

Monetary Policy and Corporate Default [☆]

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Abstract

When a corporation issues debt with a fixed nominal coupon the real value of future payments decreases with the price level. Monetary policy can therefore significantly impact corporate capital structure decisions, default, and the pricing of corporate debt through its impact on expected inflation. This monetary policy channel operates even in an environment of perfectly flexible price setting, demonstrating an important real impact of monetary policy in the absence of standard nominal frictions such as staggered price setting. We show the importance of monetary policy for corporate debt and default in a calibrated economy. In a recession marked by falling demand, weak monetary policy amplifies the direct real effects of the shock by permitting falling prices and correspondingly stronger incentives for corporate default.

Keywords: Monetary policy, Taylor rule, corporate default, capital structure, leverage, credit spreads.

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1. Introduction

The credit crisis and subsequent global recession had a severe impact on both the default rates and credit spreads of firms. According to Moody's (Emery et al. (2009)) default rates and the volume of defaulted debt reached record highs in 2009. The global default rate on speculative grade debt reached 13% in 2009, close to the previous high of 15.4% during 1933, in the midst of the Great Depression (see Figure 1). The total number of defaults in 2008 and 2009 amongst Moody's rated debt were 102 and 261, respectively, with the majority of defaults occurring in North America. The spread between Baa and Aaa debt is often used as way of measuring credit risk which is less influenced by liquidity effects than the spread relative to Treasuries (see, e.g. Chen et al. (2008)). The Baa-Aaa spread surged during the period 2008-2009, reaching a peak of just under 3.5%. The last time the Baa-Aaa spread surpassed this level was during the Great Depression (see Figure 2). This suggests that from the perspective of credit conditions, the recent recession has been the worst since the Great Depression.

While the nominal interest rate declined with GDP during both the recent crisis and the Great Depression, the behaviour of inflation has been markedly different. The Great Depression was accompanied by large deflation. During the period 2007-2009 inflation has declined, but any deflation has, so far, been negligible (see the left-hand panels of Figure 3). Furthermore the decline in real GDP during the recent crisis has been on a much smaller scale than during the Great Depression (see the right-hand panels of Figure 3). The model we develop provides insights into how monetary policy and expected inflation impact default rates and credit spreads.

Given the substantial real costs associated with asset liquidation and reorganization of financial claims in distress, the monetary authority should naturally be concerned over rising credit spreads and default rates.¹ While it is clear how a business with floating-rate obligations

¹These costs involve both direct expenses of bankruptcy and a variety of indirect effects that impair operating activities in the neighborhood of distress. The real costs of financial distress have been estimated in the range of 5-20% of firm value for firms ranging from investment grade to bankrupt. See, e.g., Warner (1977), Weiss (1990), Bris et al. (2006), Andrade and Kaplan (1998), Almeida and Philippon (2007), and van Binsbergen

benefits from the Federal Reserve lowering short-term interest rates during a recession, the situation is perhaps less obvious for long-dated fixed-rate obligations. This is where inflation and hence monetary policy can play a key role in impacting default rates. Corporate fixed-rate obligations are usually specified in nominal dollars, implying that an increase in expected inflation via a shift to a more accommodative monetary policy reduces the incentives of a corporation to default. In turn, a high level of aggregate default risk may induce a policy of sustained low interest rates to reduce default rates. Thus, we should expect strong connections between monetary policy, corporate decisions regarding debt and default, and credit markets.

Nonetheless, research linking monetary policy to structural models of corporate default remains unexplored in the literature. The aim of our paper is to take the first step in filling this gap. Attention in this area has the potential to improve theoretical understanding of how central bank policy impacts the economy via the credit risk channel.

The standard New Keynesian model of monetary economics does not consider the impact of monetary policy on capital structure. Instead, the standard approach invokes pricing frictions in the goods market to obtain an important benchmark in which monetary policy has real consequences.² A difficulty arises, however, in applying this framework to explaining the 2008 financial crisis. The standard New Keynesian model ignores financial frictions, and typically a single interest rate exists at which all households and firms can borrow and lend. This assumption is clearly at odds with the rising credit spreads and increasing default rates experienced during the financial crisis. More importantly, according to the standard New Keynesian framework, a Taylor rule for monetary policy would not have suggested an aggressive policy response by the Fed. Under a standard Taylor rule, the monetary authority responds to contemporaneous inflation and output shocks, but much of the aggressive response of the Federal Reserve in 2008 came in advance of large measurable changes in output and

et al. (2010).

²The New Keynesian paradigm departs in two important dimensions from the frictionless model, where real quantities such as output and consumption are determined independently of monetary policy. First, firms sell differentiated products for which they can set the price, consistent with the idea of imperfect competition in the goods market. Second, firms cannot reset their product price in every period, but instead price changes are staggered as in Calvo (1983). See Woodford (2003) and Gali (2008).

inflation. Rather changes in credit market conditions and credit spreads seemed to be one of the leading indicators of the financial crisis and of the Fed's aggressive monetary policy response.

In this paper we adopt a simple approach, distinct from the New Keynesian framework, where we show a role for monetary policy even under perfect competition and flexible price setting in product markets. We depart from the frictionless paradigm by modeling a cross-section of heterogeneous firms which make optimal capital structure decisions. Following Merton (1974) and Leland (1994), firms issue risky debt to take advantage of a tax benefit to debt. They choose to default when the present value of coupon payments to bond holders is greater than the present value of future dividends. When firms default, there are bankruptcy costs and bond holders take over the firm. The coupon level and default policies are set optimally by the firm and are thus endogenous to the model. An important feature of the model is that for a fixed nominal coupon, the real coupon changes with inflation. Monetary policy therefore impacts the real economy through corporate default decisions even under the assumption of perfectly flexible prices. Credit spreads and capital structure also depend on the monetary policy rule.

In the standard frictionless monetary economy, shocks to inflation have no asset pricing implications. In other words, risky assets do not demand a return premium due to correlation of their cash flows with inflation. Recently, Gallmeyer et al. (2007) show that shocks to inflation are priced when the nominal interest rate is set according to a Taylor rule, because no-arbitrage implies that inflation itself depends on macroeconomic factors present in the pricing kernel. We use the monetary policy consistent pricing approach of Gallmeyer et al. (2007), which assumes perfectly flexible pricing, and extend the idea of their approach to cases with nominal rigidities such as staggered price setting. We thereby obtain a model of sticky prices where monetary policy shocks carry a risk premium.

Our work relates to a number of other recent papers. Curdia and Woodford (2008) study the interest differential between borrowers and lenders. Their model is driven by heterogeneous preferences between borrowers and lenders but it does not incorporate default. More

closely related are Goodfriend and McCallum (2007) and Gomes and Schmid (2009). The former studies the role of capital as collateral but without default in equilibrium. The latter considers default in an equilibrium setting but it does not permit a role for monetary policy. More broadly, structural models of optimal capital structure and the pricing of corporate debt have received increasing attention in recent literature (e.g., Bhamra et al. (2010a,b,c), Carlson and Lazrak (2010), and Chen (2010)). Recent literature has also shown increasing awareness of the importance of inflation for asset prices (e.g., David (2008), David and Veronesi (2009)). By linking these literatures, we aim to deepen understanding of the interaction between monetary policy and corporate default and show how this interaction can be critical for understanding events such as the recent financial crisis.

The outline of our paper is as follows. In Section 2, we develop a structural equilibrium model of heterogeneous firms that make optimal capital structure decisions trading off the tax benefits of debt against costs of financial distress. Price setting is perfectly flexible. The monetary authority sets policy according to a Taylor rule, and firms incorporate this rule in forming their capital structure and default decisions. In Section 3, we develop a sticky-price version of the capital structure model with endogenous inflation. In Section 4, we calibrate the model and demonstrate the effects of monetary policy on aggregate default and distress costs, and examine the response of credit spreads to aggregate shocks. Section 5 concludes.

2. Flexible Price Model

We embed a structural model of credit risk inside a consumption-based asset pricing model to obtain a structural equilibrium model.³ On the corporate side the model is based on Leland (1994), so default decisions and capital structure are optimal. The monetary model is the standard flexible price model as in Gali (2008) chapter 2, which pins down inflation given paths of output and a policy rule. We follow Gallmeyer et al. (2007), who incorporate the standard model of flexible prices into a consumption-based asset pricing model with risk premia.

³The same basic approach is used, for example, in Bhamra et al. (2010a,b,c)

2.1. Equity Valuation

Firms are endowed with a project of size k which is constant over time. To save on notation, we omit a firm-specific subscript in the following. Firms produce real output y_t according to the production function

$$y_t = e^{x_t+z_t}k \tag{1}$$

where x_t and z_t denote real aggregate and firm specific productivity shocks which follow AR(1) processes

$$x_t = \rho_x x_{t-1} + \sigma_x \varepsilon_t^x, \tag{2}$$

$$z_t = \rho_z z_{t-1} + \sigma_z \varepsilon_t^z, \tag{3}$$

where $\varepsilon_t^x, \varepsilon_t^z$ are uncorrelated standard normal i.i.d. shocks. Firm-specific shocks are uncorrelated across firms.

