coefficient in the monetary policy rule. For fiscal policy, our choice for the speed of tax repayment comes from recent estimates by Drautzburg and Uhlig (2015), which we set to 0.03. Since lump sum taxes help balance the budget (which allows us to isolate the effects of distortionary tax shocks), this parameter does not meaningfully alter the quantitative results.

For monetary policy, we follow Coibion and Gorodnichenko (2015), who estimate parameters in the monetary policy rule for the Pre-Volcker and Post-Volcker eras. For the Post-Volcker era, we use their estimated coefficients of 0.90 for the inertia coefficient, 1.58 for the inflation coefficient, and 2.21 for the output growth coefficient. We show in Section 1 of the Appendix that our results are not highly sensitive to the values presented here. Moreover in Section 2 of the Appendix, we follow Orphanides (2004) and Coibion and Gorodnichenko (2015) to estimate the policy rule with Greenbook data through 2007.[8] Again, the results of these tests are consistent with the theoretical implications presented below.

For the Pre-Volcker setting, Coibion and Gorodnichenko (2015) find a lower output growth coefficient and a lower inflation coefficient and our estimates confirm these lower values in comparison to the Post-Volcker time period. Our own estimates suggest lowering the output growth coefficient to 0.94, lowering the inflation coefficient to 1.32, and setting an inertia coefficient to 0.91.[9] We note that the change in the response to output growth is the primary driver of our theoretical results.

3.6. DSGE Results

Our DSGE model results present the exact mapping from the initial tax shock to the endogenous responses of returns and cash flows implied by the solution to the model. We solve the model by taking a second order approximation of the nonlinear equilibrium conditions. We start with a discussion of the impact of an exogenous income tax rate increase on the economy as depicted in Figure 1.

Figure 1 presents the impulse response functions for an exogenous income tax rate increase under the Post-Volcker and Pre-Volcker calibrations. To better understand the importance of the cash flow channel versus the discount rate channel in determining equity prices, we compute the excess returns for two additional

[8] While Sims and Zha (2006) and others focus on a shift in the volatility of policy shocks to explain changes in inflation through time, differences in our estimated loadings across regimes are sufficient to generate our main theoretical implications.

[9] Section 2 of the Appendix details our estimation.

Parameter	Value	Description
$\frac{1}{\sigma}$	0.2	Intertemporal Elasticity of Substitution
θ	0.3	Cost share of capital
β	0.999	Quarterly subjective discount rate (Real risk-free rate 4%)
η	7	Price Elasticity of Demand (Midpoint of Schmitt-Grohe Uribe (2007) = 5 and Coibion and Gorodnichenko (2011) = 10)
δ	0.025	Quarterly Depreciation Rate
ϕ	35	Price Adjustment Costs, (Kim and Ruge-Murcia, 2007)
ι	0.25	Set to match Labor = 0.25 (See Robustness Section)
Ψ	0	Investment Adjustment Cost Parameter
ρ_G	0.87	Serial correlation of government spending
σ^{ϵ_G}	0.016	Standard deviation of innovation to government purchases
ρ_z	0.8556	Serial correlation of productivity shock
σ^{ϵ_z}	0.0064	Standard deviation of innovation to productivity shock
ρ_τ	0.9999	Serial correlation of tax shock (See Robustness Section)
σ^{ϵ_τ}	0.0022	Standard deviation of innovation to tax rate Romer and Romer (2007)
ϕ	1000	Wage adjustment costs parameter (Kim and Ruge-Murcia, 2007)
ψ	3800	Asymmetric wage adjustment costs parameter (Kim and Ruge-Murcia, 2007)

scenarios defined below: (1) *Discount Rate Only* and (2) *Cash Flow Only*. Specifically, we define

$$\text{Discount Rate Only Scenario: } P_{1,t} = E_t[M_{t+1} \cdot (P_{t+1} + D_{SS})]$$

$$\text{Cash Flow Only Scenario: } P_{2,t} = M_{SS} \cdot E_t[(P_{t+1} + D_{t+1})]$$

where M_{SS} and D_{SS} are the steady-state values of the SDF and dividends, respectively.

The *Discount Rate Only* scenario completely shuts down variation in the cash flow channel, so that the price of equity is purely a function of the sum of future SDF values. As denoted by the dashed blue line, the exogenous tax increase leads to a higher excess equity return as real interest rates decline (the real SDF rises) due to the negative wealth effects of the higher tax rate on consumption growth.

The *Cash Flow Only* scenario shuts down variation in the discount rate channel, so that the price of equity is purely a function of the future dividends discounted by the deterministic steady state of the real SDF. As denoted by the red dot-dashed line, it is clear that the excess equity return would be negative with only cash flow news. The higher income tax rate reduces output growth over the medium to long run, and this translates to lower dividend growth.

By activating both the cash flow and discount rate channels, we arrive at the black lines in Figure 1. In the left panel (Post-Volcker), the discount rate effect dominates so that the excess equity return has a positive response. For the Post-Volcker calibration, a sizable weight in the Taylor Rule is placed on output growth. This stabilizing effect generates a greater relative decline in real interest rates in response to the exogenous income tax rate increase. In addition, the greater policy response to the negative economic effects of the tax shock also helps dampen the decline in cash flow news. We explore the effects of each coefficient in the Taylor Rule in more detail in the Section 1 of the Appendix.

In contrast, for the right panel (Pre-Volcker), a smaller coefficient on output growth in the monetary policy rule implies a smaller relative decline in real interest rates. In addition, the smaller policy response to the negative economic effects of the tax shock amplifies the decline in cash flow news. As a result, the cash flow news dominates and the effect of the tax increase is a negative current excess return.

3.6.1. Pre-Volcker

Figure 2 presents the impulse response functions for an exogenous income tax rate increase for the Pre-Volcker, Post-Volcker, and RBC calibrations. The difference between the Pre-Volcker and Post-Volcker calibrations is isolated to the Taylor Rule. Specifically, the Pre-Volcker calibration (red dashed line) features a lower inflation coefficient, and a significantly lower output growth coefficient. With the lower output growth coefficient in the monetary policy reaction function, real interest rates do not decline as much and output growth declines more in the medium to long run.

For the Pre-Volcker calibration, the negative substitution effect dominates so that investment growth declines initially. Specifically, monetary policy responds less to the negative effects of the tax increase due to the lower output growth coefficient, which reduces the incentive to invest. Since the level of investment falls below its long-run level, investment growth is positive in the subsequent periods. While the initial decline in investment does lead to positive dividend growth at first, the increase in investment growth in later periods combined with the greater decline in output (compared to the Post-Volcker) leads to a larger negative sum of dividend growth. Therefore, the cashflow channel is larger. At the same time, the discount rate channel is smaller when compared to the Post-Volcker scenario. This combination of more negative cash flow news and less negative discount rate news causes a negative excess equity return because the cash flow effect dominates.

3.6.2. Post-Volcker

For the Post-Volcker scenario (the dashed blue line) , recall that dividends are an endogenous function of the production and investment decisions ($D_t = Y_t - w_t L_t - I_t$); thus, the decline in dividends is caused by the incipient increase in investment due to the negative wealth effect. Dividend growth in the medium to long run is subdued as output growth also declines due to the higher income tax rate.[10] As previously mentioned, real interest rates decline to a greater extent under the Post-Volcker regime because monetary policy responds to a greater extent through the higher coefficient on output growth.[11]

3.6.3. RBC

The solid black line reflects the Real Business Cycle Model. The Real Business Cycle model differs from the New Keynesian model by eliminating the monetary policy rule and keeping inflation constant while removing wage rigidities. Doing so replicates the natural level of output, which is the output that would occur with flexible prices. It provides a benchmark to show the importance of incorporating a role for monetary policy and nominal rigidities. As shown in Figure 2, dividends falls slightly more than the NK: Post-Volcker model and real interest rates do not fall as much in the medium-long run. This entails a larger relative effect on cash flow news versus discount rate news, so the overall effect is a negative current excess return. In contrast to the Pre-Volcker and RBC settings, the Post-Volcker monetary policy of putting greater weight on output growth leads to a larger effect on real interest rate news and a smaller decline in dividends, so that the discount rate channel dominates and the current excess return for Post-Volcker is positive.

3.6.4. Asymmetries in the Response to Fiscal Policy

This section explores the theory and intuition for why the tax shock generates asymmetric responses depending on its direction, as shown in Figure 3. Recall that for the Post-Volcker regime income tax rate

[10]Output growth largely follows the response of labor, and labor briefly rises before declining in response to the positive tax shock. These dynamics are similar to the responses one might see for a news shock. While the initial rise in labor might at first be counterintuitive, note that capital is predetermined, so that in the first period, the negative effects of the tax shock on the capital stock (via lower investment) do not occur until later periods, and the marginal product of labor is at first higher than it will be in subsequent periods when capital is lower.

[11]Another way to think about the effects on the real interest rates is to note that with the presence of capital, the real interest rates are largely equivalent to the after tax marginal product of capital. In the Post-Volcker setting, investment is higher than in the Pre-Volcker setting and the capital stock is higher in the medium to long run (due to the greater response to output in the Post-Volcker setting). A higher capital stock mechanically reduces the marginal product of capital, and although this effect is slightly tempered by the higher level of labor in the Post-Volcker setting, the overall effect is a greater decline in real interest rates when compared to the Pre-Volcker setting.

increase (blue dashed line), the negative wealth effect dominates so that consumption declines, while investment and labor initially rise. Beyond the initial period of the shock, both labor and investment continue to decline until they reach their long-run levels due to the higher tax rate. While labor and capital both decline (which would have opposite effects on the marginal product of labor), the decline in labor supply dominates so that wages rise. When wages rise, wage adjustment costs are smaller compared to the case of falling wages (due to downward nominal wage rigidities).

In contrast to the tax increase, the tax cut (black dashed line) generates a positive wealth effect so that consumption rises while investment and labor initially decline. Beyond the initial period of the shock, the benefits of the tax cut lead to a higher labor supply and higher investment. The higher labor supply dominates so that wages decline in the medium to long run. However in comparison to a wage increase, a wage decline generates greater adjustment costs, which reflect the downward nominal rigidities in the model. With wages declining less due to the greater adjustment costs, the demand for labor is lower, and investment and output do not rise as much due to the greater adjustment costs.

Relating these dynamics back to the current excess return, we see that the excess equity return declines more in response to the tax cut (evidenced by the red line showing the difference in responses to a tax increase and tax cut). This decrease can mainly be attributed to the cash flow channel, as dividends do not rise as much in response to the tax cut. The dynamics for the dividends can be explained by separating the short run from the medium to long run.

In the short run, investment does not decline as much (dividends do not increase as much) due to the positive wealth effect being dampened by the increased wage adjustment costs as wages decline over the medium to long run. In the medium to long run, investment does not rise as much (which should lead to a greater increase in dividends), but this effect is offset by the fact that output also does not rise as much (recall that $D_t = Y_t - w_t L_t - I_t$). The smaller increase in output over the medium to long run due to the increased wage adjustment costs dominates so that dividends do not rise as much over the medium to long run for the tax cut when compared to the effects of the tax increase.

Combining both the short-run effect (relatively smaller decline in investment due to smaller positive wealth effect) and medium to long run effect (relatively smaller increase in output due to wage adjustment costs coming from lower wages) leads to an unambiguously smaller increase in dividends for the tax cut. The overall effect is a greater decline in the equity return for the tax cut. To summarize, the presence of downward nominal wage rigidities (i.e. asymmetric wage adjustment costs) provides a theoretical foundation for why tax cuts could lead to larger effects on equity markets than tax increases.

The right panel removes downward nominal wage rigidities, and shows that the difference across each impulse response function is essentially zero. This demonstrates the importance of including downward nominal wage rigidities in order to generate asymmetric responses to tax cuts and tax increases.

3.7. Measuring the Impact of News on Equity Returns

In order to further decompose the impact of an exogenous tax increase on excess equity returns and to develop a framework for which to empirically test the predictions of our model, we turn to the basic framework of Campbell and Shiller (1988); Campbell (1991); and Campbell and Ammer (1993). Those studies show that according to a simple dynamic accounting identity, innovations in current equity excess returns can be decomposed as follows into revisions of future expected cash flows, revisions of future expected excess returns, and revisions of future expected real interest rates.

$$\begin{aligned} r_{ex,t+1} - E_t(r_{ex,t+1}) =& (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta d_{t+1+j} - (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{ex,t+1+j} \\ & - (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j r_{real,t+1+j} \end{aligned} \tag{16}$$

$$r_{ex,t+1} - E_t(r_{ex,t+1}) \equiv N_{CF,t+1} - N_{ex,t+1} - N_{real,t+1} \tag{17}$$

where

$$N_{CF,t+1} \equiv (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta d_{t+1+j} = r_{ex,t+1} - E_t(r_{ex,t+1}) + N_{ex,t+1} + N_{real,t+1} \tag{18}$$

$$N_{ex,t+1} \equiv (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{ex,t+1+j} \tag{19}$$

$$N_{real,t+1} \equiv (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j r^f_{real,t+1+j} \tag{20}$$

represent revisions about future cash-flows, revisions in future expected excess returns, and revisions in future real interest rates, respectively. The monthly discount factor ρ is set to 0.9962, following the previous literature (Campbell and Ammer, 1993; Bernanke and Kuttner, 2005) and is used to match the steady state average annual dividend yield of 5%. As previously stated, the above relationships reflect dynamic accounting identities and have no economic or behavioral content.

Table 1 reports the discounted sum of these effects on equity, summarizes the IRFs presented in Figure 2, and provides a benchmark for our empirical results. Over the Post-Volcker period, a one standard deviation increase in the taxes (0.22%) corresponds to a 0.0515% increase in excess equity returns. With an exogenous increase in taxes, news about both future real interest rates and cash flows is negative. The decrease in discounted future cash flows of -0.2103% is offset by the decrease in discount rates of -0.2588%. Most of this change in future discount rates is driven by news about future real interest rates rather than information about future equity premia, as monetary policy stabilizes output to a greater extent. Responses for a negative tax shock exhibit the asymmetries discussed in Section 3.6.4 with a one standard deviation decrease in taxes corresponding to a -0.0528% contemporaneous excess equity return.

Panel B of Table 1 presents results for the Pre-Volcker calibration. In this case, a one standard deviation increase in the tax rate leads to a 0.0502% decrease in excess equity returns. Again, both news about future real interest rates and cash flows is negative consistent with the findings in Gale and Orszag (2003) and Romer and Romer (2010), respectively. However in the Pre-Volcker period, the cash flow news channel dominates the real interest rate news channel such that the overall impact on equity returns is negative. Again asymmetries exist due to downward nominal wage rigidities.

Panel C of Table 1 presents results for the RBC calibration. Recall, the RBC calibration replicates the natural level of output by removing monetary policy and nominal rigidities. Similar to the previous panels, a tax increase leads to negative cash flow and discount rate news. Similar to the Pre-Volcker framework, the cash flow news channel is larger so that the overall effect of tax increase is a 0.0555% decrease in excess equity returns.

3.8. Model Robustness

3.8.1. Alternative Parameter Values

As a first pass, we verify that our choice of parameters in our calibrated model do not impact the theoretical predictions of the model. Namely, we demonstrate that the decline in excess returns in response to a tax cut is robust to perturbing all the parameters above and below their benchmark values. Specific results along with a full discussion and intuition are available in Section 1 of the Appendix.

3.8.2. Results in the FRB/US Model

While an exploration of the effects of monetary policy on real interest rates requires New Keynesian features, neither the relatively small scale of our model nor the specific form of our Taylor Rule is necessary to drive the changes to the discount rate and cash flow macroeconomic news channels across monetary policy regimes. In this section, we explore the robustness of our theoretical implications to an alternative modeling framework closely related to the model presented in Fleischman and Roberts (2011), the FRB/US model.[12] This large-scale model of the U.S. economy allows for nonlinear interactions among endogenous variables and serves as one of several workhorse models that the Federal Reserve Board staff consults for forecasting and the analysis of macroeconomic issues, including both monetary and fiscal policy.

Our approach is to take this model off the shelf and simulate the results of our fiscal policy experiment. Specifically, we peturb nominal personal tax receipts ($TFPN$) by 0.22% of taxable income ($YPN - GFTN - GSTN$) for ten years from 2020Q1 to 2029Q4.[13] Results are similar to our findings based on the DSGE model. Current excess equity returns increase following an exogenous increase in the tax rate with both cash flow and discount rate news falling following the shock. As before, the discount rate news channels dominate the cash flow news driving the increase in equity returns. Specifically, the current excess return rises 0.28%, and the discount rate news declines by 0.98% and the cash flow news declines by 0.70%.[14] In addition, when the output gap coefficient is decreased as in the case of our Pre-Volcker calibration, the discount rate news channel decreases in absolute magnitude leading to a lower current excess equity return

[12] For more information, see Brayton, Laubach, and Reifschneider (2014) and cites therein.

