Monetary Policy Rules and the Equity Premium[a]

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Abstract

We study the effect of different monetary policy rules on the equity premium using a segmented stock market model. The optimal monetary policy in our model turns out to be risk-sharing and countercyclical after financial markets' shocks. Under that policy the risky asset is not that risky, and the return on equity is low. The optimal policy, however, does not guarantee inflation stability and produces high return for nominal bonds. On the other hand, under inflation targeting policies there is no insurance against financial income risk, the monetary policy is cyclical and the equity return is high. At the same time, inflation targeting guarantees inflation stability making the nominal bond an attractive asset. Our model suggests that monetary policy objectives play a key role in affecting risk sharing and determining the equity premium.

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1 Introduction

The impact of monetary policy on financial markets is profound, for it is transmitted in the economy via the financial system. We present a model that studies how different monetary policy objectives influence the equity premium after financial shocks. In particular, we use a segmented financial markets model to study the equity premium produced by optimal monetary policy, and by other commonly used monetary policy rules, like inflation targeting. We find that the equity premium is highly affected by the monetary policy objective, an aspect that the literature has not studied before. We present analytical results and we perform a quantitative exercise to support our argument.

In our model, optimal monetary policy has risk sharing considerations, redistributing financial risk that the financial market's participants face to all agents in the economy. Through its distributional consideration, optimal monetary policy implies low risk and thus low return on the risky asset compared to the inflation targeting policy. Optimal policy however does not imply price stability, and thus leads to a higher real return for the short term nominal bond compared to inflation targeting. As a result, the equity premium produced under the optimal monetary policy resembles that produced by the representative agent model, which previous literature has found to be small.[1] This is in contrast to an inflation targeting policy which implies high equity returns, as it does not share risk, but implies low bond returns, as it stabilizes inflation. The result is a high equity premium under the inflation targeting policy and a low equity premium under the optimal policy. In our quantitative exercise we find a 1.55% equity premium under the optimal policy, and a 6.96% premium under the inflation targeting policy, i.e., almost four and a half times higher.

Financial market segmentation, which is an important ingredient of our model, has been documented (Mankiw and Zeldes, 1991; Guiso et al., 2002; Vissing-Jørgensen, 2002) and used before for the study of the equity premium. Specifically, it is used often for differentiating preference parameters, i.e., risk aversion and elasticity of intertemporal substitution, between the financial market participants and non-participants, or emphasizing their differ-

[1] This point was emphasized by Shiller (1982) and Mehra and Prescott (1985). Since then, various approaches have been followed for resolving the equity premium puzzle (for a survey see Kocherlakota, 1996.)

ences in wealth holdings (Vissing-Jørgensen, 2002; Brav et al., 2002; Guvenen, 2009; Dong, 2012). Our model however, uses the feature of financial markets segmentation in order to differentiate agents regarding their connectivity to monetary policy, and emphasize that monetary policy has real effects through distributional considerations (as in Grossman and Weiss, 1983; Rotemberg, 1984; Lucas, 1990; Fuerst, 1992; Alvarez et al., 2001; Williamson, 2005; Williamson, 2006, Zervou, 2013; Alvarez and Lippi, 2014; Azariadis et al., 2015). This is to capture that monetary policy affects directly the financial market participants, who are at the receiving end of monetary policy actions, although the non-participants are affected only indirectly, through inflation. This class of models implies that a monetary policy expansion increases the consumption of financial markets participants but hurts non-participants. On the contrary, a monetary policy tightening decreases the consumption of financial market participants but benefits non-participants.

Zervou (2013) offers a policy prescription within the segmented markets monetary model, through the study of welfare maximizing, optimal monetary policy on the offset of financial shocks. Azariadis et al. (2015) use a related model and explore optimal policy at the zero lower bound. The current paper studies the asset pricing and premia implications of the optimal policy, versus other, well-known monetary policy rules such as constant money supply, inflation targeting, and a rule that suggests that monetary policy does not intervene in agent's endowment allocations. All these different policies produce different equity premia, with the optimal one implying the least premium, and the inflation targeting one implying the highest premium.