Firms can issue nominal debt in the form of a consol bond that pays a fixed nominal coupon b^* as long as the firm does not default. At $t = 0$, the real and nominal coupon are identical, $b^* = b_0$. The real coupon at date t is

$$b_t = \frac{b^*}{P_t}, \tag{4}$$

where P_t is the price level of the consumption good. Our notational convention throughout the paper is to denote nominal quantities by superscripting with an asterisk. Variables without asterisks are real. Following (4), since the nominal coupon is fixed the real coupon changes with inflation. To write b_t in terms of stationary state variables, note that $\ln b_t - \ln b_{t-1} = -\pi_t$ where π_t is the log inflation rate, $\pi_t = \ln P_t - \ln P_{t-1}$. The real coupon therefore obeys

$$b_t = b_{t-1}e^{-\pi_t}. \tag{5}$$

In addition to the Gaussian shocks $\varepsilon_t^x, \varepsilon_t^z$, we also allow idiosyncratic technological obso-

lescence. For simplicity, we assume obsolescence implies the immediate death of the firm, and the loss of all future cash flows. This assumption provides additional flexibility in matching average credit spreads and default rates while maintaining reasonable leverage ratios, but will not impact the dynamics of default which is the focus of our study. The probability of firm death per unit time is denoted p_d . After death the firm is immediately replaced by a new firm with a new draw of z_t . Following these assumptions, after-tax nominal earnings of a firm less the coupon payment to debtholders are

$$e_t^* = \varphi_t(1 - \eta)(P_t x_t z_t k - b^*), \quad (6)$$

where φ_t is an indicator variable for whether the firm is still alive at date t and η is the corporate tax rate on profits. We can rewrite (6) in real terms as

$$e_t = \varphi_t(1 - \eta)(x_t z_t k - b_t). \quad (7)$$

All positive earnings are immediately distributed as dividends to shareholders. Negative earnings require firms to raise equity from shareholders, which is costly at rate λ :

$$d_t^* = (1 + \lambda 1_{\{e_t^* < 0\}})e_t^*. \quad (8)$$

At any time of negative earnings, equity holders can decide not to provide the new capital necessary to make payments to bondholders, resulting in default. This is the standard assumption of the structural approach to endogenous default introduced by Leland (1994). Equity holders decide when to default by maximizing the firm's nominal equity value

$$S_t^* = \max\{0, d_t^* + \mathbb{E}_t[M_{t+1}^* S_{t+1}^*]\} \quad (9)$$

where M^* is the nominal pricing kernel. Equivalently, the real equity value $S = S^*/P$ solves

$$S_t = \max\left\{0, \frac{d_t^*}{P_t} + \mathbb{E}_t[M_{t+1} S_{t+1}]\right\}. \quad (10)$$

An important aspect of the default decision is that equity holders are forward-looking in deciding whether to continue operations. In standard formulations of monetary economies (e.g., Gali, 2008), firms set prices myopically and hence monetary policy impacts the real economy only under nominal frictions such as sticky prices. By contrast, the forward-looking nature of the default decision implies real consequences even under perfectly flexible prices.

The aggregate state variables of the model are now output x_t , the long-run output mean μ_t , and the monetary policy shock s_t . Each firm also has its own state variable z_t . The boundary condition for default can be expressed as the level of the firm-specific shock for which equity value reaches zero given the values of the other state variables, i.e.,

$$z_d(x_t, \mu_t, s_t) = \min\{z : S(x_t, \mu_t, s_t, z) = 0\} \quad (11)$$

where $S_t = S(x_t, \mu_t, s_t, z)$ is the state-dependent equity value of the firm.

2.2. Debt Valuation

Bondholders receive the nominal coupon b^* as long as the firm does not default. In the case of default, bondholders receive a fraction $1 - \phi$ of the nominal after-tax value of the unlevered firm. Let A_t^* denote the value of the unlevered firm:

$$A_t^* = (1 - \eta)P_t x_t z_t k + \mathbb{E}_t[M_{t+1}^* A_{t+1}^*]. \quad (12)$$

We can give two interpretations to the value $(1 - \phi)A_t^*$ accruing to bondholders in default. First, the value may represent fractional ownership of the firm under the assumption of no deadweight bankruptcy costs, with fraction ϕ of firm value accruing to bankers and lawyers as a transfer. Alternatively, we can think of the value to debtholders conditional on default including some deadweight loss to the economy. For example, we can consider that the capital stock k_{t+1} is permanently depreciated to the level $(1 - \phi)k_t$ in the event of default, where the fractional loss ϕ represents deadweight loss of productive capacity due to, for example, the loss of intangible capital in the event of reorganization. For simplicity we focus on the first scenario.

The nominal market value of debt can be defined recursively

$$B_t^* = (b^* + \mathbb{E}_t[M_{t+1}^* B_{t+1}^*])1_{\{V_t^* > 0\}} + (1 - \phi)A_t^*1_{\{V_t^* = 0\}}. \quad (13)$$

Similarly, the real market value of debt is

$$B_t = (b_t + \mathbb{E}_t[M_{t+1} B_{t+1}])1_{\{V_t > 0\}} + (1 - \phi)A_t1_{\{V_t = 0\}}, \quad (14)$$

where the after-tax real value of assets is

$$A_t = (1 - \eta)x_t z_t k + \mathbb{E}_t[M_{t+1} A_{t+1}]. \quad (15)$$

The optimal coupon is chosen at date 0 to maximize firm value V_0 :

$$V_0 = \max_{b_0} \{S_0 + B_0\}. \quad (16)$$

Credit spreads are defined as

$$cs_t \equiv \frac{b^*}{B_t^*} - \frac{b^*}{B_t^{f,*}} = \frac{b_t}{B_t} - \frac{b_t}{B_t^f} \quad (17)$$

where $B_t^{f,*}$ is the nominal value of a default-free bond with the same nominal coupon b^* , i.e.

$$B_t^{f,*} = b^* + \mathbb{E}_t[M_{t+1}^* B_{t+1}^{f,*}], \quad (18)$$

and so

$$B_t^f = b_t + \mathbb{E}_t[M_{t+1} B_{t+1}^f]. \quad (19)$$

2.3. Aggregation

To aggregate the model, we assume that there is a continuum of firms driven by idiosyncratic shocks. In equilibrium, the representative household holds all claims of debt and equity. We assume throughout the paper that taxes and equity issuances costs are purely redistribu-

tional and have no aggregate effect. In this section we also assume to simplify computation that bankruptcy costs are purely redistributive, as for example may partially be the case with litigation costs. Extending the model to include deadweight bankruptcy costs adds to the computational requirements, but is conceptually straightforward.

Under these assumptions, real aggregate output is

$$Y_t = \int e^{x_t+z_t} k d\mu = e^{x_t} k \quad (20)$$

where μ is the distribution of firms. The second equality follows from the law of large numbers applied to z_t . Market clearing implies that real aggregate consumption is

$$C_t = Y_t.$$

The representative household has power utility with relative risk aversion coefficient γ and rate of time preference β . We also permit the possibility of time-variation in preferences, which can be interpreted as either external habit formation or demand shocks, and so, the real pricing kernel is given by

$$M_{t+1} = \beta \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \frac{Q_{t+1}}{Q_t}$$

where

$$Q_{t+1} = Q_t e^{-\frac{1}{2}(\delta v_t \sigma_x)^2 - \delta v_t \sigma_x \varepsilon_{t+1}^x}$$

is driven by shocks

$$v_t = \rho_v v_{t-1} + \sigma_v \varepsilon_t^v.$$

The log pricing kernel thus satisfies

$$\begin{aligned} m_{t+1} &= \ln M_{t+1} = \beta - \gamma \Delta x_{t+1} + \Delta q_{t+1} \\ \Delta q_{t+1} &= -\frac{1}{2}(\delta v_t \sigma_x)^2 - \delta v_t \sigma_x \varepsilon_{t+1}^x, \end{aligned}$$

so that shocks to aggregate output ε_{t+1}^x are priced, and the price of risk is time varying because of fluctuations in the state variable v_t .

2.4. The Monetary Authority

The monetary authority sets the log short-term nominal interest rate according to a modified Taylor rule

$$i_t = \tau_0 + \tau_\pi \pi_t + \tau_x x_t + s_t, \quad (21)$$

where s_t is a monetary policy shock, and the coefficients τ_0 , τ_π , τ_x , are policy parameters. The monetary policy shock follows an AR(1) process

$$s_t = \rho_s s_{t-1} + \sigma_s \varepsilon_t^s, \quad (22)$$

where ε_t^s is standard normal i.i.d. and independent of all previously specified shocks.

We assume that there exists a complete set of financial markets, including a one-period nominal riskless bond. As a result, the nominal interest rate must satisfy the nominal Euler equation

$$i_t = -\ln(E_t[e^{m_{t+1}^*}]), \quad (23)$$

where m^* is the log nominal pricing kernel, given by

$$m_{t+1}^* = m_{t+1} - \pi_{t+1}. \quad (24)$$

An equilibrium inflation rate process must satisfy both equations (21) and (23) at each point in time, which requires inflation to solve the nonlinear stochastic difference equation:

$$\begin{aligned} i_t &= -\ln(\mathbb{E}_t[e^{m_{t+1}^*}]) \\ \tau_0 + \tau_\pi \pi_t + \tau_x x_t + s_t &= -\ln(\mathbb{E}_t[e^{m_{t+1} - \pi_{t+1}}]) \end{aligned}$$

which implies

$$\pi_t = -\frac{1}{\tau_\pi} \left(\tau_0 + \tau_x x_t + s_t + \mathbb{E}_t[m_{t+1} - \pi_{t+1}] + \frac{1}{2} \text{Var}_t[m_{t+1} - \pi_{t+1}] \right). \quad (25)$$

The equilibrium inflation process thus depends on preferences, the Taylor rule, and the parameters that describe exogenous shocks.