[13] We shock nominal personal tax receipts directly to prevent the endogenous persistence in the tax rate ($TRFP$) from amplifying the effects of a tax cut or stimulus.

[14] One potential concern is that cash flows far in the future are (unrealistically) driving our results. In this set of experiments where we can more easily control for the duration of the fiscal policy experiment, we find that our main results remain.

response.

4. Data and Methodology

This section describes our empirical implementation of the equity return decomposition presented in the previous section, the sources of data which we employ, and the identification strategy we use to construct a series of plausibly exogenous shocks to tax policy.

4.1. Data and Estimation

In order to empirically implement the news decomposition described above, we require proxies for the expectations appearing in Equation 16. We follow the approach of Bernanke and Kuttner (2005) and write an n-variable, p-lag vector autoregression (VAR) as a first-order system

$$Z_{t+1} = AZ_t + w_{t+1} \tag{21}$$

where Z_{t+1} is a stacked $np \times 1$ vector containing the real interest rate, the excess equity return, and other variables that are considered useful for forecasting excess equity returns. The state vector we consider is given by

$$Z_t \equiv [r_{ex,t},\ r_{real,t},\ \Delta r_t,\ SPREAD_t, d_t - p_t,\ REL_t]' \tag{22}$$

where $r_{ex,t}$ is the CRSP value-weighted return in excess of the risk-free rate; $r_{real,t}$ is the real interest rate, defined as the 3-Month Treasury bill rate divided by quarterly CPI; Δr_t denotes the change in the nominal 3-Month Treasury bill rate; $SPREAD_t$ denotes the difference between the yields on the 10-year T-Bill and 3-month T-Bill; $d_t - p_t$ denotes the log dividend-price ratio for the S&P 500; REL_t is the difference between the 3-Month T-Bill and its 12-month moving average. Data are as in Welch and Goyal (2008).[15]

Our analysis focuses on the post-World War II period for which we can construct a series of tax policy shocks, 1947Q1 to 2007Q4. As discussed in the previous section, the hypothesized response of equity prices to fiscal policy shocks is highly dependent on monetary policy regime. To capture the Pre- and Post-Volcker

[15] We thank Amit Goyal for providing these data.

period in our data, we define the following subsamples: 1947Q1-1980Q2, and 1980Q3-2008Q2. We identify the cutoff between 1980Q2 and 1980Q3 statistically. Specifically, we test for multiple unknown structural breaks in the VAR system given in Equation 21 using the $SupW$ test of Andrews (1993). We allow for heteroskedasticity within regimes and implement the fixed regressor bootstrap of Hansen (2000) to calculate the critical values for our conditional model. This cutoff also has economic importance as inflation peaked in March 1980 following the beginning of the Volcker policy experiment in October 1979.[16]

With the VAR expressed as above, the discounted sum of revisions in expectations are estimated as follows by Campbell (1991); Campbell and Ammer (1993); and Bernanke and Kuttner (2005):

$$\begin{aligned} N_{ex,t+1} &\equiv (E_{t+1} - E_t) \sum_{j=1}^{\infty} \rho^j r_{ex,t+1+j} \\ &= \mathbf{e1}' \rho \mathbf{A} (\mathbf{I} - \rho \mathbf{A})^{-1} w_{t+1} \end{aligned} \tag{23}$$

$$\begin{aligned} N_{real,t+1} &\equiv (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j r_{real,t+1+j} \\ &= \mathbf{e2}' (\mathbf{I} - \rho \mathbf{A})^{-1} w_{t+1} \end{aligned} \tag{24}$$

$$\begin{aligned} N_{CF,t+1} &\equiv (E_{t+1} - E_t) \sum_{j=0}^{\infty} \rho^j \Delta d_{t+1+j} \\ &= r_{ex,t+1} - E_t(r_{ex,t+1}) + N_{ex,t+1} + N_{real,t+1} \\ &= \left[\mathbf{e1}' + \mathbf{e1}' \rho \mathbf{A} (\mathbf{I} - \rho \mathbf{A})^{-1} + \mathbf{e2}' (\mathbf{I} - \rho \mathbf{A})^{-1} \right] w_{t+1} \end{aligned} \tag{25}$$

In the above equations, **e1** is a vector whose first element is equal to one and zero otherwise, which corresponds to the position of the excess return on the CRSP value-weighted index in the VAR, and **e2** is a vector whose second element is equal to one and zero otherwise, corresponding to the position of the real interest rate in the VAR. In the above equations, cash-flow news is the residual of the unexpected excess return that cannot be explained by future excess returns and future real interest rates. Calculating cash-flow news as the residual has the advantage of not having to directly model the dynamics of dividends, which

[16]Our main results are quantitatively similar using cutoffs throughout the Volcker policy experiment of 1979Q3 to 1984Q1. For example, Coibion and Gorodnichenko (2015) use 1983Q1 as the cutoff between the Pre- and Post-Volcker monetary policy regimes.

often exhibit seasonality and are non-stationary.

Including variables beyond the excess equity return and real risk free rate are important for improving the forecast of future news about discount rates and cash-flows. For instance, both Δr_t and REL_t are known to be good predictors of the real interest rate. As pointed out in Campbell and Ammer (1993), the relative bill rate helps to capture the longer-run dynamics of changes in the interest rate without introducing long lags that drive up the number of parameters to be estimated. The $SPREAD_t$ variable has been popular in the predictability of returns literature as Campbell (1991) shows it tracks the business cycle relatively well. The aggregate dividend-price ratio is another popular predictor of aggregate stock returns (see Cochrane (2008)) and is appealing from a theoretical perspective based on the Campbell and Shiller (1988) decomposition.

To gauge the impact of exogenous shocks to fiscal policy on these variables of interest, we include a proxy for changes to fiscal policy in the VAR as an exogenous variable. Specifically, we let

$$w_{t+1} = \phi FISCAL_{t+1} + u_{t+1} \tag{26}$$

where $FISCAL_{t+1}$ represents an exogenous shock to fiscal policy. The effects of the fiscal shock on current (unexpected) excess returns, future excess return news, real interest rate news, and cash flow news are then given by

$$\xi_{ex,current} \equiv \mathbf{e1}'\phi \tag{27}$$

$$\xi_{ex,future} \equiv \mathbf{e1}'\rho\mathbf{A}(\mathbf{I}-\rho\mathbf{A})^{-1}\phi \tag{28}$$

$$\xi_{real} \equiv \mathbf{e2}'(\mathbf{I}-\rho\mathbf{A})^{-1}\phi \tag{29}$$

$$\xi_{CF} \equiv \mathbf{e1}'\phi + \mathbf{e1}'\rho\mathbf{A}(\mathbf{I}-\rho\mathbf{A})^{-1}\phi + \mathbf{e2}'(\mathbf{I}-\rho\mathbf{A})^{-1}\phi \tag{30}$$

Note that both the VAR dynamics and coefficient ϕ are relevant for characterizing the effects of fiscal policy.

To calculate standard errors for our news decomposition, we compute a recursive wild bootstrap as in Mertens and Ravn (2013).[17] Specifically, we estimate the VAR given in Equation 21 to obtain $\widehat{A}$ and a vector

[17]The VAR(1) system we implement removes much of the autocorrelation in the system's residuals. Specifically, the Durbin-Watson test statistics for the pre- and post-Volcker periods yield p-values of 0.605 and 0.743, respectively. The Ljung-Box test on the residuals of excess equity returns also fails to reject the null hypothesis of no autocorrelation for both subsamples at a lag length

of residuals, $\widehat{w}_{t+1}$. For each bootstrap replication $b = 1, ..., 2500$, we draw a series of residuals

$$\widehat{w}^{b}_{t+1} = \widehat{w}_{t+1}\mathbf{e}^{b}_{t+1}, \tag{31}$$

where e^{b}_{t+1} is a random variable taking on values of -1 or 1 with probability 0.5. We also generate a series of fiscal policy shocks

$$FISCAL^{b}_{t+1} = FISCAL_{t+1}\mathbf{e}^{b}_{t+1}. \tag{32}$$

After estimating the effects of the fiscal shock given by equations 27-30 for each bootstrapped sample, we can construct the empirical standard error in the usual way.

4.2. Identification of Tax Shocks

Clearly from the above discussion, obtaining an unbiased estimate of the effect of a fiscal policy shock on current excess returns relies on the exogeneity of the fiscal policy shock used in estimating Equation 26.[18] In this subsection, we describe the four series of plausibly exogenous tax shocks used to obtain our primary results: *All Shocks*, *SVAR Shocks*, *Surprise Shocks*, and *Surprise SVAR Shocks*.

We follow Romer and Romer (2010) in identifying *All Shocks* via a narrative approach. They conduct a narrative analysis that focuses on identifying all significant federal tax actions from 1947 to 2007. The sources used to identify the shocks are public government documents coming from both the executive branch (e.g. *Economic Report of the President*) and the legislative branch (e.g. *Congressional Record*). Fifty significant exogenous federal tax actions are identified and analysis is limited to tax actions that actually change tax liabilities. The size of tax changes are measured at the time of implementation and are normalized by the previous period's nominal GDP.

Common measures of tax shocks typically focus on changes in overall revenues and changes in cyclically adjusted revenues (see Blanchard and Perotti (2002)). A concern with using these measures for tax shocks is that they could reflect endogenous policy responses to the economic environment. The goal in using the

of 20.

[18]While much macroeconomic literature has focused on this question, Leeper, Walker, and Yang (2013) provides an overview of popular identification strategies used in assessing the effects of tax policy.

narrative analysis is to avoid the potential correlation of tax shocks with influences on aggregate outcomes. To accomplish this, federal tax actions are classified into four categories: spending-driven, countercyclical, deficit-driven, and for long-run growth. Spending-driven and countercyclical tax actions are considered endogenous tax changes because they are typically taken in response to current or future economic conditions. Once we exclude such actions from our analysis, we focus on the remaining deficit-driven tax change and the long-run tax change aimed at raising growth in the long run. Both of these types of tax changes are claimed to not be motivated by current or future short-run economic conditions. By focusing on these unexpected policy actions, we can more clearly discern the stock market reaction to tax changes.

Research by Mertens and Ravn (2014) highlights the potential for measurement error in narrative shock series such as our *All Shocks* variable due to necessary judgement calls in their construction, censoring problems when changes to the tax code are deemed revenue neutral, and discrepancies between actual changes in tax revenues and the projected changes in tax liabilities captured by narrative shock series. To overcome these measurement error issues, we construct the series *SVAR Shocks* following their “proxy structural VAR (SVAR)” methodology. Specifically, this technique uses a series of narrative shocks, *All Shocks*, to identify the structural shocks to a VAR such as the one in Blanchard and Perotti (2002). We estimate the impact of discretionary tax shocks from a VAR using data on total tax revenues T_t, government spending G_t, and output Y_t. The dynamics of the reduced form VAR are given by

$$Z_t = \alpha' d_t + \delta' Z_{t-1} + u_t \qquad (33)$$

where $Z_t = [T_t, G_t, Y_t]'$, d_t contains deterministic terms including a constant, linear and quadratic terms, and a dummy variable for 1975Q2, and $Z_{t-1} = [Z'_{t-1}, ..., Z'_{t-4}]$.[19] The structural shocks ε_t are related to the reduced-form residuals u_t through the equation

$$u_t = \beta \varepsilon_t \qquad (34)$$

[19]Data are from NIPA. Output is GDP in line 1 from Table 1.1.5; government spending is Federal Government Consumption Expenditures and Gross Investment in line 6 from Table 3.9.5; total tax revenue is Federal Current Tax Receipts in line 2 of Table 3.2 plus Contributions for Government Social Insurance in line 11 of Table 3.2 less corporate income taxes from Federal Reserve Banks (line 8 in Table 3.2). All series are deflated by the GDP deflator in line 1 from Table 1.1.9 and by the civilian population ages 16+ obtained from Francis and Ramey (2009).

While Blanchard and Perotti (2002), outline a series of identifying restrictions to map the reduced-form residuals u_t to the structural residuals ε_t. Mertens and Ravn (2014) augment the approach of Blanchard and Perotti (2002) via two sets of additional identifying restrictions incorporating the information in the narrative shocks m_t

$$E[m_t \varepsilon_t^T] = \phi \neq 0 \tag{35}$$

$$E[m_t \varepsilon_t^G] = E[m_t \varepsilon_t^Y] = 0 \tag{36}$$

such that

$$\phi \beta_T = E[u_t m_t] \tag{37}$$

where β_T is the first column of β. Equation 35 states that the narrative shock series is contemporaneously correlated with the structural tax shock. Equation 36 requires the narrative shock series to be uncorrelated with contemporaneous spending and output shocks. Taken together, we obtain our second set of exogenous tax shocks, *SVAR Shocks* by (1) estimating the reduced form VAR given by Equation 33, (2) regressing the reduced form residuals on the narrative shocks series m_t (i.e. our *All Shocks* series), and (3) rescaling the response functions as in the Blanchard–Perotti SVAR to generate the intended effect on tax revenues.

It is important to note that the timing of implementation for tax changes matters from a theoretical perspective. Yang (2005) and Leeper, Walker, and Yang (2013) point out the differences between anticipated and unanticipated tax changes. Romer and Romer (2010) take this into account and find only slight evidence of expectational effects. They find that the relationship between exogenous tax increases (when liabilities actually change) and output is robust while including a proxy for fiscal news. Moreover, Figure 4 of Mertens and Ravn (2012) shows that not correctly timing the implementation should bias our results toward finding no effect.[20] However, this evidence of expectational effects may only be true with respect to other macro variables, and not financial variables as we use. To address some of these concerns and provide further evidence, we consider the series of surprise narrative shocks in Mertens and Ravn (2012) as a third series of

[20]Specifically, the longer the lag between announcement and implementation the more negative the effect on output post-announcement and the lower the overall effect on output once the tax change is implemented.

potentially exogenous tax shocks, *Surprise Shocks*. Our final series of tax shocks, *Surprise SVAR Shocks*, is a series constructed by using the *Surprise Shocks* series as instruments m_t in the "proxy SVAR" of Mertens and Ravn (2014).[21]

While statistical tests of exogeneity provide only evidence of exogeneity, we follow Mertens and Ravn (2012) in running ordered probit tests to determine if our state variable can predict future signed binary tax shocks as measured by our four series. While the optimal lag length determined by BIC is one, we present the results of the ordered probit tests in Table 2 for both lag length one and lag length four. While evidence is somewhat mixed for our *All Shocks* series, we fail to reject the null hypothesis of exogeneity with respect to the financial state variables over the full sample for each of our other three tax shock series.[22] These results are consistent with the findings of Mertens and Ravn (2012), who find that tax shocks are not predictable based on macroeconomic data.

The concurrent effects of monetary policy are also frequently suggested as a possible issue with our estimation. We address this concern in two ways. First, we incorporate the federal funds rate as an additional state variable and find quantitatively similar results. Second, we perform a Hall (1986) and Evans (1992) test by regressing our tax shocks on the monetary policy shocks used in Bernanke and Kuttner (2005). Specifically, we regress our tax shocks on four lags of our tax shocks, contemporaneous monetary policy shocks and four lags of monetary policy shocks. We fail to reject the hypothesis of exogeneity (p-value = 0.4649) over the period where both of these shocks are available, 1989Q2 to 2007Q4.

5. Results

In this section, we present our main results on the impact of tax policy on equity returns for the Pre- and Post-Volcker periods. We then examine asymmetries in equity responses to fiscal policy shocks as predicted by our model. We finally turn to whether our estimated responses are a function of changes to personal or corporate taxes.

[21]Our results are quantitatively similar using four series of unanticipated shocks identified by Mertens and Ravn (2012). Two series dated effective dates of the tax changes, one raw series and one series filtered using the "proxy SVAR", and two series using the dates that the tax changes were signed, one raw series and one series filtered using the "proxy SVAR".

[22]Findings are quantitatively similar using linear probability models and Granger causality tests as in Hall (1986) and Evans (1992).

Table 3 presents some of the main results of our study and shows the impact of various tax shocks on each asset pricing channel. Panels A and B reflect estimates based on the Post- and Pre-Volcker time periods, respectively, while Panel C shows the difference across time periods. For the Post-Volcker time period, we find a one standard deviation increase in the tax rate (0.22 percent) is associated with a quarterly positive equity excess return of 0.07 to 0.47 percent.[23] The low end of this range of values is in line with with our theoretical estimate of 0.052 percent in Table 1.