Previous literature (Gust and Lopez-Salido, 2010; Drechsler et al., 2014) has studied the effect of monetary policy actions, i.e., expansion or tightening, in affecting the equity premium. Our work differs from this literature because it emphasizes the importance of monetary policy's objective, i.e., the policy rule followed, in affecting the equity premium. In that aspect, our work relates to that of Benigno and Paciello (2014), that uses a New Keynesian model to find that the optimal policy is more expansionary than the inflation targeting one in response to productivity shocks. The more cyclical policy produces higher premium, similarly to our results. However, in our model, cyclical policy is the inflation targeting policy although the optimal policy is countercyclical and minimizes the equity premium. The different results that optimal policy implies stem from the fact that the two models emphasize different frictions; Benigno and Paciello (2014) use a standard New Keynesian model although we use a segmented markets monetary model. We aim to contribute to the literature by providing an alternative perspective on how monetary policy can affect asset prices and how it can do so optimally, through redistribution and risk-sharing. Lastly, Kim and Moon (2009) use a segmented market monetary model to study asset pricing as well, and successfully match many asset pricing facts; however, contrary to our work, they do not explore the effect of possible monetary policy objectives.

The rest of the paper is organized as follows. Section 2 introduces the model economy. Section 3 derives the equity premium as a function of monetary autority's considerations. Section 4 introduces a quantitative exercise in order to quantitatively study the equity premium produced by the optimal and the 2% inflation targeting monetary policy rules. Section 5 concludes.

2 The Model Economy

We consider an infinite horizon economy in discrete time, populated by a continuum of households that are categorized into two types. A fraction $\lambda \in (0,1)$ of the population participates in the bond and stock markets; these are the traders (T). A fraction $1-\lambda$ of the population consists of agents who do not participate in financial markets and are called non-traders (N). All households have identical preferences and maximize:

$$\mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t u(c_t^i),$$

where $\beta \in (0,1)$ is the discount factor and $c_t^i \geq 0$ is consumption at time t by consumer of type $i \in \{T, N\}$. We assume that $u'(\cdot) > 0$ and $u''(\cdot) < 0$.

Each agent $i \in \{T, N\}$ begins period t with money holdings m_t^i. Agents of type T, i.e., traders, start period t holding also one period bonds b_t, and stock z_t. In addition, they receive monetary transfer τ_t from the monetary authority.[2] Also, at this point, traders

[2] Monetary transfers are directed only to the traders, as it is usually assumed in the segmented markets literature with monetary policy (see for example Alvarez et al., 2001 and Zervou, 2013). This assumption intends to capture the fact that open market operations affect directly financial markets and their par-

realize the real total dividend ε_t, à la Lucas (1978), which is random and is described by:

$$\varepsilon_t = \bar{\varepsilon} + \eta_t, \tag{1}$$

where $\bar{\varepsilon} > 0$ denotes the mean dividend and $\eta_t \in [-\bar{\varepsilon}, \infty)$ is an *iid* shock with mean zero and variance σ_ε^2.

In each time period $t = 0, \ldots, \infty$, financial markets open before the goods market does. We assume that households hold cash because they are subject to cash-in-advance constraints. The cash-in-advance constraints for traders and non-traders are as follows:

$$m_t^T + q_t z_t + b_t + \tau_t \geq p_t c_t^T + q_t z_{t+1} + s_t b_{t+1}, \tag{2}$$

$$m_t^N \geq p_t c_t^N. \tag{3}$$

Here, p_t, q_t and s_t respectively, denote the goods, stock and bond price at time t.

In addition, the traders receive real constant endowment y^T and their part of the real total dividend ε_t; the non-traders receive real constant endowment y^N. Agents, given the cash-in-advance constraints, cannot consume their non-storable endowment and dividends; they sell them in the goods market and hold the cash received for starting the next period. The budget constraints for traders and non-traders are as follows:

$$m_t^T + q_t z_t + b_t + \tau_t + p_t z_{t+1} \varepsilon_t + p_t y^T \geq m_{t+1}^T + p_t c_t^T + q_t z_{t+1} + s_t b_{t+1}, \tag{4}$$

$$m_t^N + p_t y^N \geq m_{t+1}^N + p_t c_t^N. \tag{5}$$

The maximization problem of each household is subject to the cash-in-advance and budget constraints, i.e., constraints (2) and (4) for the traders, and (3) and (5) for the non-traders. For positive bond returns the cash-in-advance constraint for traders binds. We assume it also binds for non-traders. The budget constraints bind as usual. Then:

$$p_t z_{t+1} \varepsilon_t + p_t y^T = m_{t+1}^T, \tag{6}$$

ticipants; non-participants are only affected indirectly, through inflation. This is the channel that makes monetary policy non-neutral in the model.