Equation (25) has a unique solution, the endogenous inflation process, π , that is jointly determined by the response of the monetary authority and the private sector to the same underlying exogenous shocks. Substituting inflation back into the nominal pricing kernel, (24), we arrive at what Gallmeyer et al. (2007) refer to as a unique monetary policy consistent pricing kernel: a (nominal) pricing kernel that depends on the Taylor-rule parameters τ_0, τ_π , and τ_x .

Proposition 1 *The endogenous inflation process is given by*

$$\pi_t = \kappa_0 + \kappa_x x_t + \kappa_v v_t + \kappa_s s_t. \quad (26)$$

with coefficients

$$\kappa_0 = \frac{\ln \beta + \frac{1}{2} \Sigma + \tau_0}{1 - \tau_\pi} \quad (27)$$

$$\kappa_x = \frac{\gamma(1 - \rho_x) + \tau_x}{\rho_x - \tau_\pi} \quad (28)$$

$$\kappa_v = \frac{(\gamma + \kappa_x) \sigma_x^2 \delta}{\rho_v - \tau_\pi} \quad (29)$$

$$\kappa_s = \frac{1}{\rho_s - \tau_\pi}, \quad (30)$$

where Σ is a constant given in Equation (61) of the Appendix.

From the above proposition, we can see the consequences of the Fed adopting a simple policy of keeping a fixed nominal interest rate target independent of inflation or output, with policy shocks s_t , leading to the rule $i_t = \kappa_0 + \ln s_t$. Under such a policy, the denominators of (28)-(30) are all positive. Given reasonable calibrations of the other parameters, inflation

rises with output ($\kappa_x > 0$) and in response to a positive shock to the nominal interest rate ($\kappa_s > 0$). These effects are driven by the basic identity that the nominal interest rate can be decomposed into components relating to the real interest rate and inflation. Since x is mean reverting, an increase in x implies a decline in expected future growth, hence a lower real interest rate in the future. Holding the nominal interest rate constant as the fixed interest rate target assumes, inflation must increase to allow the nominal interest rate identity to hold. Similarly, inflation must increase in response to an increase in the nominal interest rate under this policy.

We now discuss the implications of the above proposition when the Fed adopts an ‘active’ policy and chooses to fight inflation. In particular, suppose the Fed reacts aggressively towards inflation by raising the nominal interest by more than 1 b.p. when inflation rises by 1 b.p., but ignores changes in output and its long-run mean, i.e. $i_t = \kappa_0 + \tau_\pi \pi_t + \ln s_t$, where $\tau_\pi > 1$. The effects noted under the fixed interest rate target are then reversed: inflation falls as output rises ($\kappa_x < 0$) and after a positive exogenous shock to the nominal interest rate ($\kappa_s < 0$).

3. Sticky Price Model

We now assume that price adjustment is costly, and that the cost of adjustment is quadratic, as in Rotemberg (1982). Consequently, inflation is given by the New Keynesian Phillips curve, i.e.

$$\pi_t = \beta \mathbb{E}_t[\pi_{t+1}] + \lambda(y_t - y_t^*), \quad (31)$$

where λ is related to the probability of a firm not changing its price in the next period, θ , via

$$\lambda = \frac{(1 - \theta\beta)(1 - \theta)}{\theta}(\gamma + \varphi), \quad (32)$$

where φ is a positive constant.⁴ Log real output is y and y^* is log real output when price adjustment is not costly, i.e. prices are not sticky. From (20) it follows that

$$y_t^* = \ln k + x_t. \quad (33)$$

Log real output when prices are not sticky is commonly referred to as target log output. Price stickiness acts as a nominal rigidity affecting real output, and so y is endogenous. The output gap is defined as the difference between log real output and target log output, i.e. $y - y^*$. The Taylor Rule specifies the current nominal interest rate, i_t , in terms of the difference between current inflation, π_t and its target, π^* , and the current output gap with the addition of an exogenous policy shock, i.e.

$$i_t = \tau_0 + \tau_\pi(\pi_t - \pi^*) + \tau_y(y_t - y_t^*) + s_t. \quad (34)$$

Note that we shall set $\pi^* = 0$, because there is no growth in the model. From the New Keynesian Phillips curve in (31), the Taylor Rule in (34) and the nominal Euler equation (23), we derive endogenous inflation and real output, as shown in the following proposition.

Proposition 2 1. *Inflation, π , is given by*

$$\pi_t = \kappa + \kappa_x x_t + \kappa_v v_t + \kappa_s s_t,$$

⁴It would be simple to extend our model to incorporate labor in the utility function, in which case φ would be the disutility of labor parameter. To reasons of parsimony, we avoid doing this explicitly.

where

$$\kappa = \frac{-\ln \beta - \frac{1}{2}\bar{\Sigma} - \tau_0}{\tau_\pi + \tau_y a - 1} \quad (35)$$

$$\kappa_x = \frac{-\gamma(1 - \rho_x)}{\tau_\pi + \tau_y a_x + \gamma a_x(1 - \rho_x) - \rho_x} \quad (36)$$

$$\kappa_s = -\frac{1}{\tau_\pi + \tau_y a_s + \gamma a_s(1 - \rho_s) - \rho_s} \quad (37)$$

$$\kappa_v = -\frac{\{(\gamma a_x + 1)\kappa_x + \gamma\} \sigma_x^2 \delta}{\tau_\pi + \tau_y a_v + \gamma a_v(1 - \rho_v) - \rho_v}, \quad (38)$$

$\bar{\Sigma}$ is a constant given in the Appendix, and

$$a = \frac{1}{\lambda}(1 - \beta) \quad (39)$$

$$a_x = \frac{1}{\lambda}(1 - \beta \rho_x) \quad (40)$$

$$a_v = \frac{1}{\lambda}(1 - \beta \rho_v) \quad (41)$$

$$a_s = \frac{1}{\lambda}(1 - \beta \rho_s). \quad (42)$$

2. Log real output is given by

$$y_t = \psi_x x_t + \psi_v v_t + \psi_s s_t, \quad (43)$$

where

$$\psi = a\kappa \quad (44)$$

$$\psi_x = a_x \kappa_x + 1 \quad (45)$$

$$\psi_v = a_v \kappa_v \quad (46)$$

$$\psi_s = a_s \kappa_s. \quad (47)$$

We can see from the above proposition, that increasing τ_π or τ_y weakens the dependence of inflation on output, bringing inflation closer to its target value.

Note also that log real output depends on the monetary policy shock. Therefore such shocks will be priced, i.e. the log real stochastic discount factor is given by

$$m_{t+1} = \ln \beta - \gamma[\psi_x \Delta x_{t+1} + \psi_v \Delta v_{t+1} + \psi_s \Delta s_{t+1}] + \Delta q_{t+1}, \quad (48)$$

depends on s . A positive shock to monetary policy, i.e. an exogenous unexpected increase in the nominal interest rate, is accompanied by a fall in inflation (since $\kappa_s < 0$), leading to an increase in the real stochastic discount factor ($\kappa_s < 0$ implies that $\psi_s < 0$). Consequently, the risk-neutral probability of a positive shock to monetary policy exceeds the actual probability. This has the implication that even if positive shocks to monetary policy are infrequent, their importance for asset pricing will not be negligible.

Observe that when prices are not sticky, i.e. $\theta = 0$, then $\lambda \rightarrow \infty$, and the parameters for endogenous inflation reduce to

$$\kappa = \frac{-\ln \beta - \frac{1}{2}\Sigma - \tau_0}{\tau_\pi - 1} \quad (49)$$

$$\kappa_x = \frac{-\gamma(1 - \rho_x)}{\tau_\pi - \rho_x} \quad (50)$$

$$\kappa_s = -\frac{1}{\tau_\pi - \rho_s} \quad (51)$$

$$\kappa_v = -\frac{(\kappa_x + \gamma)\sigma_x^2\delta}{\tau_\pi - \rho_v}, \quad (52)$$

and $y_t = x_t$. The expressions for the κ 's are identical to those for the flexible price model shown in Proposition 1, with the exception of κ_x . The sole reason for this difference is that in contrast with (21), the Taylor Rule in the sticky price model depends on the output gap, $y - y^* = y - x$, and not just x .

Observe also that with stickier prices (higher θ and lower λ), the endogenous inflation process becomes more sensitive to changes in τ_y . This implies that the loading in the Taylor Rule on the output gap is a more effective instrument for controlling inflation when prices are stickier.

4. Model Calibration and Implications

We calibrate both flexible and sticky price versions of the monetary economy and demonstrate the impact of monetary policy on default rates and credit spreads.