For each type of shock, Panel A also shows that the tax increase has had a negative effect on cash flow news. However, the effect on real interest rate news is also negative, along with future excess returns, making the discount rate news channel larger than the cash flow news channel. Again, the relative magnitudes of the cash flow and real interest rate channel (1.5 times greater than the cash flow channel on the low end) are in line with our theoretical estimate of a real interest rate channel that is 1.25 times greater than the cash flow channel.

Importantly, regardless of the type of shock, the positive effect of tax shocks on the current excess return is found to be significant at 1 percent levels. Additionally, our most exogenous measure of tax shocks in the far right column, the Surprise SVAR shocks, also find significance for explaining this effect with regards to the real interest rate news and cash flow news channels.

Panel B focuses on the Pre-Volcker time period. Regardless of the shock, we find that tax increases have a significant negative effect on returns at the 1 percent level. The channels that drive this result are not uniform across each shock, as the signs change depending on whether or not the shocks are based on the SVAR.

5.1. Asymmetric Responses to Tax Shocks

Table 4 addresses the relevant question of whether or not equity markets respond symmetrically to tax cuts versus tax increases. Similar to Table 3, there are three panels reflecting the Post and Pre-Volcker time periods along with their Difference, but now we isolate the effects coming from Positive and Negative shocks.

Panel A shows that for 3 out of the 4 shocks, the tax cuts are associated with greater effects on equity

[23] Equivalently, a 1 percent tax increase is associated with a 0.33 to 2.32 percent higher current excess return.

markets and drive most of the significance. As was the case in Table 3 when both positive and negative were combined, the tax cuts are leading to greater cash flow news, but discount rate news is also increasing. The discount rate news is counteracting the positive cash flow news to such an extent that tax cuts are associated with lower current excess returns. This finding that tax cuts have larger effects on equity markets is consistent with the theoretical analysis in Table 1, which was based on a nonlinear New Keynesian model with downward nominal wage rigidities. Recall, the mechanism is that downward nominal wage rigidities prevent wages from falling as much when supply of labor increases. These relatively higher wages reduce labor demand, which reduces output, dividends, and cash flow news and leads to a more negative current excess return. This mechanism is not pertinent to a tax increase, which can lead to a lower labor supply and higher wages, and that explains the asymmetry.

Panel B shows the Pre-Volcker time period. Similar to Panel A, the tax cuts seem to drive the significance, with 3 out of the 4 shocks suggesting tax cuts have greater effects than tax increases. And in contrast to Panel A, tax cuts are now associated with positive effects on current excess returns. These findings are roughly consistent with the theoretical analysis in Table 1. We find it interesting that both our theoretical and empirical analysis suggest that tax cuts tend to have greater effects than tax increases, regardless of the time period.

5.2. Tax Response Channels

Of interest is ensuring that equity returns respond to the personal income tax channel identified in our model, rather than changes in corporate income taxes. We investigate this channel in the following subsection.

While our four exogenous tax shock series do not differentiate between these two channels, we appeal to three alternative measures identified in the macroeconomics and finance literature to identify the personal income tax channel, specifically. The first two measures, *Personal Tax Shocks* and *Personal Tax SVAR Shocks*, are identified through narrative accounts of federal tax liability changes by Mertens and Ravn (2013). As before, the *Personal Tax SVAR Shocks* series uses the narrative shocks as instruments for structural shocks to tax revenues through the "proxy SVAR" methodology of Mertens and Ravn (2014). The third measure is a market-based measure used by Leeper, Walker, and Yang (2013) and Kueng (2015). These papers have the insight that, in the United States, municipal bonds are exempt from federal taxes, and the differential tax treatment of municipal and treasury bonds can help identify news about tax changes.[24] Specifically if a municipal bond and a taxable bond have the same term to maturity, callability, market risk, credit risk, and so on, then

$$\tau_t = 1 - \frac{Y_t^M}{Y_t} = \sum_{k=t}^{T} \omega_k \tau_k^e \tag{38}$$

where Y_t^M is the yield at time t on a municipal bond maturing at time T, Y_t is the yield at time t on a taxable bond maturing at time T, and τ_k^e is the expected future tax rate at time k. Put differently, the one minus the current municipal bond spread is a weighted average of discounted expected future tax rates. Our empirical implementation uses yields from the Bond Buyer Go 20-Bond Municipal Bond Index, consisting of 20 general obligation bonds that mature in 20 years, and the yields on the 20-year treasury to construct of time series of τ. Similar in spirit to the augmented structural VAR in Leeper, Walker, and Yang (2013), we use changes in τ as instruments for structural shocks to tax revenues through the "proxy SVAR" methodology of Mertens and Ravn (2014).[25]

Table 5 shows similar results to those presented in previous tables. Specifically, the Post-Volcker time period shown in Panel A suggests a tax increase results in a significantly positive effect on the current excess return. Across each shock, the discount rate news dominates the cash flow news so that the overall effect is positive. Panel B, the Pre-Volcker time period, shows the opposite effect. For this time period, the discount rate news (sum of real interest rates and future excess returns) tends to be less negative across the different shocks, so that the overall effect is significantly negative.

6. Additional Tests

This section provides additional robustness tests of our main results. We first test our hypotheses within the framework of Sialm (2009). Next, we test equity responses to changes in tax policy at a higher frequency than the quarterly results presented above. We also present evidence that our documented responses across monetary policy regimes are robust to economic expansion and contractions, as well as recent periods when

[24]See Poterba (1989); Fortune (1996); Park (1997); Kueng (2015) for evidence that changes in municipal bond spreads predict changes fiscal policy.

[25]Again, results are quantitatively similar using the raw series of $\Delta\tau$ in place of the SVAR series.

monetary policy's role may be diminished due to the zero lower bound on nominal interest rates. Finally, we estimate our model using a time varying parameter VAR framework and verify that our results are robust to a more general specification of parameter changes through time.

6.1. Sialm (2009) Regressions

Sialm (2009) investigates, both in the time-series and cross section, whether changes in taxes have had an impact on US equity prices. Over the period between 1913 and 2006, an effective tax yield series is constructed for the marginal investor that takes into account variation over time in federal income taxes, dividend taxes, and short- and long-term capital gains. This tax yield, along with numerous controls, is used in annual time series regressions to back out its relationship with equity valuations.

We replicate Sialm (2009) using the exact same data and methodology. To show further robustness for the results, Sialm (2009) splits the sample in half at 1960 and shows that both sub-samples continue to reflect a negative relationship between tax yield and equity valuations. We perform a similar test, but instead split the data in 1980. We split the time series at 1980 to reflect the change in the stance of monetary policy, as our previous theoretical and empirical results suggest there should be a change in sign from negative to positive.

Table 6 shows our replication results with multiple robustness checks for the Pre-Volcker and Post-Volcker periods. These robustness checks are borrowed exactly from Table 4, p.1370 of Sialm (2009). The additional control variables are the interest rate, inflation rate, growth rate, quality spread, term spread, and time trend. As pointed out in Sialm (2009), each of these variables are important to control for when trying to extract the effects of tax yield on equity valuations. Results are qualitatively similar when the Post-Volcker sample is extended to 2015 and the set of regressors is expanded to include ZLB, a binary variable equal to one in years after 2008 and zero, otherwise, designed to capture periods in which the zero lower bound on nominal rates binds.

As can be seen from Table 6, the signs flip from negative to positive, and continue to remain highly significant. Using a completely independent series from our own empirical analysis above, this provides additional evidence for our story that the relationship between equity and taxes changed after 1980.

6.2. High Frequency Results

A potential concern of our results is that the response to fiscal policy shocks may be conflated with other news over a quarterly horizon. In other words, the frequency of our analysis may not be narrow enough to precisely identify the response of equity returns to news about future tax policy. A similar vein of doubt is the critique of Leeper, Walker, and Yang (2013) who point out theoretical differences between the response to unanticipated and anticipated tax shocks and highlight the importance of investor foresight in interpreting fiscal policy responses. This point is especially important when dealing with a forward-looking efficient stock market, which should have already incorporated information regarding expected changes in future tax rates. While the series constructed in Section 4.2 rely on quarterly macroeconomic series to implement the "proxy SVAR" method of Mertens and Ravn (2014), the τ measure of expected future tax rates introduced in Section 5.2 is available at a higher frequency for a portion of our sample period. In this subsection, we estimate the responses of current excess equity returns to daily and weekly changes in expected future tax rates. Due to the forecasting requirements of our news decomposition, we do not further decompose current excess equity returns due to noise in the forecasts of future returns at higher frequencies.

To this end, we estimate regressions of the following form

$$r_{ex,t \to t+j} = \beta \times \Delta\tau_t + \gamma \times Controls_t \quad (39)$$

where $r_{ex,t \to t+j}$ is the cumulative return in the CRSP value-weighted index in excess of the risk-free rate over the event window t to $t+j$, $\Delta\tau_t$ is the change in the expected future tax rate over $t-1$ to t, and $Controls_t$ is a vector of additional controls. As defined in Section 5.2, $\Delta\tau_t$ is equal to one minus the ratio of the yield on municipal bond and the yield on a treasury bond of equal maturity. Our primary variable of interest in these regressions is β which captures the response in excess equity returns to changes in τ. Given the limited time-series availability of τ at a high frequency, this variable is a natural complement to the estimate of the current excess equity return responses presented in Panel B of Table 3.

We begin with results of daily return regressions. While these regressions have the tightest event windows for identification purposes, a daily measure of $\Delta\tau_t$ is available for a relatively short time period. For these regressions, we use the Bloomberg BVAL Muni Benchmarks for yields on municipal bonds. This yield curve is constructed with yields from high quality US municipal bonds with an average rating of Aaa from

Moody's and S&P and is available daily from 2009Q1 to 2015Q4. We consider maturities of 5, 10, and 30 years for our analysis. This data is only available over a limited sample period during the Post-Volcker regime. We consider specifications both with and without $\Delta Spread$ even though some of the concern of credit spreads driving changes in τ are mitigated by yields based on Aaa instruments.

Panel A of Table 7 presents the results of these daily return regressions over one day windows and one week windows. Beginning with the 5 year maturity, we see a significant positive relationship between excess returns and the change in our implied tax measure. The implied effect on excess return becomes larger with each maturity, suggesting a high persistence, which is consistent with our alternative measures of tax shocks, which are all permanent.

We also investigate the impact of changes in τ on weekly excess returns. For these regressions, we use the Bond Buyer Go 20-Bond Municipal Bond Index for yields on municipal bonds. This index consists of 20 general obligation bonds that mature in 20 years. The average rating of the 20 bonds is roughly equivalent to Moody's Investors Service's Aa2 rating and Standard & Poor's Corporations's AA rating. Given the lower rating of these municipal bonds, changes in credit spreads during the financial crisis, rather than changes in expected future tax rates, may have driven changes in τ. For this reason, we estimate these weekly regressions over two sample periods: 1980Q2 to 2008Q2 and 1980Q2 to 2015Q4. The first period avoids the financial crisis and lines up well with the sample period we explore in our main results. The second period controls for changes in credit spreads, $\Delta Spread$, explicitly by including the change in the spread between Baa-rated and Aaa-rated corporate bond yields in our regressions.

Research suggests that recessionary and expansionary environments drive the interpretation of macroeconomic news as good or bad rather than being primarily driven by monetary policy regime.[26] To test this hypothesis within our setting, we include $NBER$, a binary variable equal to one if the observation occurs during an NBER-dated recession and equal to zero otherwise, and its interaction with our fiscal policy variable. Panel B of Table 7 presents the results of these regressions over one week windows, one month windows, two month windows, and one quarter windows. Across each horizon, we find a significant positive effect of the implied tax change on the excess return. The implied coefficient on the "(0,12) Event Window" (quarter

[26]See McQueen and Roley (1993); Boyd, Hu, and Jagannathan (2005); Goldberg and Grisse (2013); Law, Song, and Yaron (2016) among others.

horizon) corresponds to a 0.3438% increase in the excess return for a 1% increase in our tax rate. For comparison, our previous empirical estimates based on the SVAR Surprise tax shocks in Table 3 was 0.071% for a one standard deviation increase in the tax rate (0.22%). Instead of assuming a 1% change but a 0.22% change, the expected effect based on this regression is 0.075%, which is very close to the estimates based on the SVAR Surprise tax shocks. In these regressions, we do not find that interaction between $\Delta\tau$ and $NBER$ Indicator are statistically significant.

This panel also enables us to examine the impact of the zero lower bound on nominal interest rates on our findings, as in Law, Song, and Yaron (2016). Compared to Specifications 7 and 8 Panel A, we see little change in the parameter estimates in Specifications 1 and 2 of Panel B after including data outside of the financial crisis when the zero lower bound (ZLB) in interest rates was binding. In other words, the lack of slack in adjusting nominal interest rates seems to have little impact on the response of real equity returns to changes in expected tax rates and is insufficient to change the sign of our estimates.[27]

6.3. Cross-sectional Evidence

Our previous results do not rule out an omitted variable, such as a change in an aggregate risk factor, being correlated with both market returns and fiscal policy shocks. In this section, we provide cross-sectional evidence that our measure of fiscal policy shocks from the last section, $\Delta\tau$, is not merely a proxy for changes in aggregate risk.

We replace the market returns in Table 7 with long-short portfolio returns formed on firm characteristics that proxy for a firm's exposure to personal income tax shocks. By forming a long-short portfolio, these returns should, at least partially, account for contemporaneous changes in risk insomuch as we are able to construct portfolio legs with similar quantities of risk. To motivate these measures, we note that revisions in future discount rates should be the same across the long and short legs if they have similar exposure to aggregate risk. Thus, the timing and size of future after-tax cash flows should determine the differential returns. Since the impact of tax increase on cash flow news is negative, we would expect firms with relatively low after-tax cash flows to outperform firms with relatively high after-tax cash flows.

[27] Evidence from the FRB-US model (unreported) is similar. The equity return response falls roughly 14bps from 39.09bps without the ZLB binding to 25.25bps with the ZLB binding. Moreover, the real interest rate channel remains active in both scenarios with and without the ZLB binding.

First, we sort stocks into portfolios based on tercile of *Payout Ratio*, equal to total dividends (CompuStat field DVT) divided by net income (CompuStat field NI), as of June in the previous year following Fama and French (1993). Panel A of Table 8 presents the parameter estimates from the regression of long-short portfolio returns on $\Delta\tau$. As predicted, firms with low payout ratios outperform those with high payout ratios when expected future tax rates increase. While the difference at short maturities, that is when future tax increases are expected to be short lived, are modest and often indistinguishable from zero. At longer horizons, the differential return is statistically and economically significant. For a 30-year maturity of τ, low payout ratio stocks outperform high payout ratio stocks by roughly 1% for a one standard deviation increase in the tax rate (0.22%) at both the one day and one week window.

Next, we look at *Institutional Ownership* as a proxy of the proportion of equity held by taxable investors. Institutional ownership may be positively correlated with payout ratio as documented by Allen, Bernardo, and Welch (2000) with these effects working in opposite directions with respect to a firm's exposure to fiscal policy. Therefore, we control for a firm's payout ratio by forming portfolios based on sorting firms first into terciles of payout ratio and then terciles of institutional ownership. *Institutional Ownership* is equal to the dollar amount of positions reported in 13F filings divided by the market capitalization of the firm, as June in the previous year. Again we find that firms with high institutional ownership or a relatively low proportion of equity held by taxable investors (low exposure to changes in future tax rates) tend to outperfom firms with low institutional ownership (high exposure to changes in future tax rates), especially at longer maturities of τ and for firms with higher dividends paid (larger payout ratios). For example at a maturity of τ of ten years, we find that high institutional ownership firms outperform low institutional ownership firms by roughly 62 basis points in the middle tercile of payout ratio and 98 basis points for high payout ratio firms at the one day window when future tax rates increase by one standard deviation.

Admittedly, our portfolios may differ in their quantities of risk. Panel B of Table 8 repeats the above analysis replacing the raw returns of each portfolio leg with the abnormal return from the Fama-French three factor model. Specifically, we define abnormal returns as

$$e_{i,t} = R_{i,t} - R_{f,t} - \widehat{\alpha}_{i,t} - \widehat{\beta}_{i,t} * (R_{m,t} - R_{f,t}) - \widehat{\beta}_{i,t}^{SMB} * R_{SMB,t} - \widehat{\beta}_{i,t}^{HML} * R_{HML,t} \tag{40}$$

where $\widehat{\alpha}_{i,t}$ and $\widehat{\beta}_{i,t}$ are estimated using rolling regressions over the previous twelve months. Panel B of

8 reports the loadings from the regression of long-short abnormal returns on $\Delta\tau$. The results are largely consistent with those in Panel A.