for traders, and

$$p_t y^N = m_{t+1}^N, \tag{7}$$

for non-traders. Solving the traders' maximization problem, we get the intertemporal optimality conditions, which describe the pricing of nominal bonds and stock. Solving for the real bond and stock price, $\hat{s}_t \equiv \frac{s_t}{p_t}$ and $\hat{q}_t \equiv \frac{q_t}{p_t}$ respectively, the pricing equations imply:

$$\hat{s}_t = \beta \mathrm{E}_t \frac{u'(c_{t+1}^T)}{u'(c_t^T)} \frac{1}{p_{t+1}}, \tag{8}$$

$$\hat{q}_t = \beta \mathrm{E}_t \frac{u'(c_{t+1}^T)}{u'(c_t^T)} \left(\hat{q}_{t+1} + \frac{p_t \varepsilon_t}{p_{t+1}} \right). \tag{9}$$

We now specify monetary policy and its budget constraint. Each trader receives money transfer τ_t from the monetary authority. The total money supply $\bar{M}_t$ in period t is:

$$\bar{M}_t = \lambda \tau_t + \bar{M}_{t-1} \quad \text{or equivalently,} \quad \bar{M}_t = \bar{M}_{t-1}(1 + \mu_t), \tag{10}$$

where, $\mu_t \in [-1, \infty)$ denotes the money growth rate from time $t-1$ to time t. Negative μ_t implies that the monetary authority tightens and receives a lump-sum tax from the traders.

The model's equilibrium is similar to Zervou (2013) which we present at the Appendix A.1. The solution includes the quantity equation for determining goods price, equilibrium consumption for non-traders, and for traders, respectively:

$$p_t = \frac{\bar{M}_t}{\bar{y} + \varepsilon_t - \bar{\varepsilon}}, \tag{11}$$

$$c_t^N = \frac{p_{t-1}}{p_t} \bar{y} = \frac{\bar{y} + \varepsilon_t - \bar{\varepsilon}}{\bar{y} + \varepsilon_{t-1} - \bar{\varepsilon}} \frac{\bar{y}}{1 + \mu_t}, \tag{12}$$

$$c_t^T = \frac{\bar{y} + \varepsilon_t - \bar{\varepsilon}}{\lambda} \frac{(\varepsilon_{t-1} - \bar{\varepsilon})(1 + \mu_t) + \bar{y}(\lambda + \mu_t)}{(\bar{y} + \varepsilon_{t-1} - \bar{\varepsilon})(1 + \mu_t)}. \tag{13}$$

From equations (12) and (13) we see the distributional effects that monetary policy has in our segmented financial markets model. Specifically, monetary authorities find the financial market participants at the receiving end of their actions. After a monetary expansion cash is directed to traders increasing their consumption. Higher inflation is generated, hurting however the non-traders. On the contrary, tight monetary policy decreases traders' liquidity and consumption, with lower inflation benefiting the non-traders. These distributional effects give rise to short-run monetary non-neutrality in the model.

3 The Equity Premium

Defining the gross real interest rate as $\hat{r}_{t+1} \equiv \frac{\frac{1}{p_{t+1}}}{\hat{s}_t}$ and the gross real return of the risky asset as $\hat{R}_{t+1} \equiv \frac{\hat{q}_{t+1}+\frac{p_t \varepsilon_t}{p_{t+1}}}{\hat{q}_t}$, and substituting in the real bond and stock pricing equations (8) and (9), respectively, we have:[3]

$$\begin{aligned} \mathrm{E}_t u^{'}(c_{t+1}^T)\hat{r}_{t+1} &= u^{'}(c_t^T), \\ \beta \mathrm{E}_t u^{'}(c_{t+1}^T)\hat{R}_{t+1} &= u^{'}(c_t^T). \end{aligned} \tag{14}$$