4.1. Calibration

Our calibration is summarized in Table 1. We set the annualized time discount factor equal to around 0.96 (0.99 in quarterly units), which is within the range commonly chosen in the literature (for example, 0.99 in Abel (1999), 0.93 in Abel (1990), 0.89 in Campbell and Cochrane (1999) and 0.998 in Bansal and Yaron (2004)). We choose a coefficient of relative risk aversion of 10. Risk aversion is usually chosen to be in the range 3-10 (see, for example Mehra and Prescott (1985) who argue that relative risk aversion is less than or equal to 10 and Bansal and Yaron (2004) who set relative risk aversion equal to 10). Project size is set to one, without loss of generality. The corporate tax rate is 10% per annum (close to the mean tax rate on equity income of 12% estimated in Graham (2000)). Equity issuance costs are equal to 5 %, slightly lower than 8.3 %, as estimated by Hennessy and Whited (2007) for the sample of Compustat firms. and close to the estimate of 5.14% in Altinkilic and Hansen (2000) We set the loss rate in default equal to 20 % (see, for example Andrade and Kaplan (1998) who report default costs of about 10–25% of asset value and Hennessy and Whited (2007) who estimate bankruptcy costs to be 10%).

Our estimates for the volatility and persistence of aggregate shocks are in line for those based on the Solow residual in Cooley and Prescott (1995). Standard practice is to apply the HP filter to real GDP data from the Bureau of Economic Analysis, and to concentrate on the detrended data. We choose the persistence and volatility of shocks to x (0.95, 1.0) accordingly. Monetary policy shocks are persistent with small volatility as in Gallmeyer et al. (2008).

To investigate the model, we consider different combinations of flexible vs. sticky prices, and variations in Taylor rule parameters as described below. In all cases, we assume exogenous stochastic obsolescence at the rate of 10 basis points per quarter. Upon replacement, a firm

selects its optimal coupon, and this ensures that despite static capital structure, aggregate leverage does not vanish in the long run.

4.2. Results

The first scenario we consider assumes flexible prices and the constant target interest rate policy $\tau_\pi = \tau_x = 0$, which we describe as the ‘passive’ monetary policy. The passive monetary policy provides a coarse representation of monetary policy during the Great Depression, during which strong deflationary pressures existed (see Figure 3, with sustained inflation rates of -10%), yet interest rates were brought down slowly, not reaching a level of 1% until 1934. In our calibration of the passive policy, the monetary authority does not seek to aggressively fight deflation, and as a consequence deflation is strong after negative shocks to aggregate productivity ($\kappa_x > 0$).

Figure 4 shows the endogenous default policies of firms and credit spreads under the passive policy with flexible prices. Firms default earlier when x is low, since current profits are lower and deflation increases the real value of future coupon payments. Endogenous deflation thus has an important impact on corporate default decisions. Figure 4 also shows that the endogenous coupon b increases in x and the idiosyncratic shock z , consistent with the idea that lower cash flows and lower inflation both erode the ability to take on a larger debt load. The next set of panels evaluates the impact of the state variables on leverage, holding the coupon choice constant across states. Leverage decreases in both the systematic and idiosyncratic productivities x and z . The final set of panels shows credit spreads. We again hold the coupon payment constant across states to focus on the credit risk implications. Credit spreads rise as idiosyncratic productivity and aggregate productivity fall, as expected.

Figure 5 shows the same graphs in the flexible price model with an ‘active’ monetary policy following the rule $\tau_\pi = 1.5$ and $\tau_x = 0.125$. The active policy is taken to represent the goals of monetary policy during the recent credit crisis. In this case the default policy implies earlier default in good times when productivity x is high. The reason for this result is that in the model inflation is low when x is high ($\kappa_x < 0$), which discourages firms from defaulting on their debt. This specification therefore implies that active monetary policy reduces the

threat of deflation in recessions. The optimal coupon is lower when aggregate output is large, due to expected deflation. Leverage increases with x because the deflation induced by an increase in x increases the value of debt proportionately more than equity. Credit spreads however rise as x falls. The active monetary policy thus averts the threat of deflation during recessions, which reduces default rates and credit spreads.

Some caveats are required in interpreting these results. The active monetary policy requires the monetary authority to decrease interest rates linearly with respect to falling output and inflation, which may in instances imply negative interest rates. In reality, the Federal Reserve cannot implement such policies, hence we should anticipate uncertainty over the ability of the Federal Reserve to combat default in deflationary times as successfully as our model suggests. Nonetheless, the stark contrast in default rates and credit spreads between the active and passive monetary policy provide useful insights for understanding current policy decisions.

We investigate whether default policies differ qualitatively in the sticky price model in Figures 6 and 7. The results show similar qualitative patterns to the flexible price model. Under passive monetary policy $\tau_\pi = \tau_x = 0$ shown in Figure 6, the default boundary is downward sloping in x , consistent with the fact that inflation remains procyclical when the monetary authority does not actively fight inflation. The shapes of the coupon, leverage, and credit spread plots are also qualitatively similar to the flexible price case shown in Figure 4. Quantitatively, the default boundaries appear similar in the flexible and sticky price cases shown in Figures 4 and 6. The optimal coupon choice is larger under flexible prices than with sticky prices, and credit spreads are also larger.

Under the active monetary policy with sticky prices and standard Taylor rule parameters shown in Figure 7, the default boundary is downward sloping since inflation is countercyclical. The default boundaries are however noticeably higher and somewhat flatter than in Figure 5, under flexible prices. The coupon levels are also lower under sticky than flexible prices.

To summarize, the sticky and flexible price models have similar qualitative implications. When monetary policy is passive $\tau_\pi = \tau_x = 0$, inflation is procyclical and large waves of

default occur after a negative shock to output under both flexible and sticky prices. However, under an active monetary policy $\tau_\pi = 1.5$, $\tau_x = 0.125$ inflation is countercyclical and relative to the passive case we find lower incidences of default and lower credit spreads following a negative output shock. These qualitative results do not depend on whether price setting is flexible or sticky.

To give an idea of the real and financial moments generated by our monetary model of default, Tables 2 and 4 present financial moments under the flexible and Tables 3 and 5 under the sticky price models with passive and active monetary policies. First examining the flexible price model in Tables 2 and 4, we see that the market risk premium is higher with a passive than an active monetary policy, return volatilities are higher, and inflation is higher, but risk free rate volatility and inflation volatility are much lower. The larger inflation volatility under the active monetary policy helps to explain the relatively more conservative debt policies shown in Figure 6, under active monetary policy, versus Figure 4, under the passive monetary policy.

4.3. Policy Experiment with Changing Taylor Rule

The previous exercise assumed that the central bank would choose a single Taylor rule that would remain constant over time. We now consider an experiment where we compare a continuously active monetary policy with the case where the central bank unexpectedly changes its Taylor rule from active to passive. In both situations we start with the active policy $\tau_\pi = 1.5$, $\tau_x = 0.125$. We simulate this policy for a period of time and allow firms to choose their capital structures optimally under the assumption that this monetary policy will persist indefinitely. We then allow the economy to be hit by a large negative shock to x and consider two scenarios. In the first scenario, the central bank continues with the active monetary policy following the negative real shock. In the second scenario, the central bank switches from the active to a more ‘passive’ monetary policy, which we represent by the simple rule $\tau_\pi = \tau_x = 0$. Figure 8 shows that if the central bank switches from an active to a passive monetary policy following a negative shock, then a large increase in defaults and credit spreads can be generated.

5. Conclusion

Monetary policy impacts corporate default through its influence on inflation and inflation expectations. Passive monetary policy – as some would argue occurred during the Great Depression – generates procyclical inflation. Adverse real shocks thus generate strong deflationary pressures, compounding the incentives of corporations to default and thereby generating a potentially strong amplification mechanism. More active monetary policy can dampen this amplification mechanism, reducing default rates and credit spreads.

We see several potential directions for further research. First, the commitment and ability of the monetary authority to an active policy may be uncertain, and tradeoffs typically exist between price stabilization goals and other objectives. In this case, the ability of the monetary authority to maintain countercyclical inflation may not be certain. Second, the model we have considered permits only perpetual debt. In an environment with finite-duration debt, the ability to refinance and the risk posed by stochastic interest rates at the rollover date provide an additional channel through which monetary policy can impact default decisions and credit spreads.