6.4. Time Varying Parameter VAR

While we provide both theoretical and statistical evidence supporting a focus on broad monetary policy regimes, our choice of sample periods may seem somewhat ad hoc. To this end, we estimate a Bayesian time varying parameter VAR (TVP-VAR) in the spirit of Primiceri (2005). This model allows both the VAR loadings in Equation 21 and the loadings on fiscal policy in Equation 26. While specifics pertaining to the estimated model and our results within the framework of this model are available in Section 3 of the Appendix, we briefly summarize our main takeaways from this analysis below.

For many of the estimates, the 68 percent coverage intervals are quite wide and do not allow us to reject the null of zero response. However for both the *All Shocks* and *Surprise Shocks* series, the coverage interval for overall equity response in the Post-Volcker period is positive with the range covering the fixed-loading responses reported in Table 3. Results are similar for the difference in the overall response across the two monetary policy regimes as well. The overall equity response increases with the onset of the Post-Volcker regime, and the size of the estimated difference in the TVP-VAR is in line with those reported in the main results of the paper.

7. Conclusion

With the recent increase in attention on fiscal policy, we provide a critical theoretical and empirical analysis that suggests a key driver of tax effects on equity markets is the Federal Reserve. With a more aggressive stance of monetary policy to inflation and/or real activity since 1980, we find that tax cuts are associated with lower excess equity returns, despite our findings of positive effects on cash flow news.

We conduct similar analysis for the Pre-1980 era and come to the opposite conclusion. With a less aggressive monetary policy, the cash flow news is larger than the discount rate news, and tax cuts are associated with higher equity returns. These empirical findings are easily motivated by a standard theoretical New Keynesian model that exhibits a shift in the aggressiveness of monetary policy.

Our empirical analysis is based on a wide range of measures for tax shocks, including those based on Romer and Romer (2010), Mertens and Ravn (2012), municipal bond yield data, and also the tax yield data from Sialm (2009). These data series allow us to provide inference at the weekly, monthly, quarterly, and annual frequencies. And each of these series comes to the same conclusion: tax cuts are associated with lower equity returns since 1980.

Overall, some will suggest the recent run-up in the stock market seems to contradict both our theoretical and empirical analysis. We posit that our findings remain valid and that the recent experience could be due to a few issues: (1) there are additional factors at play such as changes in regulation, government spending, and repatriation that may be important, (2) because of the proximity to the zero lower bound monetary policy may not be acting as aggressively as it did in previous post-1980 tightening cycles, and (3) investors are unusually optimistic.

References

Afonso, António, and Ricardo M Sousa, 2011, What are the effects of fiscal policy on asset markets?, *Economic Modelling* 28, 1871–1890.

———, 2012, The macroeconomic effects of fiscal policy, *Applied Economics* 44, 4439–4454.

Agnello, Luca, and Ricardo M Sousa, 2013, Fiscal policy and asset prices, *Bulletin of Economic Research* 65, 154–177.

Ai, Hengjie, and Ravi Bansal, 2016, Risk preferences and the macro announcement premium, *NBER Working Paper*.

Allen, Franklin, Antonio Bernardo, and Ivo Welch, 2000, A theory of dividends based on tax clienteles, *The Journal of Finance* 55, 2499–2536.

Amromin, Gene, Paul Harrison, and Steven Sharpe, 2008, How did the 2003 dividend tax cut affect stock prices?, *Financial Management* 37, 625–646.

Andrews, DWK, 1993, Tests for parameter instability and structural change with unknown change point, *Econometrica* 61, 821–856.

Ardagna, Silvia, 2009, Financial markets' behavior around episodes of large changes in the fiscal stance, *European Economic Review* 53, 37–55.

Arin, K Peren, Abdullah Mamun, and Nanda Purushothman, 2009, The effects of tax policy on financial markets: G3 evidence, *Review of Financial Economics* 18, 33–46.

Auerbach, Alan J, and Kevin A Hassett, 2005, The 2003 dividend tax cuts and the value of the firm: An event study, *NBER Working Paper*.

Ayers, Benjamin C, C Bryan Cloyd, and John R Robinson, 2002, The effect of shareholder-level dividend taxes on stock prices: Evidence from the revenue reconciliation act of 1993, *The Accounting Review* 77, 933–947.

Bansal, Ravi, Robert F Dittmar, and Christian T Lundblad, 2005, Consumption, dividends, and the cross section of equity returns, *The Journal of Finance* 60, 1639–1672.

Bansal, Ravi, and Amir Yaron, 2004, Risks for the long run: A potential resolution of asset pricing puzzles, *The Journal of Finance* 59, 1481–1509.

Barsky, R, F T Juster, M S Kimball, and M D Shapiro, 1997, Preference parameters and behavioral heterogeneity: An experimental approach in the health and retirement study, *The Quarterly Journal of Economics* 112, 537–579.

Belke, Ansgar, and Jens Klose, 2011, Does the ecb rely on a taylor rule during the financial crisis? comparing ex-post and real time data with real time forecasts, *Economic analysis and policy* 41, 147–171.

Belo, Frederico, Vito D Gala, and Jun Li, 2013, Government spending, political cycles, and the cross section of stock returns, *Journal of Financial Economics* 107, 305–324.

Belo, Frederico, and Jianfeng Yu, 2013, Government investment and the stock market, *Journal of Monetary Economics* 60, 325–339.

Bernanke, B S, and K N Kuttner, 2005, What explains the stock market's reaction to Federal Reserve policy?, *The Journal of Finance* 60, 1221–1257.

Bhattarai, Saroj, Jae Won Lee, and Woong Yong Park, 2016, Policy regimes, policy shifts, and us business cycles, *Review of Economics and Statistics* 98, 968–983.

Blanchard, O, and R Perotti, 2002, An empirical characterization of the dynamic effects of changes in government spending and taxes on output, *The Quarterly Journal of Economics* 117, 1329–1368.

Blanchard, Olivier J, 1981, Output, the stock market, and interest rates, *The American Economic Review* 71, 132–143.

Boyd, J H, J Hu, and R Jagannathan, 2005, The stock market's reaction to unemployment news: Why bad news is usually good for stocks, *The Journal of Finance* 60, 649–672.

Brayton, F, T Laubach, and D Reifschneider, 2014, The FRB/US Model: A Tool for Macroeconomic Policy Analysis, *FEDS Notes*.

Campbell, John Y, 1991, A variance decomposition for stock returns, *The Economic Journal* 101, 157–179.

——— , and J Ammer, 1993, What Moves the Stock and Bond Markets? A Variance Decomposition for Long-Term Asset Returns, *The Journal of Finance* 48, 3–37.

Campbell, John Y, and N G Mankiw, 1989, Consumption, income, and interest rates: Reinterpreting the time series evidence, in O J Blanchard, and S Fischer, ed.: *NBER Macroeconomics Annual 1989, Volume 4* . pp. 185–216 (MIT Press).

Campbell, John Y, Carolin Pflueger, and Luis M Viceira, 2017, Monetary policy drivers of bond and equity risks, .

Campbell, John Y, and R J Shiller, 1988, The dividend-price ratio and expectations of future dividends and discount factors, *Review of Financial Studies* 1, 195–228.

Chari, V V, P J Kehoe, and E R McGrattan, 2002, Can sticky price models generate volatile and persistent real exchange rates?, *The Review of Economic Studies* 69, 533–563.

Chen, L, and X Zhao, 2009, Return Decomposition, *Review of Financial Studies* 22, 5213–5249.

Clarida, Richard, Jordi Gali, and Mark Gertler, 2000, Monetary policy rules and macroeconomic stability: evidence and some theory, *The Quarterly Journal of Economics* 115, 147–180.

Cochrane, John H, 2008, The Dog That Did Not Bark: A Defense of Return Predictability, *Review of Financial Studies* 21, 1533–1575.

Cohen, Randolph B, Christopher Polk, and Tuomo Vuolteenaho, 2009, The price is (almost) right, *The Journal of Finance* 64, 2739–2782.

Coibion, O, and Y Gorodnichenko, 2011, Monetary policy, trend inflation, and the great moderation: An alternative interpretation, *The American Economic Review* 101, 341–370.

——— , 2015, Is the Phillips Curve alive and well after all? inflation expectations and the missing disinflation, *American Economic Journal: Macroeconomics* 7, 197–232.

Croce, Mariano M, Howard Kung, Thien T Nguyen, and Lukas Schmid, 2012, Fiscal policies and asset prices, *The Review of Financial Studies* 25, 2635–2672.

Croce, Mariano M, Thien T Nguyen, Steve Raymond, and Lukas Schmid, 2017, Government debt and the returns to innovation, *Working Paper*.

Croce, Mariano M, Thien T Nguyen, and Lukas Schmid, 2012, The market price of fiscal uncertainty, *Journal of Monetary Economics* 59, 401–416.

——— , 2013, Fiscal policy and the distribution of consumption risk, .

Da, Zhi, 2009, Cash flow, consumption risk, and the cross-section of stock returns, *The Journal of Finance* 64, 923–956.

——— , Mitch Warachka, and Hayong Yun, 2016, Fiscal policy, consumption risk, and stock returns: Evidence from us states, .

Dai, Zhonglan, Edward Maydew, Douglas A Shackelford, and Harold H Zhang, 2008, Capital gains taxes and asset prices: Capitalization or lock-in?, *The Journal of Finance* 63, 709–742.

Drautzburg, Thorsten, and Harald Uhlig, 2015, Fiscal stimulus and distortionary taxation, *Review of Economic Dynamics* 18, 894–920.

Evans, C L, 1992, Productivity shocks and real business cycles, *Journal of Monetary Economics* 29, 191–208.

Evans, Charles L, and David A Marshall, 2009, Fundamental economic shocks and the macroeconomy, *Journal of Money, Credit and Banking* 41, 1515–1555.

Fama, Eugene F., and Kenneth R. French, 1993, Common risk factors in stocks and bonds, journal of financial economics, *Journal of Financial Economics* 33, 3–56.

Fleischman, C A, and J M Roberts, 2011, From many series, one cycle: improved estimates of the business cycle from a multivariate unobserved components model, .

Fortune, Peter, 1996, Do Municipal Bond Yields Forecast Tax Policy?, *New England Economic Review* pp. 29–48.

Francis, N, and V A Ramey, 2009, Measures of per Capita Hours and Their Implications for the Technology-Hours Debate, *Journal of Money, Credit and Banking* 41, 1071–1097.

Gale, W G, and P R Orszag, 2003, Economic effects of sustained budget deficits, *National Tax Journal* 56, 463–485.

Gallmeyer, Michael, Burton Hollifield, and Stanley Zin, 2005, Taylor rules, mccallum rules, and the term structure of interest rates, *Journal of Monetary Economics* 52, 921–950.

Goldberg, L S, and C Grisse, 2013, Time variation in asset price responses to macro announcements, *Federal Reserve Bank of New York Staff Report No.*

Gomes, Francisco, Alexander Michaelides, and Valery Polkovnichenko, 2012, Fiscal policy and asset prices with incomplete markets, *The Review of Financial Studies* 26, 531–566.

Hall, R E, 1986, The relation between price and marginal cost in US industry, *The Journal of Political Economy* 96, 921–947.

——— , 1988, Intertemporal substitution in consumption, *The Journal of Political Economy* 96, 339–357.

Hanlon, Michelle, and Shane Heitzman, 2010, A review of tax research, *Journal of Accounting and Economics* 50, 127–178.

Hansen, B E, 2000, Testing for structural change in conditional models, *Journal of Econometrics* 97.

Hansen, Lars Peter, John C Heaton, and Nan Li, 2008, Consumption strikes back? Measuring long-run risk, *Journal of Political Economy* 116, 260–302.

House, C L, and M D Shapiro, 2006, Phased-in tax cuts and economic activity, *The American Economic Review* 96, 1835–1849.

Jones, P M, E Olson, and M E Wohar, 2015, Asymmetric tax multipliers, *Journal of Macroeconomics* 43, 38–48.

Kim, Jinill, and Francisco J Ruge-Murcia, 2009, How much inflation is necessary to grease the wheels?, *Journal of Monetary Economics* 56, 365–377.

Kueng, L, 2015, Tax News: The Response of Household Spending to Changes in Expected Taxes, *Working Paper*.

Kung, Howard, 2015, Macroeconomic linkages between monetary policy and the term structure of interest rates, *Journal of Financial Economics* 115, 42–57.

Lang, Mark H, and Douglas A Shackelford, 2000, Capitalization of capital gains taxes: Evidence from stock price reactions to the 1997 rate reduction, *Journal of Public Economics* 76, 69–85.

Law, Tzuo-Hann, Dongho Song, and A Yaron, 2016, Fearing the Fed: How Wall Street Reads Main Street, *Working Paper*.

Leeper, E M, T B Walker, and SCS Yang, 2013, Fiscal foresight and information flows, *Econometrica* 81, 1115–1145.

Lettau, Martin, and Sydney C Ludvigson, 2005, Expected returns and expected dividend growth, *Journal of Financial Economics* 76, 583–626.

Lubik, Thomas A, and Frank Schorfheide, 2004, Testing for indeterminacy: an application to us monetary policy, *The American Economic Review* 94, 190–217.

Maio, P, 2014, Another Look at the Stock Return Response to Monetary Policy Actions, *Review of Finance* 18, 321–371.

McGrattan, Ellen R, and Edward C Prescott, 2005, Taxes, regulations, and the value of us and uk corporations, *The Review of Economic Studies* 72, 767–796.

McQueen, G, and V V Roley, 1993, Stock prices, news, and business conditions, *Review of Financial Studies* 6, 683–707.

Meltzer, Allan H, 2005, Origins of the great inflation, *Federal Reserve Bank of St Louis Review* 87, 145–175.

Mertens, K, and M O Ravn, 2012, Empirical evidence on the aggregate effects of anticipated and unanticipated US tax policy shocks, *American Economic Journal: Economic Policy* 4, 145–181.

———, 2013, The Dynamic Effects of Personal and Corporate Income Tax Changes in the United States, *The American Economic Review* 103, 1212–1247.

———, 2014, A reconciliation of SVAR and narrative estimates of tax multipliers, *Journal of Monetary Economics* 68, S1–S19.

Mulligan, Casey B, 2002, A century of labor-leisure distortions, *NBER Working Paper*.

Mumtaz, Haroon, and Konstantinos Theodoridis, 2017, Fiscal policy shocks and stock prices in the united states, *Working Paper*.

Orphanides, Athanasios, 1992, When good news is bad news: Macroeconomic news and the stock market, *Board of Governors of the Federal Reserve System Working Paper*.

———, 2004, Monetary policy rules, macroeconomic stability, and inflation: A view from the trenches, *Journal of Money, Credit, and Banking* 36, 151–175.

Park, S, 1997, The relationship between government financial condition and expected tax rates reflected in municipal bond yields, *National Tax Journal* 50, 23–38.

Pastor, Lubos, and Pietro Veronesi, 2012, Uncertainty about government policy and stock prices, *The Journal of Finance* 67, 1219–1264.

———, 2013, Political uncertainty and risk premia, *Journal of Financial Economics* 110, 520–545.

———, 2017, Political cycles and stock returns, .

Patelis, Alex D, 1997, Stock return predictability and the role of monetary policy, *The Journal of Finance* 52, 1951–1972.

Piazzesi, Monika, Martin Schneider, and Selale Tuzel, 2007, Housing, consumption and asset pricing, *Journal of Financial Economics* 83, 531–569.

Poterba, J M, 1989, Tax reform and the market for tax-exempt debt, *Regional Science and Urban Economics* 19, 537–562.

Primiceri, G E, 2005, Time varying structural vector autoregressions and monetary policy, *The Review of Economic Studies* 72, 821–852.

Romer, C D, and D H Romer, 2002, The Evolution of Economic Understanding and Postwar Stabilization Policy, in *Rethinking Stabilization Policy* (Kansas City, MO).

——— , 2010, The macroeconomic effects of tax changes: Estimates based on a new measure of fiscal shocks, *The American Economic Review* 100, 763–801.

Rotemberg, Julio J, 1982, Sticky prices in the united states, *Journal of Political Economy* 90, 1187–1211.

Santos, Tano, and Pietro Veronesi, 2010, Habit formation, the cross section of stock returns and the cash-flow risk puzzle, *Journal of Financial Economics* 98, 385–413.

Schmitt-Grohé, Stephanie, and Martín Uribe, 2007, Optimal simple and implementable monetary and fiscal rules, *Journal of Monetary Economics* 54, 1702–1725.

Sialm, Clemens, 2005, Tax changes and asset pricing: Time-series evidence, *NBER Working Paper*.

——— , 2006, Stochastic taxation and asset pricing in dynamic general equilibrium, *Journal of Economic Dynamics and Control* 30, 511–540.