Appendix

Proof of Proposition 1

The real log pricing kernel is given by

$$m_{t+1} = \beta - \gamma \Delta x_{t+1} + \Delta q_{t+1}. \quad (53)$$

Hence,

$$m_{t+1} = \ln \beta - \gamma [(\rho_x - 1)x_t + \sigma_x \varepsilon_{t+1}^x] - \frac{1}{2}(\delta v_t \sigma_x)^2 - \delta v_t \sigma_x \varepsilon_{t+1}^x \quad (54)$$

$$= \ln \beta - \gamma(\rho_x - 1)x_t - \frac{1}{2}(\delta v_t \sigma_x)^2 - (\gamma \sigma_x + \delta v_t \sigma_x) \varepsilon_{t+1}^x. \quad (55)$$

The Taylor rule is given by (21). No-arbitrage and the Gaussian structure of shocks imply that inflation is given by

$$\pi_t = \kappa_0 + \kappa_x x_t + \kappa_v v_t + \kappa_s s_t, \quad (56)$$

where the κ coefficients are chosen such that (23) holds. From (24) it follows that

$$m_{t+1}^* = \ln \beta - \gamma(x_{t+1} - x_t) + \Delta q_{t+1} - \kappa_0 - \kappa_x x_{t+1} - \kappa_v v_{t+1} - \kappa_s s_{t+1} \quad (57)$$

$$= \ln \beta - [(\gamma + \kappa_x)\rho_x - \gamma]x_t - (\gamma + \kappa_x)\sigma_x \varepsilon_{t+1}^x - \frac{1}{2}(\delta v_t \sigma_x)^2 - \delta v_t \sigma_x \varepsilon_{t+1}^x - \kappa_0 - \kappa_v v_{t+1} - \kappa_s s_{t+1}. \quad (58)$$

Hence,

$$\mathbb{E}_t[m_{t+1}^*] = \ln \beta - [(\gamma + \kappa_x)\rho_x - \gamma]x_t - \frac{1}{2}(\delta v_t \sigma_x)^2 - \kappa_0 - \kappa_v \rho_v v_t - \kappa_s \rho_s s_t \quad (59)$$

$$\text{Var}_t(m_{t+1}^*) = (\gamma + \kappa_x)^2 \sigma_x^2 + (\delta v_t \sigma_x)^2 + 2(\gamma + \kappa_x)\sigma_x \delta v_t \sigma_x + \kappa_v^2 \sigma_v^2 + \kappa_s^2 \sigma_s^2, \quad (60)$$

where

$$\Sigma = (\gamma + \kappa_x)^2 \sigma_x^2 + \kappa_v^2 \sigma_v^2 + \kappa_s^2 \sigma_s^2. \quad (61)$$

Hence,

$$\begin{aligned}
-\mathbb{E}_t[m_{t+1}^*] - \frac{1}{2}\text{Var}_t(m_{t+1}^*) &= \kappa_0 - \ln \beta - \frac{1}{2}\Sigma + [(\gamma + \kappa_x)\rho_x - \gamma]x_t + \kappa_v\rho_v v_t + \kappa_s\rho_s s_t \\
&\quad - (\gamma + \kappa_x)\sigma_x^2 \delta v_t.
\end{aligned} \tag{62}$$

Substituting (56) into (21) gives

$$i_t = \tau_0 + \tau_\pi(\kappa_0 + \kappa_x x_t + \kappa_v v_t + \kappa_s s_t) + \tau_x x_t + s_t \tag{63}$$

$$= \tau_0 + \tau_\pi \kappa_0 + (\tau_\pi \kappa_x + \tau_x)x_t + \tau_\pi \kappa_v v_t + (\tau_\pi \kappa_s + 1)s_t \tag{64}$$

Comparing coefficients gives the following equations:

$$\tau_0 + \tau_\pi \kappa_0 = -\ln \beta + \kappa_0 - \frac{1}{2}\Sigma \tag{65}$$

$$\tau_\pi \kappa_x + \tau_x = (\gamma + \kappa_x)\rho_x - \gamma \tag{66}$$

$$\tau_\pi \kappa_v = \kappa_v \rho_v - (\gamma + \kappa_x)\sigma_x^2 \delta \tag{67}$$

$$\tau_\pi \kappa_s + 1 = \kappa_s \rho_s. \tag{68}$$

Solving the above equations gives (27) – (30).

Proof of Proposition 2

The real pricing kernel is given by

$$M_{t+1} = \beta \left(\frac{C_{t+1}}{C_t} \right)^{-\gamma} \frac{Q_{t+1}}{Q_t}. \tag{69}$$

Hence,

$$m_{t+1} = \ln M_{t+1} = \ln \beta - \gamma(c_{t+1} - c_t) + \Delta q_{t+1} \tag{70}$$

Market clearing implies $C = Y$, and so $c_{t+1} - c_t = y_{t+1} - y_t$, where y is to be determined. Thus,

$$m_{t+1} = \ln \beta - \gamma \Delta y_{t+1} - \frac{1}{2} (\delta v_t \sigma_x)^2 - \delta v_t \sigma_x \varepsilon_{t+1}^x \quad (71)$$

Suppose output and inflation are of the form of the form (43) and (??). Hence, (31) implies that

$$\kappa + \kappa_x x_t + \kappa_v v_t + \kappa_s s_t = \beta \kappa + \beta \rho_x \kappa_x x_t + \beta \rho_v \kappa_v v_t + \beta \rho_s \kappa_s s_t + \lambda [\psi + (\psi_x - 1)x_t + \psi_v v_t + \psi_s s_t]. \quad (72)$$

Comparing coefficients gives

$$\kappa = \beta \kappa + \lambda \psi \quad (73)$$

$$\kappa_x = \beta \rho_x \kappa_x + \lambda (\psi_x - 1) \quad (74)$$

$$\kappa_v = \beta \rho_v \kappa_v + \lambda \psi_v \quad (75)$$

$$\kappa_s = \beta \rho_s \kappa_s + \lambda \psi_s \quad (76)$$

Hence

$$\psi = \frac{1}{\lambda} \kappa (1 - \beta) \quad (77)$$

$$\psi_x = \frac{1}{\lambda} \kappa_x (1 - \beta \rho_x) + 1 \quad (78)$$

$$\psi_v = \frac{1}{\lambda} \kappa_v (1 - \beta \rho_v) \quad (79)$$

$$\psi_s = \frac{1}{\lambda} \kappa_s (1 - \beta \rho_s) \quad (80)$$

We rewrite the above solution as (44) – (47).

The nominal log pricing kernel is given by

$$m_{t+1}^* = m_{t+1} - \pi_{t+1} \quad (81)$$

$$= \ln \beta - \gamma(y_{t+1} - y_t) + \Delta q_{t+1} - \pi_{t+1} \quad (82)$$

$$= \ln \beta - \gamma[\psi_x(x_{t+1} - x_t) + \psi_v(v_{t+1} - v_t) + \psi_s(s_{t+1} - s_t)] + \Delta q_{t+1} \\ - (\kappa + \kappa_x x_{t+1} + \kappa_v v_{t+1} + \kappa_s s_{t+1}). \quad (83)$$

Therefore

$$E_t[m_{t+1}^*] + \frac{1}{2} \text{Var}_t[m_{t+1}^*] = \ln \beta - \kappa + \frac{1}{2} \bar{\Sigma} \quad (84) \\ + \{b_x \kappa_x + \gamma(1 - \rho_x)\} x_t \\ + b_s \kappa_s s_t \\ + \{b_v \kappa_v + (\gamma a_x + 1) \sigma_x^2 \delta \kappa_x + \gamma \sigma_x^2 \delta\} v_t,$$

where $\bar{\Sigma}$,

$$\bar{\Sigma} = (\gamma \psi_x + \kappa_x)^2 \sigma_x^2 + (\gamma \psi_v + \kappa_v)^2 \sigma_v^2 + (\gamma \psi_s + \kappa_s)^2 \sigma_s^2, \quad (85)$$

b_x , b_v , b_s are given by

$$b_x = [\gamma a_x (1 - \rho_x) - \rho_x] \quad (86)$$

$$b_s = [\gamma a_s (1 - \rho_s) - \rho_s] \quad (87)$$

$$b_v = [\gamma a_v (1 - \rho_v) - \rho_v], \quad (88)$$

and a , a_x , a_v , and a_s are given in (39) – (42). Wlog $k = 1$, and so

$$i_t = \tau_0 + \tau_\pi (\pi_t - \pi^*) + \tau_y (y_t - x_t) + s_t. \quad (89)$$

Substituting (43) and (??) into the above equation gives

$$\begin{aligned} i_t &= \tau_0 + \tau_\pi(\kappa + \kappa_x x_t + \kappa_v v_t + \kappa_s s_t - \pi^*) \\ &\quad + \tau_y[\psi + (\psi_x - 1)x_t + \psi_v v_t + \psi_s s_t] + s_t \end{aligned} \quad (90)$$

$$\begin{aligned} &= \tau_0 + \tau_\pi(\kappa - \pi^*) + \tau_y\psi + [\tau_\pi\kappa_x + \tau_y(\psi_x - 1)]x_t \\ &\quad + (\tau_\pi\kappa_v + \tau_y\psi_v)v_t \\ &\quad + (\tau_\pi\kappa_s + \tau_y\psi_s + 1)s_t \end{aligned} \quad (91)$$

From (23), we obtain

$$\begin{aligned} &\tau_0 + \tau_\pi(\kappa - \pi^*) + \tau_y\psi + [\tau_\pi\kappa_x + \tau_y(\psi_x - 1)]x_t \\ &\quad + (\tau_\pi\kappa_v + \tau_y\psi_v)v_t \\ &\quad + (\tau_\pi\kappa_s + \tau_y\psi_s + 1)s_t \end{aligned} \quad (92)$$

$$= -\ln\beta + \kappa - \frac{1}{2}\Sigma \quad (93)$$

$$\begin{aligned} &- \{b_x\kappa_x + \gamma(1 - \rho_x)\} x_t \\ &\quad - b_s\kappa_s s_t \\ &\quad - \{b_v\kappa_v + (\gamma a_x + 1)\sigma_x^2\delta\kappa_x + \gamma\sigma_x^2\delta\} v_t. \end{aligned} \quad (94)$$