——— , 2009, Tax Changes and Asset Pricing, *The American Economic Review* 99, 1356–1383.

Sims, Christopher A, and Tao Zha, 2006, Were there regime switches in us monetary policy?, *The American Economic Review* 96, 54–81.

Sims, Eric, and Jonathan Wolff, 2016, The state-dependent effects of tax shocks, *Working Paper*.

Smets, Frank, and Rafael Wouters, 2007, Shocks and frictions in us business cycles: A bayesian dsge approach, *The American Economic Review* 97, 586–606.

Tavares, Jose, and Rossen Valkanov, 2001, The neglected effect of fiscal policy on stock and bond returns, *Working Paper*.

Vuolteenaho, Tuomo, 2002, What drives firm-level stock returns?, *The Journal of Finance* 57, 233–264.

Welch, Ivo, and Amit Goyal, 2008, A Comprehensive Look at The Empirical Performance of Equity Premium Prediction, *Review of Financial Studies* 21, 1455–1508.

Yang, SCS, 2005, Quantifying tax effects under policy foresight, *Journal of Monetary Economics* 52, 1557–1568.

Figure 1: Post- vs Pre-Volcker : Cash Flow versus Discount Rate Channels

This figure shows the excess equity returns across the Pre and Post Volcker regimes in response to a one standard deviation income tax rate increase (0.22%). The only difference across the two calibrations is the definition of the monetary policy rule. In the Pre-Volcker, $\alpha_\pi = 1.32$, $\alpha_{\Delta y} = 0.94$, $\alpha_R = 0.91$. In the Post-Volcker, $\alpha_\pi = 1.58$, $\alpha_{\Delta y} = 2.21$, $\alpha_R = 0.9$. We isolate the effects of each channel by showing what the excess return would be if only one channel was active at a time. The left panel, the Post-Volcker, shows the excess return would be negative if the excess return was only a function of cash flow news (dashed red line). Instead, the discount rate channel dominates and the overall effect is positive. The right panel, the Pre-Volcker, shows the excess return would be positive if the excess return was only a function of discount rate news (dashed blue line). Instead, the cash flow channel dominates and the overall effect is negative. The discount rate channel dominates for the Post-Volcker because of the greater response to output growth, which generates greater changes in real interest rates and dampens the decline in cash flow news.

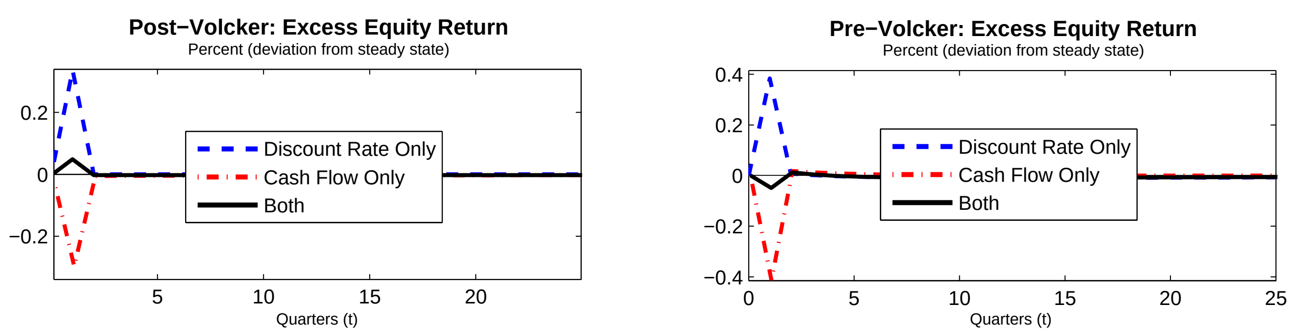


Figure 2: Post vs Pre-Volcker vs RBC Responses to Increase in Income Tax Rate

This figure displays economic variables across the Pre and Post Volcker regimes and the RBC model, in response to a one standard deviation income tax rate increase (0.22%). The only difference across the two calibrations is the definition of the monetary policy rule. In the Pre-Volcker, $\alpha_\pi = 1.32, \alpha_{\Delta y} = 0.94, \alpha_R = 0.91$. In the Post-Volcker, $\alpha_\pi = 1.58, \alpha_{\Delta y} = 2.21, \alpha_R = 0.9$. The RBC framework eliminates the monetary policy rule and removes nominal rigidities. This figure shows the importance of incorporating a role for monetary policy and nominal rigidities. In contrast to the Pre-Volcker (dashed red line) and RBC (solid black line) settings, the Post-Volcker (dashed blue line) monetary policy of putting greater weight on output growth leads to a larger effect on real interest rate news and a smaller decline in dividends, so that the discount rate channel dominates and the current excess return for Post-Volcker is positive.

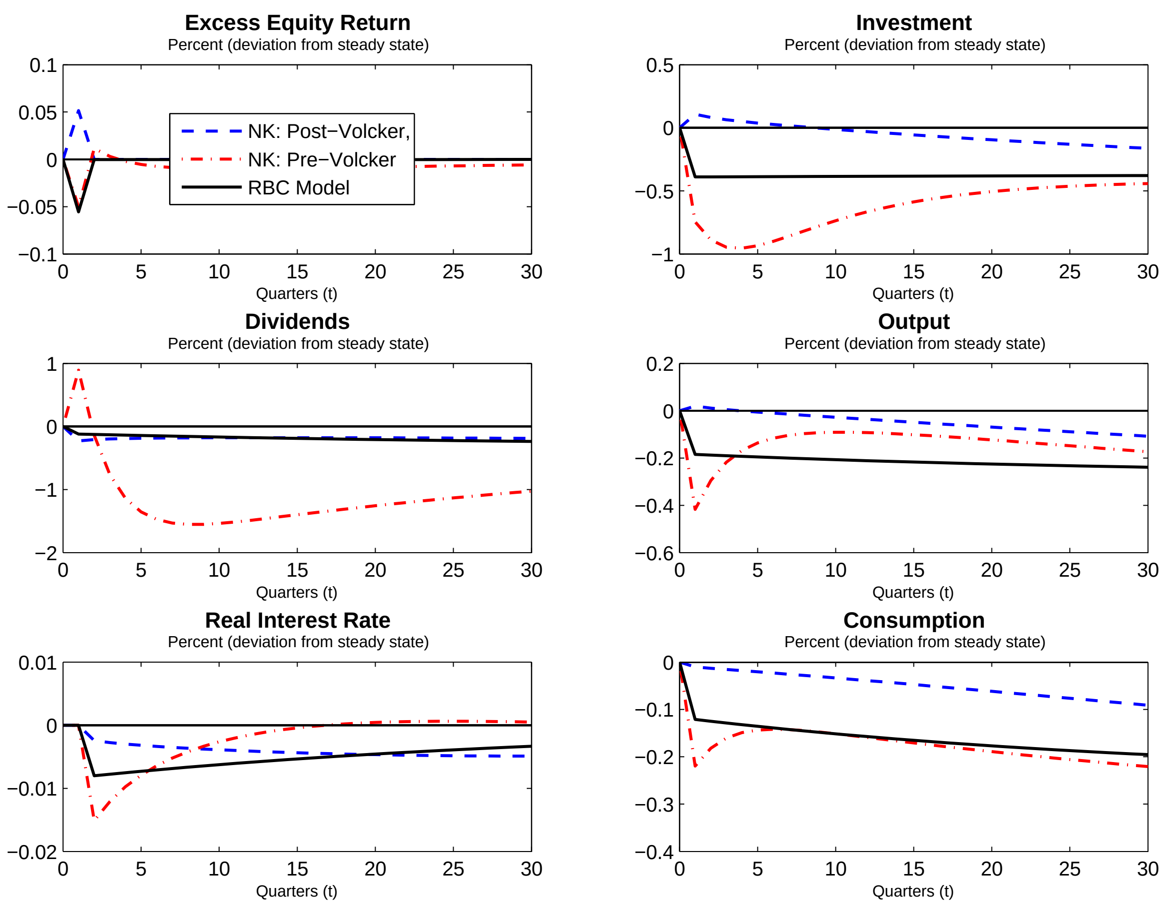


Figure 3: Asymmetric Responses Due to Downward Nominal Wage Rigidities

This figure shows the responses in the Post-Volcker regime to a tax cut (dashed black line), a tax increase (dashed blue line), and the difference (multiplied by 10 for ease of exposition) in responses to the tax cut and tax increase (solid red line). The left panel, which exhibits downward nominal wage rigidities, shows that in response to an income tax cut, labor supply rises with the increased incentive to work causing wages to decline. However, wages do not fall as much in the presence of downward nominal wage rigidities so that labor demand doesn't rise as much. With not as much labor demand, output along with dividends increase less so that cash flow news is less positive and the overall effect is a larger negative effect on equity returns when compared to the positive effects coming from tax increases. The right panel shows the case with no downward nominal wage rigidities, and the difference (solid red line) is nearly zero across each response. This demonstrates the potential importance of including downward nominal wage rigidities to generate the asymmetric responses.

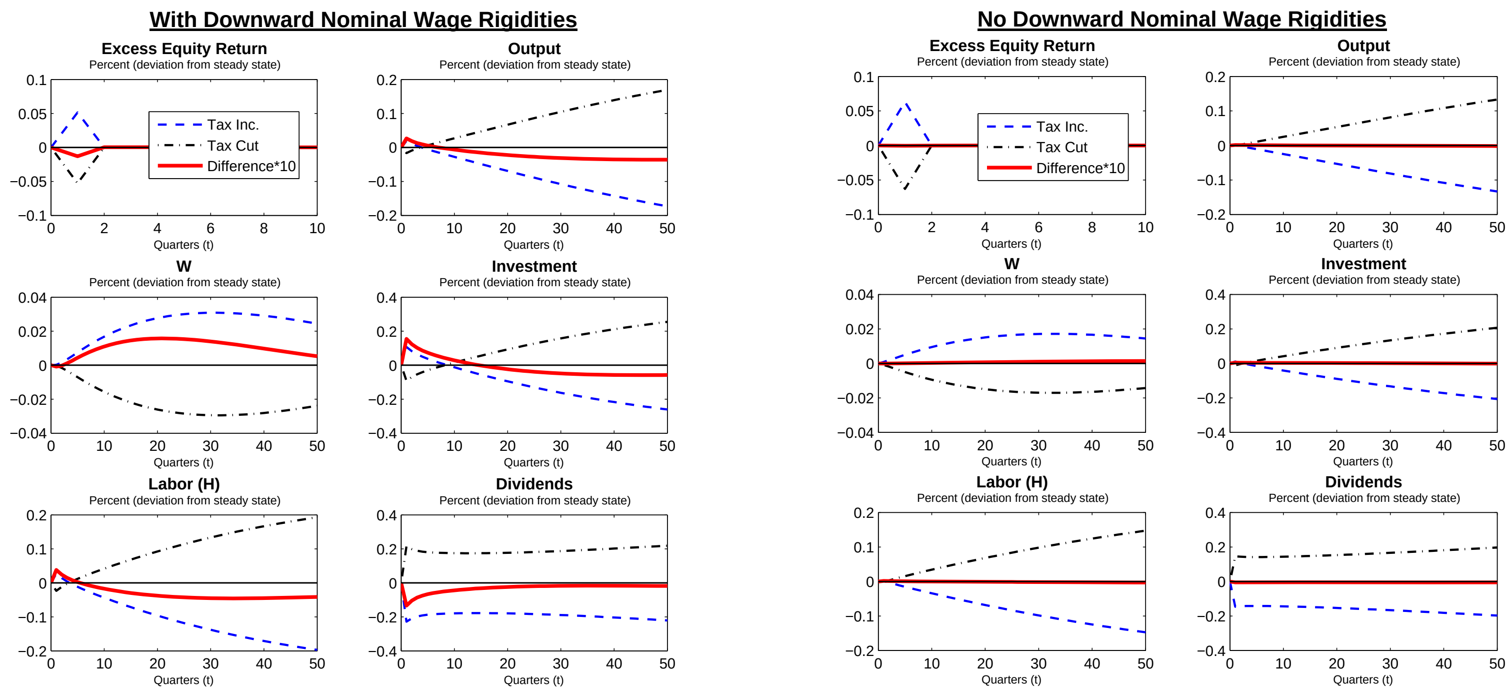


Table 1: The impact of exogenous fiscal policy shocks on simulated returns

This table reports the impact of positive and negative exogenous tax shocks on the current excess equity return, and the discounted sums of future excess equity returns, current and future real interest rates, and current and future cash flows. Data are the solutions to the DSGE model described in Section 3. Data from the Pre-Volcker and Post-Volcker calibrations are reported in Panel A and B, respectively.

	Positive	Negative	Difference
Panel A: Post-Volcker			
Current Excess Return	0.0515	−0.0528	0.0013
Future Excess Return	−0.0030	0.0034	0.0005
Real Interest Rate News	−0.2588	0.2574	−0.0014
Cash Flow News	−0.2103	0.2080	−0.0023
Panel B: Pre-Volcker			
Current Excess Return	−0.0502	0.0494	−0.0008
Future Excess Return	−0.0513	0.0523	0.0011
Real Interest Rate News	−0.2272	0.2258	−0.0014
Cash Flow News	−0.3287	0.3276	−0.0011
Panel C: Real Business Cycle (RBC) Model			
Current Excess Return	−0.0555	0.0550	−0.0005
Future Excess Return	−0.0118	0.0119	0.0000
Real Interest Rate News	−0.1882	0.1880	−0.0002
Cash Flow News	−0.2556	0.2549	−0.0007

Table 2: Tests for exogeneity of tax shocks

The table reports the results for tests of exogeneity of the tax shocks using ordered probit regressions. The values reported are p-values of likelihood ratio tests of the hypothesis that 1 lag and 1 to 4 lags of the state variables have no predictive power for the timing of tax changes. The state variables are the excess return, real interest rate, change in the 3-month T-bill rate, the difference in yields on the 10-year T-Note and 3-month T-Bill, the log dividend price ratio, and the difference between the 3-month T-Bill and its 12-month moving average. All tests are specified as $H_0 : \beta = 0$ against $H_1 : \beta \neq 0$ where β is the coefficient vector of lagged observables. Tax shocks are described in Section 4.2.