Comparing coefficients gives

$$\tau_0 + \tau_\pi(\kappa - \pi^*) + \tau_y\psi = -\ln\beta + \kappa - \frac{1}{2}\bar{\Sigma} \quad (95)$$

$$\tau_\pi\kappa_x + \tau_y(\psi_x - 1) = -\{b_x\kappa_x + \gamma(1 - \rho_x)\} \quad (96)$$

$$\tau_\pi\kappa_s + \tau_y\psi_s + 1 = -b_s\kappa_s \quad (97)$$

$$\tau_\pi\kappa_v + \tau_y\psi_v = -\{b_v\kappa_v + (\gamma a_x + 1)\sigma_x^2\delta\kappa_x + \gamma\sigma_x^2\delta\}. \quad (98)$$

Using (44) – (47), we rewrite the above equations as

$$\tau_0 + \tau_\pi(\kappa - \pi^*) + \tau_y a \kappa = -\ln \beta + \kappa - \frac{1}{2} \bar{\Sigma} \quad (99)$$

$$\tau_\pi \kappa_x + \tau_y a_x \kappa_x = -\{b_x \kappa_x + \gamma(1 - \rho_x)\} \quad (100)$$

$$\tau_\pi \kappa_s + \tau_y a_s \kappa_s + 1 = -b_s \kappa_s \quad (101)$$

$$\tau_\pi \kappa_v + \tau_y a_v \kappa_v = -\{b_v \kappa_v + (\gamma a_x + 1) \sigma_x^2 \delta \kappa_x + \gamma \sigma_x^2 \delta\}. \quad (102)$$

To set $\pi^* = 0$, we need $\kappa = 0$, and so $\psi = 0$. The above equations then reduce to

$$\tau_0 + \tau_\pi \kappa + \tau_y a \kappa = -\ln \beta + \kappa - \frac{1}{2} \bar{\Sigma} \quad (103)$$

$$\tau_\pi \kappa_x + \tau_y a_x \kappa_x = -\{b_x \kappa_x + \gamma(1 - \rho_x)\} \quad (104)$$

$$\tau_\pi \kappa_s + \tau_y a_s \kappa_s + 1 = -b_s \kappa_s \quad (105)$$

$$\tau_\pi \kappa_v + \tau_y a_v \kappa_v = -\{b_v \kappa_v + (\gamma a_x + 1) \sigma_x^2 \delta \kappa_x + \gamma \sigma_x^2 \delta\}. \quad (106)$$

Solving the above equations gives (49) – (52).

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Table 1: Quarterly Calibration

| Parameter | Value |
|--|-------|
| Time discount rate, β | 0.99 |
| Risk aversion, γ | 10.00 |
| Project size, k | 1.00 |
| Corporate tax rate, η | 0.10 |
| Equity issuance costs, λ | 0.05 |
| Loss rate in default, ϕ | 0.20 |
| Aggregate shock volatility, σ_x (%) | 0.75 |
| Aggregate shock persistence, ρ_x | 0.90 |
| Idiosyncratic shock volatility, σ_z (%) | 15.00 |
| Idiosyncratic shock persistence, ρ_z | 0.95 |
| Exogenous firm exit rate, φ (%) | 0.10 |
| Monetary policy shock volatility, σ_s (%) | 0.50 |
| Monetary policy shock persistence, ρ_s | 0.90 |

Table 2: Calibrated Annual Moments of Flexible Price Model

| Moment | Data | Passive Policy | Active Policy |
|---|-------|----------------|---------------|
| Taylor rule on inflation, τ_π | | 0 | 1.50 |
| Taylor rule on output gap, τ_y | | 0 | 0.12 |
| Inflation rule coefficient on output, κ_x | | 1.11 | -1.87 |
| Inflation rule coefficient on monetary policy shock, κ_s | | 1.11 | -1.67 |
| Average real risk-free rate (%) | | 2.89 | 2.89 |
| Real risk-free rate volatility (%) | | 3.43 | 3.43 |
| Average nominal risk-free rate (%) | 4.92 | 2.61 | 3.26 |
| Nom. risk-free rate volatility (%) | 1.44 | 2.30 | 9.86 |
| Average inflation rate (%) | 3.36 | -0.01 | 0.01 |
| Inflation rate volatility (%) | 1.10 | 4.60 | 7.50 |
| Correlation between nom. rf and inflation | 71.82 | 55.77 | 98.40 |
| Correlation between nom. rf and output | 18.68 | 0.22 | -93.68 |
| Correlation between inflation and output | 14.57 | 83.12 | -85.95 |
| Taylor rule regression coeff. on inflation | 1.57 | 0.90 | 0.90 |
| Taylor rule regression coeff. on output | 0.35 | -1.00 | -1.00 |

Table 3: Calibrated Annual Moments of Sticky Price Model

| Moment | Data | Passive Policy | Active Policy |
|---|-------|----------------|---------------|
| Taylor rule on inflation, τ_π | | 0 | 1.50 |
| Taylor rule on output gap, τ_y | | 0 | 0.12 |
| Inflation rule coefficient on output, κ_x | | 1.46 | -1.19 |
| Inflation rule coefficient on monetary policy shock, κ_s | | 1.46 | -1.19 |
| Real output coefficient on output, ψ_x | | 1.32 | 0.74 |
| Rule output coefficient on monetary policy shock, ψ_s | | 0.32 | -0.26 |
| Average real risk-free rate (%) | | 2.02 | 3.38 |
| Real risk-free rate volatility (%) | | 4.59 | 2.62 |
| Average nominal risk-free rate (%) | 4.92 | 1.54 | 3.49 |
| Nom. risk-free rate volatility (%) | 1.44 | 2.29 | 6.51 |
| Average inflation rate (%) | 3.36 | 0.04 | -0.03 |
| Inflation rate volatility (%) | 1.10 | 6.05 | 4.91 |
| Correlation between nom. rf and inflation | 71.82 | 55.69 | 95.63 |
| Correlation between nom. rf and output gap | 18.68 | 16.17 | -87.00 |
| Correlation between inflation and output gap | 14.57 | 90.97 | -68.77 |
| Taylor rule regression coeff. on inflation | 1.57 | 0.21 | 1.27 |
| Taylor rule regression coeff. on output gap | 0.35 | 0.00 | 0.00 |

Table 4: Annual Financial Moments of Flexible Price Model

For this table, we simulate 100 economies, each containing 1000 firms for 100 years. We report cross-simulation average.

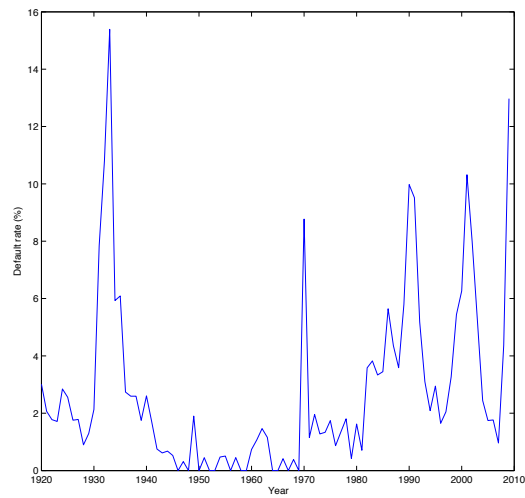
| Moment | Passive Policy | Active Policy |
|-----------------------------------|----------------|---------------|
| Average real market return (%) | 8.81 | 5.73 |
| 25-% percentile | 7.03 | 5.37 |
| 75-% percentile | 10.30 | 6.52 |
| Real market return volatility (%) | 26.10 | 12.38 |
| 25-% percentile | 20.56 | 10.52 |
| 75-% percentile | 30.79 | 12.87 |
| Average default rate (%) | 0.90 | 0.72 |
| 25-% percentile | 0.37 | 0.36 |
| 75-% percentile | 1.47 | 0.55 |
| Average credit spread (b.p.) | 102.48 | 94.92 |
| 25-% percentile | 75.60 | 75.84 |
| 75-% percentile | 125.32 | 111.12 |
| Credit spread volatility (b.p.) | 15.80 | 18.45 |
| 25-% percentile | 6.80 | 13.52 |
| 75-% percentile | 25.14 | 22.94 |
| Average market leverage (%) | 39.66 | 25.97 |
| 25-% percentile | 28.06 | 15.33 |
| 75-% percentile | 50.09 | 36.97 |

Table 5: Annual Financial Moments of the Sticky Price Model

For this table, we simulate 100 economies, each containing 1000 firms for 100 years. We report cross-simulation average.