	All Shocks	SVAR Shocks	Surprise Shocks	Surprise SVAR Shocks
Panel A: 1980Q3 - 2007Q4				
Lag 1	0.5747	0.7077	0.1414	0.7596
Lags 1-4	0.0261	0.2716	0.0349	0.8943
Panel B: 1947Q1 - 1980Q2				
Lag 1	0.0129	0.5696	0.7008	0.6041
Lags 1-4	0.0925	0.3762	0.5690	0.4422
Panel C: 1947Q1 - 2007Q4				
Lag 1	0.0574	0.7391	0.4682	0.7913
Lags 1-4	0.0125	0.2782	0.2281	0.7819

Table 3: The impact of exogenous tax shocks on equity returns

This table reports the impact of exogenous tax shocks on the current excess equity return, and the discounted sums of future excess equity returns, current and future real interest rates, and current and future dividends (cash flows). The six-variable VAR(1) used to construct excess equity return and real interest rate forecasts is estimated over the sample indicated in the column headings. The VAR state variables are defined in the text. Tax shocks are described in Section 4.2. Standard errors are calculated by the bootstrap algorithm discussed in Section 4. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

	All Shocks	SVAR Shocks	Surprise Shocks	Surprise SVAR Shocks
Panel A: 1980Q3 - 2007Q4				
Current Excess Return	0.4662***	0.1200***	0.0998***	0.0710***
Future Excess Return	−0.2250**	−0.0772***	−0.0712	−0.0328
Real Interest Rate News	−0.5520***	−0.0790*	−0.0800	−0.0885**
Cash Flow News	−0.3108**	−0.0362	−0.0515	−0.0503**
Panel B: 1947Q1 - 1980Q2				
Current Excess Return	−0.2072***	−0.0563***	−0.0823***	−0.0470***
Future Excess Return	0.2910	0.0968	0.1375	0.0890
Real Interest Rate News	0.1005	−0.0843	0.0485	−0.0645
Cash Flow News	0.1842	−0.0440	0.1037	−0.0227
Panel C: Difference				
Current Excess Return	−0.6735**	−0.1762*	−0.1820	−0.1180
Future Excess Return	0.5162*	0.1740*	0.2087	0.1217
Real Interest Rate News	0.6525**	−0.0053	0.1283	0.0240
Cash Flow News	0.4950	−0.0050	0.1552	0.0278

Table 4: Asymmetries in the impact of exogenous tax shocks on equity returns

This table reports the impact of positive and negative exogenous tax shocks on the current excess equity return, and the discounted sums of future excess equity returns, current and future real interest rates, and current and future dividends (cash flows). The six-variable VAR(1) used to construct excess equity return and real interest rate forecasts is estimated over the sample indicated in the column headings. The VAR state variables are defined in the text. Tax shocks are described in Section 4.2. Responses for negative tax shocks are multiplied by negative one to ease exposition. Standard errors are calculated by the bootstrap algorithm discussed in Section 4. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

	All Shocks		SVAR Shocks		Surprise Shocks		Surprise SVAR Shocks	
	Positive	Negative	Positive	Negative	Positive	Negative	Positive	Negative
Panel A: 1980Q3 - 2007Q4								
Current Excess Returns	0.1225	−0.6255***	0.0922***	−0.1427***	0.1913***	−0.0395	0.0272	−0.1163***
Future Excess Returns	−0.0495	0.3065**	−0.0605***	0.0910***	−0.0938	0.0565	−0.0152	0.0510*
Real Interest Rate News	−0.2475**	0.6930***	−0.0643	0.0910*	−0.2707**	−0.0457	−0.0437	0.1348**
Cash Flow News	−0.1742**	0.3740**	−0.0328	0.0393	−0.1732**	−0.0290	−0.0318	0.0695**
Panel B: 1947Q1 - 1980Q2								
Current Excess Returns	0.1000	0.2315***	−0.0420***	0.0720***	−0.0077	0.1143***	−0.0060	0.0855***
Future Excess Returns	−0.0085	−0.3147	0.0823	−0.1125	0.0815	−0.1618**	0.0355	−0.1390
Real Interest Rate News	0.3827	−0.0783	−0.1055	0.0612	−0.0182	−0.0770	−0.0810	0.0493
Cash Flow News	0.4740	−0.1613	−0.0653	0.0205	0.0555	−0.1247	−0.0515	−0.0043
Panel C: Difference								
Current Excess Returns	0.0225	0.8572**	−0.1343*	0.2147*	−0.1993	0.1537	−0.0333	0.2015
Future Excess Returns	0.0408	−0.6212	0.1427*	−0.2035*	0.1752	−0.2182	0.0508	−0.1900
Real Interest Rate News	0.6302**	−0.7712*	−0.0410	−0.0300	0.2527	−0.0312	−0.0372	−0.0855
Cash Flow News	0.6485**	−0.5353	−0.0325	−0.0187	0.2288	−0.0958	−0.0198	−0.0740

Table 5: Personal income tax change and equity returns

This table reports the impact of personal income tax changes on the current excess equity return, and the discounted sums of future excess equity returns, current and future real interest rates, and current and future dividends (cash flows). The six-variable VAR(1) used to construct excess equity return and real interest rate forecasts is estimated over the sample indicated in the column headings. The VAR state variables are defined in the text. Our personal income tax shock series are described in Section 5.2. The column *All Shocks* from Table 3 is included for reference. Standard errors are calculated by the bootstrap algorithm discussed in Section 4. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

	All Shocks	Personal Tax Shocks	Personal Tax SVAR Shocks	τ SVAR Shocks
Panel A: 1980Q3 - 2007Q4				
Current Excess Return	0.4662***	0.2243***	0.0762***	0.0473***
Future Excess Return	−0.2250**	−0.1938*	−0.0365*	−0.0425**
Real Interest Rate News	−0.5520***	−0.1903	−0.0907**	0.0073
Cash Flow News	−0.3108**	−0.1598	−0.0508**	0.0023
Panel B: 1947Q1 - 1980Q2				
Current Excess Return	−0.2072***	−0.1715***	−0.0563***	−0.0480***
Future Excess Return	0.2910	0.2457	0.0803	0.058**
Real Interest Rate News	0.1005	−0.0565	−0.0925	−0.0873**
Cash Flow News	0.1842	0.0180	−0.0685	−0.0775*
Panel C: Difference				
Current Excess Return	−0.6735**	−0.3957	−0.1323**	−0.0955
Future Excess Return	0.5162*	0.4395	0.1165*	0.1005
Real Interest Rate News	0.6525**	0.1340	−0.0020	−0.0800
Cash Flow News	0.4950	0.1777	−0.0177	−0.0750

Table 6: Taxes and valuation ratios

This table replicates the regression results of Sialm (2009) splitting the sample on monetary policy regimes. The dependent variable is equity Q and is obtained from the Federal Reserve Board's Flow of Funds Accounts as the ratio between the market value of equities outstanding of nonfinancial corporate business (FL103164003) and the net worth at market value of nonfarm nonfinancial corporate business (FL102090005). Tax yield is defined as in Sialm (2009) as the sum of the dividend tax rate times the dividend yield, the short-term capital gains tax rate times the short-term capital gains yield, and the long-term capital gains tax rate times the long-term capital gains yield. Growth rate is the per capita real growth rate of aggregate output. Quality spread is the difference in yields between Baa and Aaa bonds. Term spread is the difference between yields in Aaa bonds and the one-year interest rate on commercial paper by Shiller. Data are annual. Standard errors are Newey-West adjusted using a four-year lag. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

	Pre-Volcker			Post-Volcker		
	(1)	(2)	(3)	(4)	(5)	(6)
Tax yield	−21.9137***	−24.8777***	−26.1699***	94.8644***	73.4594**	83.8285***
	(-6.93)	(-9.08)	(-7.33)	(3.21)	(2.76)	(3.10)
Interest rate	−2.2804	−2.3816**	−6.9016***	−0.0542	3.6974	−10.232
	(-1.48)	(-2.06)	(-4.26)	(-0.02)	(1.50)	(-1.67)
Inflation rate	−1.0218**	−1.2312***	−0.9899**	−7.9740**	−5.5663***	−8.0374***
	(-2.46)	(-3.64)	(-2.33)	(-2.30)	(-2.99)	(-3.33)
Growth rate	0.7142*	0.5901**	0.8446**	−0.1992	−2.4128	0.5071
	(1.89)	(2.42)	(2.59)	(-0.09)	(-1.20)	(0.21)
Quality spread		−13.2198***			−58.6862***	
		(-4.01)			(-3.98)	
Term spread			−9.9800**			−14.7938
			(-2.45)			(-1.51)
Time trend	0.0062**	0.0037	0.0084***	0.0738***	0.0550**	0.0422
	(2.58)	(1.66)	(4.96)	(3.00)	(2.82)	(1.48)
Constant	0.8332***	1.1546***	1.0888***	−5.7105**	−3.5845*	−2.133
	(8.36)	(9.07)	(7.45)	(-2.60)	(-1.91)	(-0.73)
Time period	1919-1979	1919-1979	1919-1979	1980-2006	1980-2006	1980-2006
N	60	60	60	27	27	27
R^2	0.4291	0.5474	0.5346	0.5702	0.7251	0.6150

Table 7: Excess returns around changes in expected future tax rates

This table reports parameter estimates from the regression of excess returns on changes in expected future tax rates (τ) and other controls. The dependent variable in each regression is the CRSP value-weighted index return in excess of the risk-free rate over the window specified in the column header. $\Delta\tau$ is the change in the expected future tax rate equal to one minus the ratio of the yield on municipal bond and the yield on a treasury bond of equal maturity. $NBER$ is a binary variable equal to one if the observation occurs during an NBER-dated recession and equal to zero otherwise. Panel A reports parameter estimates for regressions using daily excess returns. For this panel, the sample period is 2009Q1 to 2015Q4 ($n = 1743$). τ is constructed using the Bloomberg BVAL Muni Benchmark with maturity reported in the row τ *Maturity*. Panel B reports parameter estimates for regressions using weekly excess returns. For these panels, the sample period for odd columns is 1980Q2 to 2008Q2 ($n = 1455$), while the sample period for even columns is 1980Q2 to 2015Q4 ($n = 1851$). τ is constructed using the Bond Buyer Go 20-Bond Municipal Bond Index, which has maturity of 20 years. Standard errors are Newey-West adjusted with lag length eight. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

Panel A: Daily Event Windows

	(0,1) Event Window				(0,5) Event Window			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.0005**	0.0005**	0.0005**	0.0005*	0.0026**	0.0026**	0.0026**	0.0026**
$\Delta\tau$	0.0208	0.1000***	0.1702***	0.2253***	0.0486	0.0989***	0.1652***	0.2225***
τ Maturity	2 yr	5 yr	10 yr	30 yr	2 yr	5 yr	10 yr	30 yr

Panel B: Weekly Event Windows with NBER Indicators

	(0,1) Event Window		(0,4) Event Window		(0,8) Event Window		(0,12) Event Window	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Intercept	0.0013**	0.0016***	0.0049**	0.0061***	0.0093**	0.0114***	0.0132***	0.0164***
NBER	−0.0007	−0.0030	−0.0002	−0.0094	0.0017	−0.0137	0.0074	−0.0147
$\Delta\tau$	0.2252**	0.1638***	0.4689***	0.2404**	0.6804***	0.3023**	0.6239***	0.3438**
$\Delta\tau \times$ NBER	−0.0743	−0.2777	0.0283	−0.0433	−0.1536	−0.1312	−0.0940	0.0668

Table 8: Long-short portfolio returns around changes in expected future tax rates

This table reports parameter estimates from the regression of portfolio returns on changes in expected future tax rates (τ) and other controls. $\Delta\tau$ is the change in the expected future tax rate equal to one minus the ratio of the yield on municipal bond and the yield on a treasury bond of equal maturity. τ is constructed using the Bloomberg BVAL Muni Benchmark with maturity reported in the row τ *Maturity*. The sample period is 2009Q1 to 2015Q4 ($n = 1743$). The dependent variable in Panel A is the value-weighted return of the long portfolio in excess of the value-weighted return of the short portfolio. $HiPR$, $MidPR$, and $LoPR$ denote the high, medium, and low tercile of Payout Ratio, respectively. $HiIO$, $MidIO$, and $LoIO$ denote the high, medium, and low tercile of Institutional Ownership, respectively. The dependent variable in Panel B is the abnormal portion of the value-weighted return of the long portfolio with respect to the Fama-French three factor model in excess of the abnormal return for the short portfolio. Standard errors are Newey-West adjusted with lag length eight. *, **, and *** denote significance at the 10 percent, 5 percent, and 1 percent levels, respectively.

	(0,1) Event Window				(0,5) Event Window			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Raw Returns								
$R^{LoPR} - R^{HiPR}$	−0.0046	0.0143**	0.0268***	0.0498***	0.0001	0.0139	0.0240	0.0496***
$R^{LoPR\times HiIO} - R^{LoPR\times LoIO}$	0.0018	−0.0006	−0.0141	0.0020	0.0252	0.0298	0.0138	0.0186
$R^{MidPR\times HiIO} - R^{MidPR\times LoIO}$	0.0014	0.0257***	0.0283***	0.0397***	0.0076	0.0163	0.0286	0.0337*
$R^{HiPR\times HiIO} - R^{HiPR\times LoIO}$	−0.0012	0.0171*	0.0445***	0.0538***	−0.0108	0.0210	0.0407**	0.0872***
Panel B: Abnormal Returns								
$e^{LoPR} - e^{HiPR}$	−0.0079	0.0019	0.0015	0.0129*	−0.0122	−0.0003	0.0017	0.0211*
$e^{LoPR\times HiIO} - e^{LoPR\times LoIO}$	−0.0014	−0.0058	−0.0147	−0.0041	0.0201	0.0228	0.0124	0.0161
$e^{MidPR\times HiIO} - e^{MidPR\times LoIO}$	−0.0041	0.0015	−0.0058	−0.0054	−0.0125	−0.0099	−0.0039	−0.0067
$e^{HiPR\times HiIO} - e^{HiPR\times LoIO}$	0.0055	0.0153**	0.0258***	0.0295**	−0.0031	0.0215	0.0308*	0.0612***
τ Maturity	2 yr	5 yr	10 yr	30 yr	2 yr	5 yr	10 yr	30 yr

Appendix for Taxes and the Fed

1. Alternative Parameter Values

1.1. Monetary Policy Rule Parameters

The monetary policy rules we consider involve three parameters: the inertia coefficient, the inflation coefficient, and the output growth coefficient. With the benchmark values of 0.9, 1.58, and 2.2, respectively, we show that the inertia coefficient (weight on previous period's interest rate) does not meaningfully alter the results for values between 0 and 0.95. Intuitively, the greater the inertia coefficient, the less monetary policy responds in the short run and the more it influences the long-run. This is consistent with Panel A of Table A.1 which shows that real interest rates fall more as the coefficient rises, and the current excess return becomes more positive.

The inflation coefficient also exhibits a monotonic relationship with real interest rates and the cash flow news channel. We find that for a higher inflation coefficient, inflation rises less and is stabilized to a greater extent. As a result, real interest rates do not decline as much in the medium-long term as the inflation coefficient rises.

In contrast, an increase in the output growth coefficient tends to stabilize output while generating greater decreases in the real interest rates. Increases in the coefficients on inflation and output growth have opposite effects because inflation rises (higher taxes increase costs of production) and output declines in response to the tax increase. Therefore, increasing the output growth coefficient generates higher inflation and lower real interest rates, while increasing the inflation coefficient generates lower inflation and smaller declines in real interest rates. While the effects of various output growth coefficients are relatively stable at the Post-Volcker benchmark calibration, when moving to the benchmark values for the Pre-Volcker calibration, we see that the results do depend on the output growth coefficient.

When the inertia coefficient and inflation coefficient are 0.91 and 1.32, respectively, we observe a change in sign for the current excess return as the output growth coefficient increases. As explained in the previous section, the higher output growth coefficient generates greater declines in real interest rates as monetary policy tries to stabilize the decline in output. In addition, as monetary policy stabilizes output to a greater extent, dividends do not decline as much so that the discount channel is relatively larger and excess returns increase. While the relationship between output growth and the asset pricing channels for the Post-Volcker framework is not strictly monotonic, as the output coefficient rises from 1.2 to 2.4, the results are quantitatively consistent.

1.2. New Keynesian Parameters

The two main parameters of the New Keynesian block are the price adjustment costs and elasticity of substitution across goods, which captures the degree of monopolistic competition. In Panel B of Table A.1, we can see that as the price adjustment costs increase, real interest rates do not decline as much and dividends fall more.[1] Both of these effects combine to make the current excess return less positive in response to the tax increase. The intuition for the smaller decline in real interest rates is that as price adjustment costs become larger, the aggregate supply curve becomes flatter so that the tax increase influences the economy less. The dividends ($D_t = Y_t - w_t L_t - I_t$) fall more because investment does not fall as much in the medium-long run (the flatter supply curve reduces the effects of the tax increase on investment so investment is relatively higher and dividends are relatively lower).

With regards to market power, as the elasticity of substitution across goods increases, the market power declines. While this does not largely influence the real interest rate channel, it does influence the dividends. The dividends are a function of the firm's profits and as market power decreases, profits become smaller and less volatile. With dividends declining less over the medium-long run, current excess returns become more positive as the market power decreases.

1.3. Utility Parameters

The subjective discount factor captures the patience of households and firms and the degree to which they are forward looking. With a lower subjective discount factor, households are less patient and require greater interest rates for markets to clear. This leads to larger steady state interest rates and larger fluctuations. As a result, real interest rates decline more in response to the tax increase and this can lead to a more positive current excess return.[2]

The intertemporal elasticity of substitution (IES) captures how sensitive households are to interest rate fluctuations. The greater the IES, the less interest rates need to fluctuate in order for markets to clear. As shown in Panel C of Table A.1, values between 0.15 to 0.25 lead to results that are qualitatively consistent. [3] As the IES declines to zero, the discount rate channel becomes larger and the current excess return rises.

Risk aversion captures the aversion of households to changes in consumption across states. Higher risk aversion increases the precautionary savings motive and tends to reduce steady state real interest rates. The overall effects of higher risk aversion in the model have little influence over the channels and largely does not alter the existing results.

The leisure share parameter in the consumption-leisure bundle pins down the steady state level of labor. The higher the value, the less households work and the more inelastic the labor supply. As labor becomes more inelastic, it declines less in response to the tax increase, and this results in more stable investment and output responses. With greater stability in investment and output, dividends ($D_t = Y_t - w_t L - t - I_t$) do not decline as much as labor becomes less elastic. With a smaller decline in cash flow news, the current excess return becomes more positive as labor becomes less elastic.

[1]Beyond the price adjustment costs value of 35, there is a monotonic relationship.

[2]This monotonically holds for values declining until $\beta = 0.994$. For values less than 0.994 for the subjective discount factor, the real interest rates do not decline as much and responses level off, as shown by the channels for 0.99 in Table A.1.

[3]Intertemporal elasticity of substitution values around 0.2 are consistent with a substantial literature in macroeconomics, see for example Chari, Kehoe, and McGrattan (2002); House and Shapiro (2006); Piazzesi, Schneider, and Tuzel (2007), as well as empirical work by Barsky, Juster, Kimball, and Shapiro (1997); Campbell and Mankiw (1989); Hall (1988).

1.4. Production Parameters

The capital share of income and depreciation rate parameters pin down the amount of capital. With a higher share of capital or lower depreciation rate, investment does not rise as much initially (investment rises initially due to the negative wealth effect) in the short-medium term as capital makes up a larger percentage of GDP and becomes less volatile. With investment not rising as much, dividends do not decline as much, so that the current excess return becomes more positive as the capital share of income rises or depreciation rate declines.

1.5. Tax Rate Parameters

The persistence of the tax rate shock determines how permanent the tax rate change is. We find that for a wide range of persistence parameters, the relative magnitudes of the cash flow and discount rate channels are unaltered. The discount rate channel is almost always larger and this implies positive current excess returns in response to the tax increase. The cash flow channel dominates only when the persistence value is less than 0.5. However, at such a low persistence, the tax shock is very short-lived and has almost no effect on current excess returns. The predicted effect on current excess returns at a persistence value of 0.5 is minus 4 one-hundredths of a basis point. Given that the price of equity takes into account all future expected discounted cash flows, it is intuitive that a temporary tax shock would have almost no effect.

Different levels of the marginal tax rate have also been tested, and the results in Panel D of Table A.1 are shown to be robust.

1.6. Wage Parameters

Increasing the wage adjustment costs makes wages stickier. By making wages less volatile, both labor and investment do not rise as much initially. With a smaller rise in investment, dividends do not decline as much initially compared to the scenario with more flexible wages. After the initial period, both labor and investment begin to decline due to the tax increase but again, do not decline as quickly due to the stickier wages. This keeps output relatively higher in the medium-long term for the sticky wage scenario, and dividends do not decline as much in the medium-long term. Both the short-run and medium-long run effects suggest the greater the wage adjustment costs, the less dividends decline.

Real interest rates also decline by less due to the higher marginal product of capital coming from the smaller decline in labor with sticky wages. However, in the medium-long run, the relatively higher capital stock mechanically entails relatively lower real interest rates, which slightly offsets the previous effect.

The overall effect of the cash flow and discount rate channels is that the cash flow channel declines by less, and the current excess return becomes more positive with greater wage adjustment costs.

The asymmetric wage cost parameter alters the quadratic-cost function so that declines have larger costs, and increases have smaller costs. As a result, the higher the asymmetry parameter, the lower the stickiness of wage increases. This is confirmed by the table, which shows that the higher asymmetry parameter has the opposite effect of the wage adjustment costs parameter (because wage increases are less sticky). The dividends become more negative, and the overall effect on current excess returns becomes less positive.

The elasticity of substitution across labor inputs pins down the market power of households in labor supply. The table shows that as market power increases, the cash flow news declines more. This is consistent with more volatile responses of labor and investment. The more market power, the more elastic the household's labor supply so that investment and labor rise more initially, resulting in a greater initial decline in dividends. Over the medium-long run, labor declines to a greater extent with more market power, so that output declines more as do dividends. The overall effect is greater declines in dividends and a less positive response of current excess returns as the market power of workers rises.

1.7. Timing of the Tax Shock

We also change the timing of the tax shock to capture the potential effects of news of future tax changes in Panel F of Table A.1. Specifically, we "announce" tax increases two and four quarters before the exogenous shock to taxes occurs. While the timing of the shock will influence real dynamics such as investment and output, the overall effect on the current return is modest. With respect to a tax increase, the current excess return becomes slightly less positive with further lags in implementation due to the sum of real interest rates not falling as much. In response to an expected tax increase, real interest rates rise initially because investment and labor rise to a greater extent, and then real interest rates decline along with investment and labor once the tax increase is in place. The greater the lag in implementation, the more real interest rates rise prior to the actual change. The timing does not significantly matter for the current excess return because in the model, agents and firms are forward-looking and have rational expectations. Furthermore, if one were to calculate the excess return in any period beyond the initial period of this exercise, the current excess return would be very close to zero.

Investment adjustment costs reduce the volatility of investment, which means investment does not rise as much initially and does not fall as much in the following periods. The short run effect entails a smaller decline in dividends ($D_t = Y_t - w_t L_t - I_t$), while the medium-long run effect implies a smaller decline in output, so that dividends overall fall less as the investment adjustment costs parameter rises. With dividends falling less, the current excess return becomes more positive.

2. Results Based On Estimated Rule

For the main results of our paper, we largely relied on estimates coming from Coibion and Gorodnichenko (2015). Coibion and Gorodnichenko (2015) follow Orphanides (2005) and use Greenbook data and least squares estimation for two time periods: (1) 1969-1978 and (2) 1983-2002. For the robustness of our theoretical results, we re-do their analysis for the time period 1979Q3 to 2007Q4. Each window between FOMC meetings represents one time period. This provides alternative estimates for the monetary policy rule, which is modeled as a function of the previous period's federal funds rate, the Greenbook time t inflation rate, and the Greenbook output growth at time t.

We find values of 0.8 for the inertia coefficient, 1.8 for the inflation coefficient, and 1.15 for the output growth for the Post-Volcker time period. These values are within confidence intervals of our main results, which for clarity were 0.9 for the inertia coefficient, 1.58 for the inflation coefficient and 2.21 for the output growth coefficient.

Since Greenbook data is only available post-1969 yielding a relatively short time series to estimate our pre-Volcker policy rule, we supplement this data with forecasts of future inflation and output growth constructed using a large panel of macroeconomic data. Specifically, we regress the Greenbook forecasts used in estimating the monetary policy rule from 1969 to 1978 on variables from the FRED-MD database selected using an elastic net where the regularization parameters are chosen using cross validation. These estimates are then used to form forecasts from 1959 to 1968.[4] The results for the Pre-Volcker estimation are included in the main text.

We show in Figure A.1 the responses to the setup with the estimated rule. We also show responses based on the calibration in the main text but with different values for the output growth coefficient. Specifically, we use one standard error deviations from the point estimate of 2.2, which is 1.4 and 3.

3. Time Varying Parameter VAR

While we provide both theoretical and statistical evidence supporting a focus on broad monetary policy regimes, our choice of sample periods may seem somewhat ad hoc. In this section, we estimate a Bayesian time varying parameter VAR (TVP-VAR) in the spirit of Primiceri (2005). This model allows both the VAR loadings in Equation 21 and the loadings on fiscal policy in Equation 26. Specifically, we estimate the following VAR model:

$$Z_t = c_t + A_{1,t} Z_{t-1} + \phi_t FISCAL_t + u_t, \ t = 1, ..., T \tag{A.1}$$

where Z_t is a $n \times 1$ vector of endogenous variables; c_t is a $n \times 1$ vector of time-varying intercepts; $A_{1,t}$ is a $n \times n$ matrix of time-varying coefficients with lag length 1; phi_t is a $n \times 1$ vector of time-varying loadings on fiscal policy shocks, and u_t is a $n \times 1$ vector of residuals. The time-varying VAR can then be rewritten as:

$$\begin{aligned} Z_t &= X_t' \tilde{A}_t + \Sigma_t \epsilon_t \\ X_t' &= I \otimes [1, Z_{t-1}', FISCAL_t], \end{aligned} \tag{A.2}$$

where $\tilde{A}_t$ is a stacked vector containing all coefficients of the right hand side of equation 21. $Var(\epsilon_t) = I_n$ and the operator $\otimes$ denotes the Kronecker product.

The dynamics of the time-varying parameters (A_t) are following a driftless random walk:

$$A_t = A_{t-1} + \nu_t, \tag{A.3}$$

[4] Additional details regarding these forecasts are available from the authors upon request.

The vector of innovations $[\epsilon_t \ , \nu_t \ ]$ is assumed to be jointly normally distributed with variance-covariance matrix:

$$Var(\epsilon_t \ , \nu_t \ ) = \begin{bmatrix} I_n & 0 \\ 0 & Q \end{bmatrix}, \tag{A.4}$$

where I_n is an n dimensional identity matrix and Q is a positive definite matrix.

For evaluating posteriors, prior distributions need to be specified. For the calibration of these priors, we use a training sample that is 25 periods long starting in 1947:Q1and run an OLS estimation on a fixed-coefficient VAR model. The OLS point estimates ($\widehat{B_{OLS}}$) and four times their variance specify the mean and the variance of B_0. The prior covariance matrix is specified to be $4 \cdot I_n$. The priors for the initial states of the time-varying VAR-parameters B_0 follow a normal distribution. The hyperparameter Q is the covariance matrix of the innovations (see equations 4.5, 4.6 and 4.7). Matrix Q is distributed as an independent inverse-Wishart. In summary:

$$\begin{aligned} B_0 &\sim N(\widehat{B_{OLS}}, 4 \cdot V(\widehat{B_{OLS}})), \\ Q &\sim IW(k_Q^2 \cdot \tau \cdot V(\widehat{B_{OLS}}), \tau), \\ \Sigma &\sim IW(I(M), M+1) \end{aligned} \tag{A.5}$$

where τ has the size of the training sample, the size of the training sample defines the degrees of freedom for Q. Finally, the parameter $k_Q = 0.1$ defines prior beliefs about the degree of time variation in the parameters, covariances and volatilities.[5]

Estimation for this reduced form VAR is carried out using Bayesian methods for the sample from 1953:Q1 to 2007:Q4. For approximating the posterior distribution, 50,000 iterations of the Gibbs sampler are used and we drop the first 20,000 iterations for convergence. For breaking the autocorrelation of the draws, only every $10th$ iteration is kept. Our final estimates are therefore based on 3,000 iterations. The sample autocorrelation functions of the draws die out rather quickly. Furthermore, the convergence diagnostics reveal satisfactory results.[6]

Panel A of Figure A.2 plots the posterior median of the equity return response to the *All Shocks* series of fiscal policy shocks through time. While time-series variation in the response is evident, the broad pattern that fiscal policy's effect on excess equity returns depending on monetary policy regime remains. During the Pre-Volcker regime, stocks respond negatively to exogenous increases in the tax rate with the posterior median response falling below zero in each period. With the onset of the Post-Volcker regime, the response becomes positive. Moreover, these responses don't appear to vary substantially during NBER recessions with the exception of the run-up to early 1990s recession. Panel B plots the posterior median of the combined

[5]As a sensitivity check, we also experimented with other value combinations of these coefficients. The responses obtained are robust to those presented.

[6]A detailed overview can be obtained upon request.

response of discount rates (both real interest rates and the future equity returns) to fiscal policy shocks. Again, responses are volatile around the 1987 crash and the early 1990s recession, but overall results are consistent with our previous findings.

Table A.3 presents the posterior medians for all equity response channels by monetary policy regime for each of our exogenous tax shock series. For many of the estimates, the 68 percent coverage intervals are quite wide and do not allow us to reject the null of zero response. However for both the *All Shocks* and *Surprise Shocks* series, the coverage interval for overall equity response in the Post-Volcker period is positive with the range covering the fixed-loading responses reported in Table 3. Results are similar for the difference in the overall response across the two monetary policy regimes as well. The overall equity response to increases with the onset of the Post-Volcker regime, and the size of the estimated difference in the TVP-VAR is in line with those reported in the main results of the paper.

Figure A.1: Post-Volcker Responses Based on Estimation and Robustness

This figure shows the economic responses for the Post Volcker regime (based on estimated parameters and the main framework at different values for the output growth coefficient) in response to a one standard deviation income tax rate increase (0.22%). The only difference across the two calibrations is the definition of the monetary policy rule. For the Post-Volcker based on the estimated rule, $\alpha_\pi = 1.8, \alpha_{\Delta y} = 1.15, \alpha_R = 0.8$. For the Post-Volcker based on the main results, $\alpha_\pi = 1.58$, $\alpha_{\Delta y} = 1.4$ or $\alpha_{\Delta y} = 3$, and $\alpha_R = 0.9$. We use the values of 1.4 and 3 because these are -/+ 1 standard error (0.8) based on the estimates in Coibion and Gorodnichenko (2011). The results are similar to what are presented in the main text: in response to a tax increase, the discount rate news dominates the cash flow news so that the overall effect is positive.

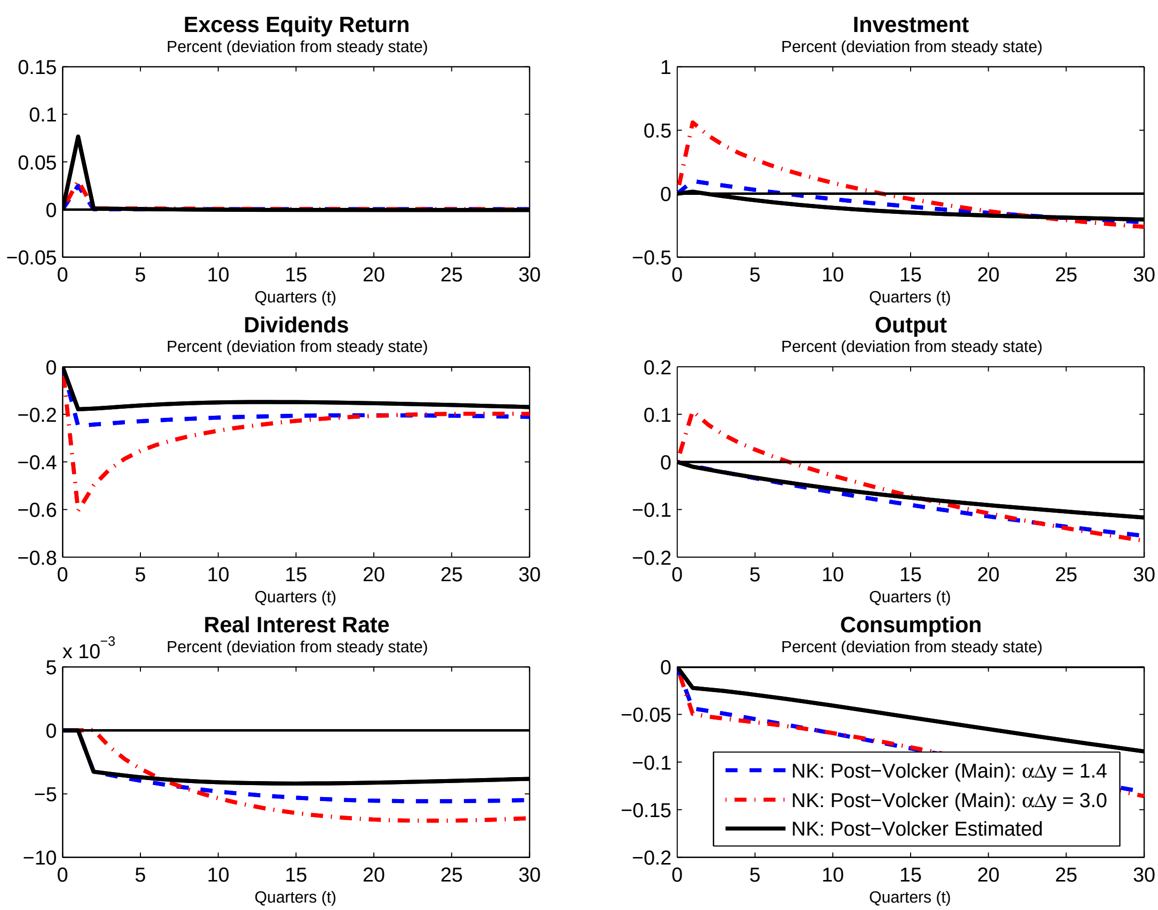
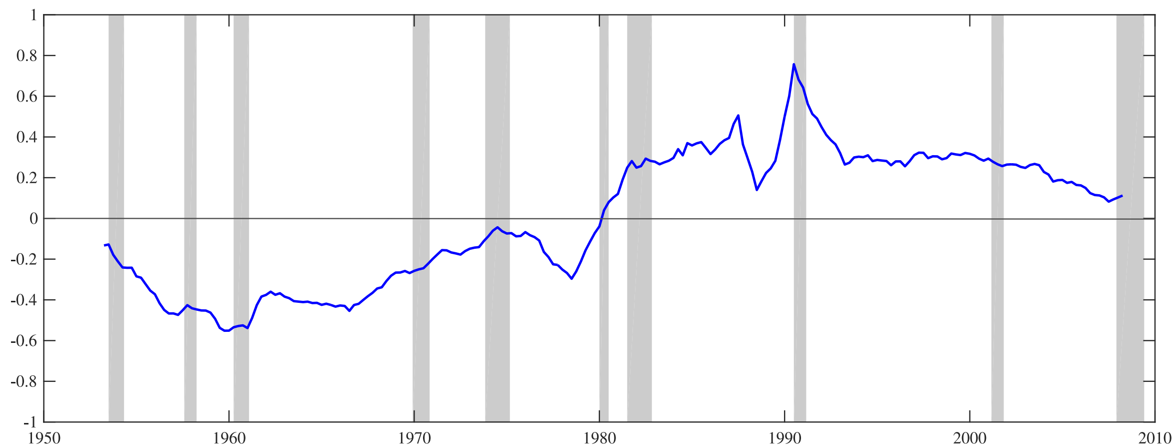


Figure A.2: TVP-VAR response to tax shocks

This figure presents the time-varying effect of a positive tax shock on the current excess return and discount rate news. Tax shocks are the *All Shocks* series described in Section 4.2. The estimation follows Primiceri (2005) and is described in Section 3. The posterior median of the responses is plotted. The shaded areas coincide with NBER recessions.