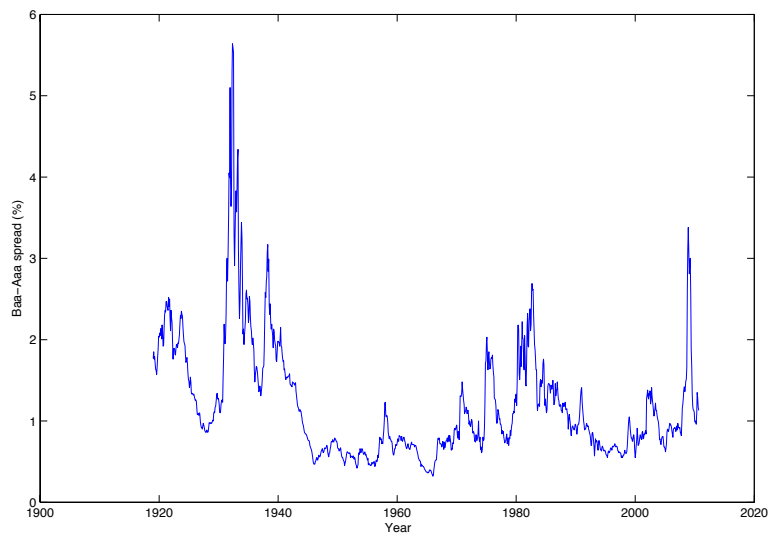
| Moment | Passive Policy | Active Policy |
|-----------------------------------|----------------|---------------|
| Average real market return (%) | 8.40 | 5.68 |
| 25-% percentile | 7.42 | 5.05 |
| 75-% percentile | 8.70 | 6.38 |
| Real market return volatility (%) | 26.83 | 10.59 |
| 25-% percentile | 22.82 | 8.79 |
| 75-% percentile | 28.85 | 12.70 |
| Average default rate (%) | 0.73 | 0.70 |
| 25-% percentile | 0.37 | 0.36 |
| 75-% percentile | 0.54 | 0.61 |
| Average credit spread (b.p.) | 85.67 | 95.23 |
| 25-% percentile | 64.78 | 76.74 |
| 75-% percentile | 104.90 | 113.20 |
| Credit spread volatility (b.p.) | 12.17 | 12.88 |
| 25-% percentile | 5.10 | 8.94 |
| 75-% percentile | 14.29 | 16.89 |
| Average market leverage (%) | 23.60 | 33.15 |
| 25-% percentile | 13.47 | 21.75 |
| 75-% percentile | 32.68 | 43.83 |

Figure 1: Global Speculative Grade Default Rates, 1920-2009



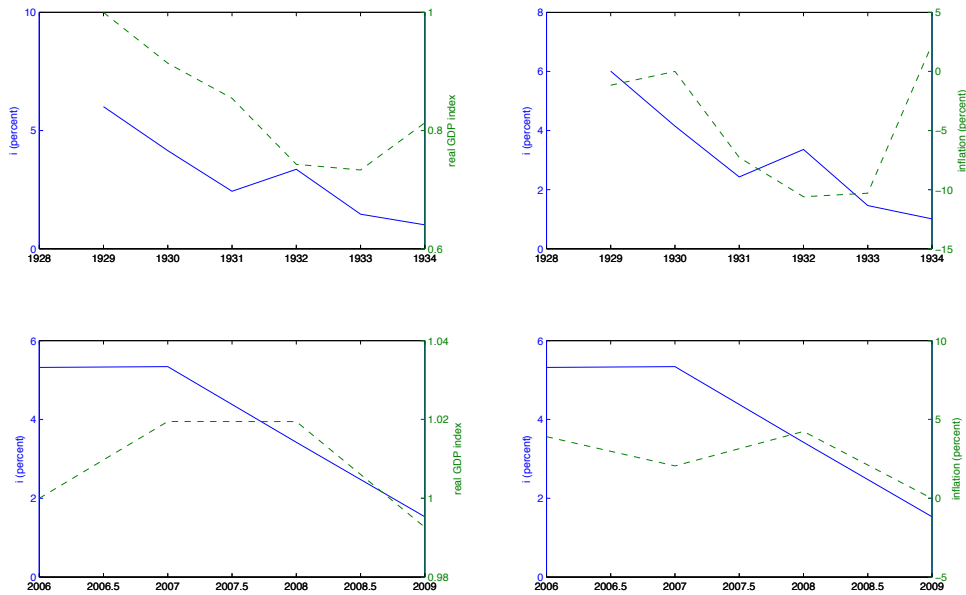
The figure shows the percentage annual global default rate for speculative grade debt from 1920 till 2009. This figure is produced using the same data as Exhibit 5 in Emery et al. (2009).

Figure 2: Baa-Aaa Credit Spread, 1919-2009



The figure shows the spread (in annualized percentage units) between Baa and Aaa Moody's rated debt from 1919 till 2010.

Figure 3: Nominal Interest Rates, Inflation and GDP, 1929-1934 v 2006-2009



The upper panels show the nominal risk-free rate in units of percent p.a. (solid line), together with real GDP (with real GDP in 1929 set to 1) and CPI inflation (in units of percent p.a.) during the period 1929-1934. The lower panels show the same quantities (with real GDP in 2006 set to 1). Data on the nominal risk-free rate and CPI inflation is from Robert Shiller's website and real GDP data is from the Bureau of Economic Analysis.

Caption for Figures 4-7:

The top figure shows the optimal default boundary z_d for a given initial state as a function of the aggregate state x . The second figure shows the optimal nominal coupon b/k as a function of the idiosyncratic state z . The third figure shows leverage for a given initial state as a function of the idiosyncratic state z . The last figure depicts credit spreads for a given initial state as a function of the idiosyncratic state z . In the left panels, we vary the aggregate state by one standard deviation above (dashed red line) and below (solid blue line) the mean, holding everything else constant. Similarly, for the right panels we change the monetary policy shock.

Figure 4: Optimal Financial Policies in the Flexible Price Model under a Passive Monetary Policy

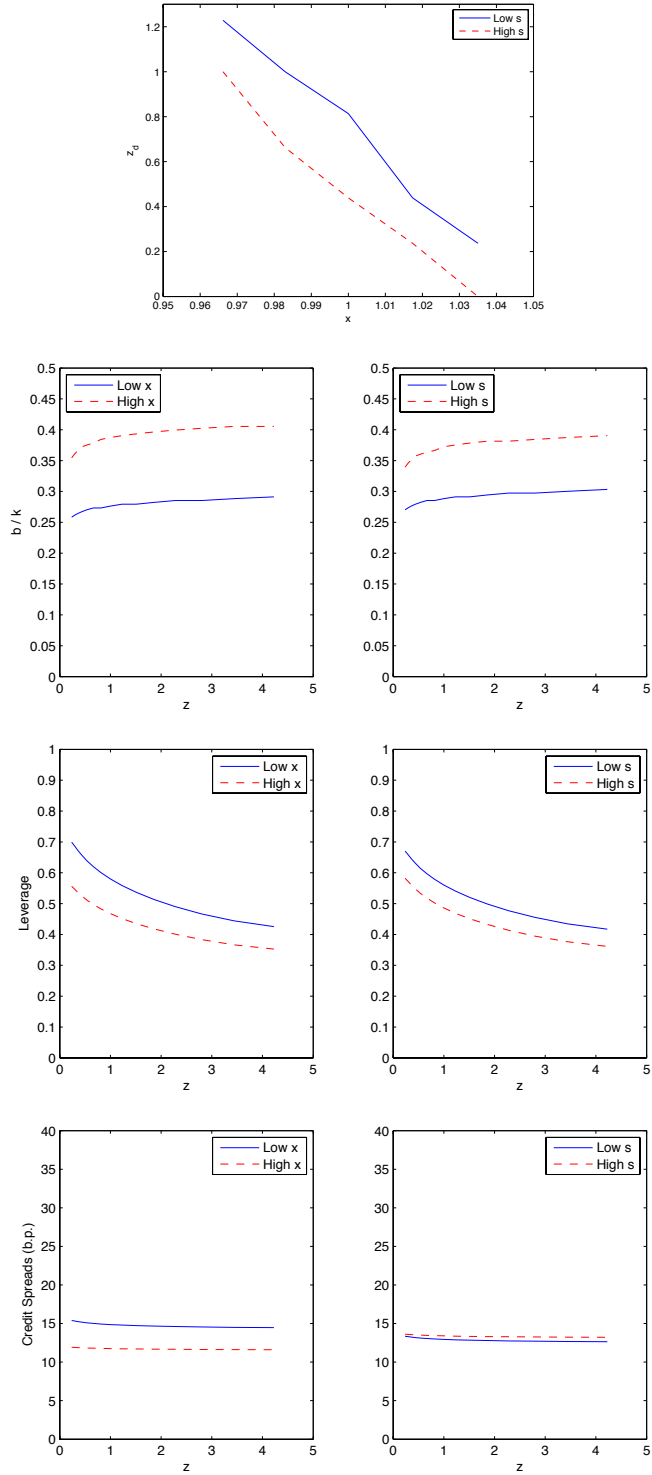


Figure 5: Optimal Financial Policies in the Flexible Price Model under an Active Monetary Policy