Panel A: Current Excess Return



Panel B: Discount Rate News

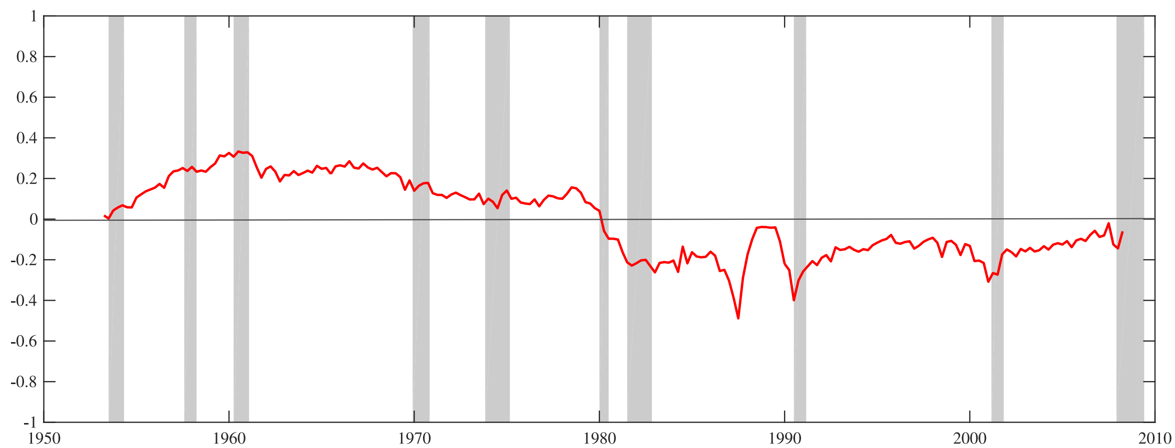


Table A.1: Robustness of simulated results to changes in model parameters

This table reports the impact of a positive exogenous tax shock on the current excess equity return, and the discounted sums of future excess equity returns, current and future real interest rates, and current and future cash flows. Data are the solutions to the DSGE model described in Section 3. In the first column of each panel, the results from our preferred calibration is presented for reference.

Panel A: Monetary Policy Rule Parameters

		Inertia Coefficient ($\alpha_\rho = 0.90$)		Inflation Coefficient ($\alpha_\pi = 1.58$)		Output Growth Coefficient ($\alpha_{\Delta y} = 2.2$)	
	Baseline	0.00	0.95	1.25	2	1.2	2.4
Current Excess Return	0.0515	0.0419	0.0534	0.0600	0.0565	0.0286	0.0434
Future Excess Return	−0.0030	−0.0081	0.0002	0.0135	−0.0053	0.0646	0.0030
Real Interest Rate News	−0.2588	−0.2489	−0.2624	−0.3009	−0.2475	−0.2815	−0.2704
Cash Flow News	−0.2103	−0.2151	−0.2088	−0.2274	−0.1963	−0.1883	−0.2239

Panel B: New Keynesian Parameters

		Price adjustment costs (= 35)		Elast. subs. of goods ($\eta = 7$)	
	Baseline	10	100	4	10
Current Excess Return	0.0515	0.0524	0.0492	0.0274	0.0735
Future Excess Return	−0.0030	−0.0031	−0.0044	−0.0030	−0.0031
Real Interest Rate News	−0.2588	−0.2581	−0.2570	−0.2633	−0.2565
Cash Flow News	−0.2103	−0.2088	−0.2123	−0.2389	−0.1861

Panel C: Utility Parameters

		Risk Aversion ($\gamma = 5$)		Subjective Discount Factor ($\beta = 0.9990$)		Intertemporal Elasticity of Substitution ($\psi = 0.2$)	
	Baseline	2	10	0.99	0.9999	0.15	0.25
Current Excess Return	0.0515	0.0496	0.0554	0.0508	0.0486	0.0895	0.0160
Future Excess Return	−0.0030	0.0011	−0.0091	−0.0060	−0.0017	−0.0026	0.0057
Real Interest Rate News	−0.2588	−0.2657	−0.2446	−0.2535	−0.2528	−0.2776	−0.2437
Cash Flow News	−0.2103	−0.2150	−0.1983	−0.2086	−0.2059	−0.1907	−0.2221

Table A.1: Robustness of simulated results to changes in model parameters (cont.)

Panel D: Production & Tax Rate Parameters

		Capital Share ($\theta = 0.3$)		Depreciation ($\delta = 0.10$)		Tax Rate Persistence ($\rho^{\tau} = 0.9999$)		Marginal Tax Rate ($\tau^{SS} = 0.17$)	
	Baseline	0.25	0.35	0.06	0.14	0.99	0.9	0.10	0.25
Current Excess Return	0.0515	0.0309	0.0716	0.0627	0.0434	0.0515	0.0044	0.0494	0.0530
Future Excess Return	−0.0030	−0.0045	−0.0015	−0.0022	−0.0029	−0.0030	0.0001	−0.0029	−0.0027
Real Interest Rate News	−0.2588	−0.2511	−0.2664	−0.2586	−0.2574	−0.2588	−0.0174	−0.2388	−0.2820
Cash Flow News	−0.2103	−0.2246	−0.1963	−0.1982	−0.2169	−0.2103	−0.0129	−0.1924	−0.2317

Panel E: Wage Parameters

		Wage adjustment costs ($\phi = 1000$)		Asym. wage adjustment costs ($\psi = 3800$)		Labor Hours ($\iota = 0.25$)		Market Power of Workers ($\theta_W = 1.4$)	
	Baseline	500	1500	0	5000	0.2	0.3	1.2	1.6
Current Excess Return	0.0515	0.0262	0.0599	0.0630	0.0453	0.0243	0.0872	0.0734	0.0299
Future Excess Return	−0.0030	0.0072	−0.0043	−0.0064	−0.0003	0.0045	−0.0014	−0.0041	0.0027
Real Interest Rate News	−0.2588	−0.2762	−0.2377	−0.2400	−0.2667	−0.2517	−0.2571	−0.2278	−0.2624
Cash Flow News	−0.2103	−0.2429	−0.1821	−0.1834	−0.2217	−0.2228	−0.1713	−0.1586	−0.2298

Panel F: Misc. Parameterizations

		Output Growth Coefficient (when $\alpha_R = 0.91, \alpha_\pi = 1.32$) (Pre-Volcker)			Tax Shock at time ($t = 0$)		Investment Adj. Costs ($\Psi = 0$)	
	Baseline	0.94	1.50	2.00	2	4	1	5
Current Excess Return	0.0515	−0.0502	0.0381	0.0556	0.0516	0.0498	0.0603	0.0624
Future Excess Return	−0.0030	−0.0513	0.0092	0.0034	−0.0030	−0.0030	0.0006	0.0016
Real Interest Rate News	−0.2588	−0.2272	−0.2784	−0.2712	−0.2569	−0.2526	−0.2607	−0.2573
Cash Flow News	−0.2103	−0.3287	−0.2312	−0.2121	−0.2083	−0.2057	−0.1998	−0.1933

Table A.2: Robustness of simulated results to estimated monetary policy rule

This table reports the impact of a positive exogenous tax shock on the current excess equity return, and the discounted sums of future excess equity returns, current and future real interest rates, and current and future cash flows. Data are the solutions to the DSGE model described in Section 3. In the first column of each panel, the results from our preferred calibration with the alternative monetary policy rule is presented for reference.

Panel A: Monetary Policy Rule Parameters

		Inertia Coefficient ($\alpha_\rho = 0.80$)		Inflation Coefficient ($\alpha_\pi = 1.8$)		Output Growth Coefficient ($\alpha_{\Delta y} = 1.15$)	
	Baseline	0.00	0.9	1.5	2.5	1.05	2
Current Excess Return	0.0765	0.0730	0.0414	0.1589	0.0207	0.1377	0.0620
Future Excess Return	−0.0079	−0.0278	0.0498	−0.0238	0.0173	−0.0867	−0.0045
Real Interest Rate News	−0.2299	−0.2217	−0.2573	−0.2050	−0.2325	−0.1892	−0.2458
Cash Flow News	−0.1613	−0.1766	−0.1660	−0.0699	−0.1945	−0.1382	−0.1884

Panel B: New Keynesian Parameters

		Price adjustment costs (= 35)		Elast. subs. of goods ($\eta = 7$)	
	Baseline	10	200	5	10
Current Excess Return	0.0765	0.0762	0.0821	0.0813	0.0847
Future Excess Return	−0.0079	−0.0095	−0.0100	−0.0437	0.0138
Real Interest Rate News	−0.2299	−0.2289	−0.2241	−0.2167	−0.2368
Cash Flow News	−0.1613	−0.1622	−0.1520	−0.1791	−0.1383

Panel C: Utility Parameters

		Risk Aversion ($\gamma = 5$)		Subjective Discount Factor ($\beta = 0.9990$)		Intertemporal Elasticity of Substitution ($\psi = 0.2$)	
	Baseline	2	10	0.99	0.9999	0.15	0.25
Current Excess Return	0.0765	0.0734	0.0817	0.1469	0.0638	0.1463	0.0374
Future Excess Return	−0.0079	−0.0053	−0.0129	−0.0764	0.0022	−0.0678	0.0149
Real Interest Rate News	−0.2299	−0.2345	−0.2218	−0.2351	−0.2255	−0.2121	−0.2331
Cash Flow News	−0.1613	−0.1664	−0.1530	−0.1646	−0.1595	−0.1336	−0.1808

Table A.2: Robustness of simulated results to estimated monetary policy rule (cont.)

Panel D: Production & Tax Rate Parameters

		Capital Share ($\theta = 0.3$)		Depreciation ($\delta = 0.10$)		Tax Rate Persistence ($\rho^{\tau} = 0.9999$)		Marginal Tax Rate ($\tau^{SS} = 0.17$)	
	Baseline	0.25	0.35	0.08	0.12	0.999	0.995	0.10	0.24
Current Excess Return	0.0765	0.0837	0.0772	0.0693	0.0915	0.0590	0.0151	0.0833	0.0696
Future Excess Return	−0.0079	−0.0207	−0.0003	0.0047	−0.0262	0.0001	0.0212	−0.0269	0.0103
Real Interest Rate News	−0.2299	−0.2209	−0.2376	−0.2375	−0.2203	−0.2194	−0.1783	−0.2025	−0.2607
Cash Flow News	−0.1613	−0.1580	−0.1607	−0.1635	−0.1550	−0.1602	−0.1420	−0.1461	−0.1808

Panel E: Wage Parameters

		Wage adjustment costs ($\phi = 1000$)		Asym. wage adjustment costs ($\psi = 3800$)		Labor Hours ($\iota = 0.25$)		Market Power of Workers ($\theta_W = 1.4$)	
	Baseline	750	1250	0	5000	0.2	0.3	1.3	1.5
Current Excess Return	0.0765	0.0459	0.1090	0.0470	0.0826	0.0156	0.1807	0.1573	0.0400
Future Excess Return	−0.0079	0.0117	−0.0326	−0.0036	−0.0339	0.0233	−0.1036	−0.0773	0.0154
Real Interest Rate News	−0.2299	−0.2432	−0.2127	−0.2888	−0.2152	−0.2344	−0.1983	−0.1906	−0.2417
Cash Flow News	−0.1613	−0.1857	−0.1363	−0.2453	−0.1665	−0.1955	−0.1211	−0.1106	−0.1863

Panel F: Misc. Parameterizations

		Output Growth Coefficient (when $\alpha_R = 0.91, \alpha_\pi = 1.32$) (Pre-Volcker)			Tax Shock at time ($t = 0$)		Investment Adj. Costs ($\Psi = 0$)	
	Baseline	0.94	1.50	2.00	2	4	1	5
Current Excess Return	0.0765	−0.0502	0.0381	0.0556	0.0776	0.0779	0.0849	0.0950
Future Excess Return	−0.0079	−0.0513	0.0092	0.0034	−0.0087	−0.0102	−0.0131	−0.0369
Real Interest Rate News	−0.2299	−0.2272	−0.2784	−0.2712	−0.2279	−0.2234	−0.2248	−0.1815
Cash Flow News	−0.1613	−0.3287	−0.2312	−0.2121	−0.1590	−0.1557	−0.1531	−0.1234

Table A.3: The impact of exogenous tax shocks on equity returns in a TVP-VAR framework

This table reports the impact of exogenous tax shocks on the current excess equity return, and the discounted sums of future excess equity returns, current and future real interest rates, and current and future dividends (cash flows) in a Bayesian time varying parameter VAR (TVP-VAR) framework. The six-variable VAR(1) used to construct excess equity return and real interest rate forecasts is estimated over the sample 1947Q1 to 2007Q4. The VAR state variables are defined in the text. Tax shocks are described in Section 4.2. The estimation follows Primiceri (2005) and is described in Section 3. The posterior median of the responses over the Pre- and Post-Volcker periods are reported in Panel A and B, respectively. Posterior medians in bold do not contain 0.0 in the 68 percent coverage of the posterior distribution. The interval of the 68 percent coverage of the posterior distribution is presented in parentheses below the posterior median.

	All Shocks	SVAR Shocks	Surprise Shocks	Surprise SVAR Shocks
Panel A: 1980Q3 - 2007Q4				
Current Excess Return	**0.3110**	0.0033	**0.2981**	-0.0270
	(0.0424, 0.5868)	(-0.0918, 0.0971)	(0.0478, 0.5553)	(-0.1055, 0.0521)
Future Excess Return	-0.2499	-0.0244	-0.2225	0.0089
	(-1.3769, 0.8440)	(-0.5451, 0.4969)	(-1.2253, 0.7590)	(-0.5097, 0.5118)
Real Interest Rate News	0.0259	0.0006	0.0398	0.0064
	(-0.8289, 0.8646)	(-0.4073, 0.4143)	(-0.7565, 0.8204)	(-0.3993, 0.4166)
Cash Flow News	0.0741	-0.0211	0.1015	-0.0144
	(-1.1955, 1.3372)	(-0.6189, 0.5838)	(-1.0361, 1.2216)	(-0.6159, 0.5979)
Panel B: 1947Q1 - 1980Q2				
Current Excess Return	**-0.2648**	-0.0435	-0.0765	-0.0182
	(-0.5262, -0.0094)	(-0.1068, 0.0198)	(-0.2531, 0.1036)	(-0.0809, 0.0432)
Future Excess Return	0.1177	0.0074	-0.0144	-0.0134
	(-0.9181, 1.1469)	(-0.5184, 0.5078)	(-0.8871, 0.8412)	(-0.5239, 0.4972)
Real Interest Rate News	0.0250	0.0062	0.0428	0.0165
	(-0.7664, 0.8109)	(-0.4165, 0.4340)	(-0.6581, 0.7221)	(-0.4081, 0.4432)
Cash Flow News	-0.1270	-0.0311	-0.0528	-0.0145
	(-1.3229, 1.0612)	(-0.6500, 0.5721)	(-1.0891, 0.9729)	(-0.6511, 0.6059)
Panel C: Difference				
Current Excess Return	**-0.5785**	-0.0463	**-0.3719**	0.0085
	(-0.9299, -0.2331)	(-0.1567, 0.0645)	(-0.6674, -0.0824)	(-0.0902, 0.1069)
Future Excess Return	0.3650	0.0290	0.2036	-0.0174
	(-1.7058, 2.4682)	(-1.0017, 1.0337)	(-1.6167, 2.0137)	(-1.0431, 0.9750)
Real Interest Rate News	-0.0055	0.0069	0.0008	0.0149
	(-1.6301, 1.6337)	(-0.8343, 0.8318)	(-1.4614, 1.4856)	(-0.8023, 0.8296)
Cash Flow News	-0.1913	-0.0126	-0.1563	-0.0053
	(-2.6187, 2.1942)	(-1.2052, 1.1919)	(-2.3146, 1.9879)	(-1.2540, 1.2397)