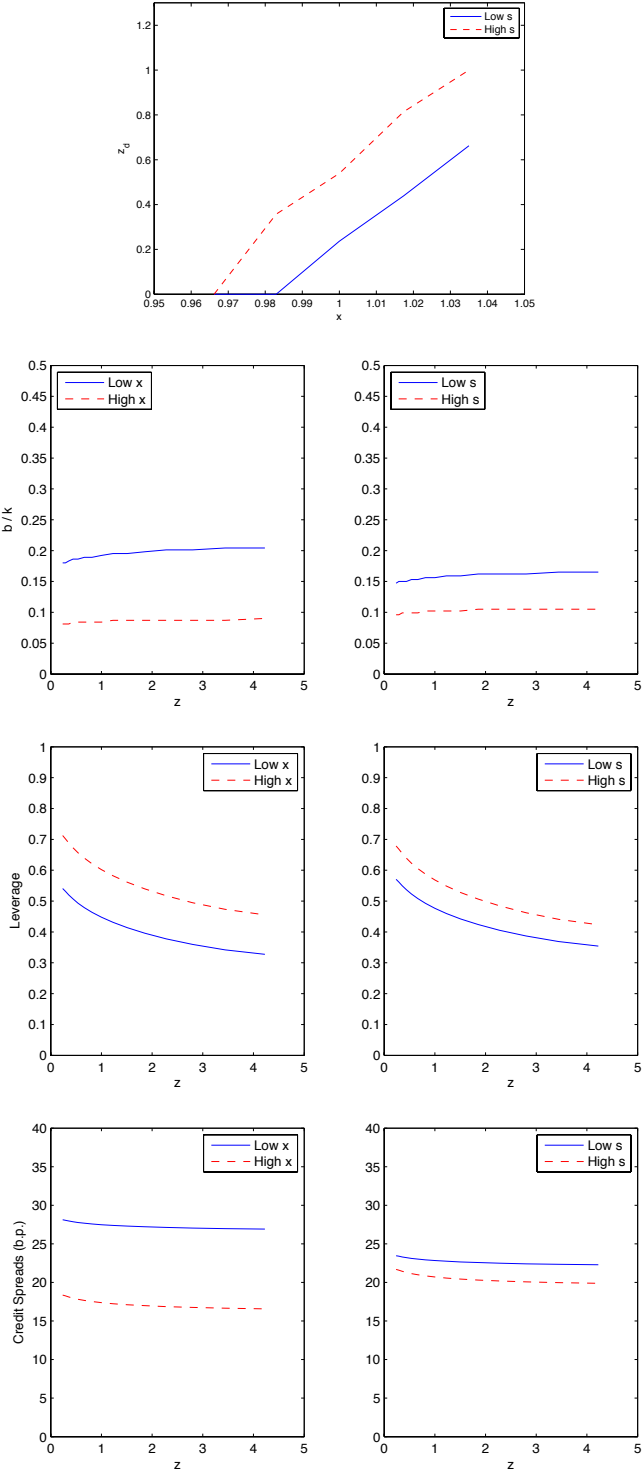


Figure 6: Optimal Financial Policies in the Sticky Price Model under a Passive Monetary Policy

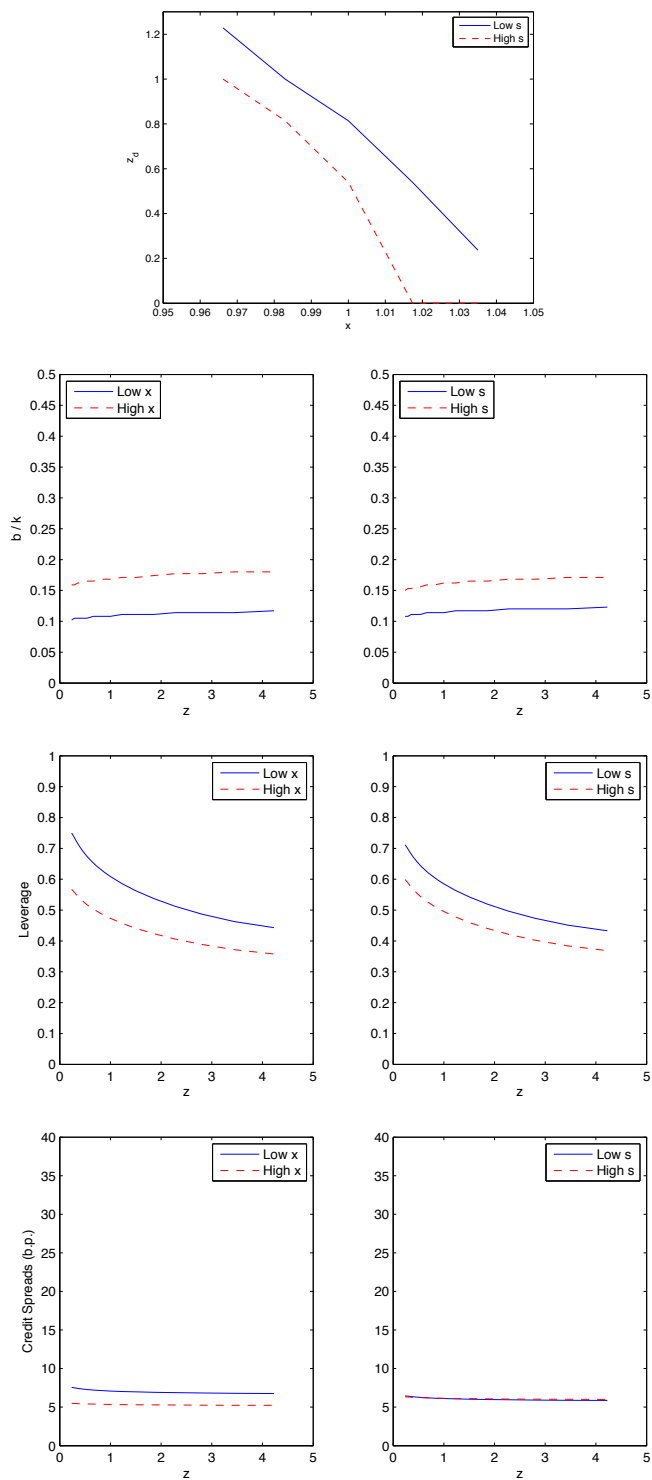


Figure 7: Optimal Financial Policies in the Sticky Price Model under an Active Monetary Policy

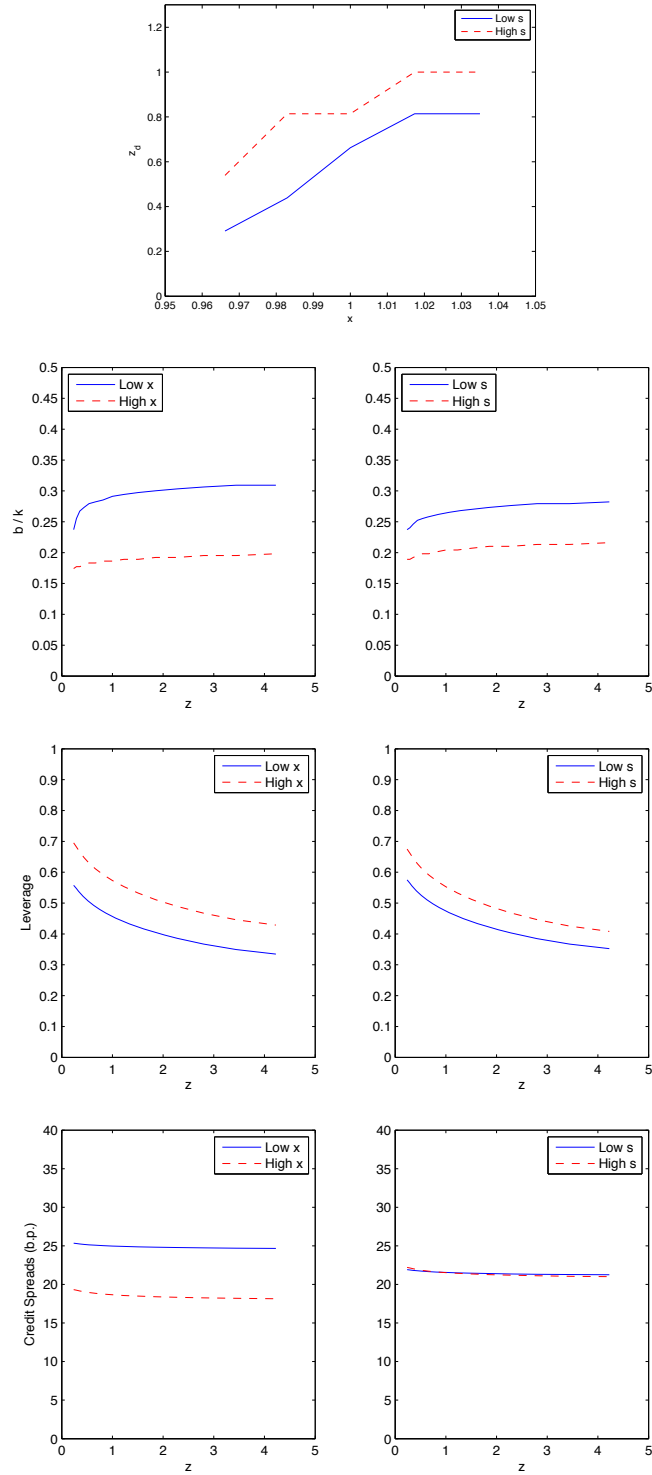


Figure 8: Recession Scenario