The expression for the stock price, given by equation (9), can be rewritten replacing the value of $\hat{q}_{t+1}$ recursively, as follows:

$$u^{'}(c_t^T)\hat{q}_t = \sum_{j=1}^{\infty} \mathrm{E}_t \beta^j \frac{u^{'}(c_{t+j}^T)}{p_{t+j}} p_{t+j-1}\varepsilon_{t+j-1}. \tag{15}$$

The real expected equity premium is defined as $\mathrm{E}_t\hat{\Pi}_{t+1} \equiv \mathrm{E}_t(\hat{R}_{t+1} - \hat{r}_{t+1})$ $= \mathrm{E}_t \left[\frac{p_t}{p_{t+1}}(R_{t+1} - r_{t+1})\right] = \mathrm{E}_t \frac{p_t}{p_{t+1}} \Pi_{t+1}$, where Π_{t+1} is the nominal equity premium. Here, the operator $\mathrm{E}_t(.)$ denotes the conditional expectation based on the realized information until time t, when the shocks of the current period are already known.

By noting that for any random variable x, y, it is true that $\mathrm{E}_t xy = \mathrm{E}_t x \mathrm{E}_t y + \mathrm{Cov}_t(x, y)$, where $\mathrm{Cov}_t(.)$ is the conditional covariance, and applying this formula to equation (14) we can compute the real equity premium as:

$$\mathrm{E}_t\hat{\Pi}_{t+1} = -\frac{\mathrm{Cov}_t\left(u^{'}(c_{t+1}^T), \hat{R}_{t+1}\right)}{\mathrm{E}_t u^{'}(c_{t+1}^T)} + \frac{\mathrm{Cov}_t\left(u^{'}(c_{t+1}^T), \hat{r}_{t+1}\right)}{\mathrm{E}_t u^{'}(c_{t+1}^T)}. \tag{16}$$

As usual (see for example Mehra and Prescott, 1985), the equation above reveals that the expected equity premium depends on the covariance of the asset returns with the marginal

[3] Because of the cash-in-advance timing, dividend ε_t becomes known and is sold in the goods market at period t, but is used for consumption at period $t+1$. Then, the relevant dividend amount for calculating expected returns is ε_t.

utility of consumption. Note that in our model, given the cash-in-advance constraint, inflation affects the value of real dividend as today's real dividends are sold and consumed a period after. Also note that traders have access to a regular nominal bond and not an indexed bond, so the second term of equation (16) is also relevant. Our analysis relates to the inflation premium (for a discussion about the inflation premium see Labadie, 1989). We follow this approach in order to show that monetary policy affects the real equity premium beyond the inflation premium.

We rewrite equation (16) of the real equity premium, in an alternative representation which is useful for our later calculations. This is the following:

$$\mathrm{E}_t\hat{\Pi}_{t+1} = -\frac{\mathrm{Cov}_t(u^{'}(c^T_{t+1}), \hat{q}_{t+1})}{\hat{q}_t \mathrm{E}_t u^{'}(c^T_{t+1})} + \frac{\mathrm{Cov}_t\left(u^{'}(c^T_{t+1}), \frac{1}{p_{t+1}}\right)}{\mathrm{E}_t u^{'}(c^T_{t+1})} \frac{\mathrm{E}_t u'(c^T_{t+1})\hat{q}_{t+1}}{\hat{q}_t \mathrm{E}_t \frac{u'(c^T_{t+1})}{p_{t+1}}}. \tag{17}$$

An increase in real stock price increases traders' consumption because of the income effect, causing $\mathrm{Cov}_t(u^{'}(c^T_{t+1}), \hat{q}_{t+1})$ to be negative. Accordingly, the first term of the right hand side of equation (17) is positive. Moreover, an increase in the goods price level, as a result of the substitution effect, decreases consumption, makes $\mathrm{Cov}_t(u^{'}(c^T_{t+1}), \frac{1}{p_{t+1}})$ negative, and causes the second part of the right hand side of equation (17) to be negative. Therefore, the value of the equity premium depends on the the correlation of stock prices and good prices and on the relative magnitude of the substitution and income effects. How monetary policy reacts to shocks affects the correlation of stock prices and goods prices, as well as the magnitude of the substitution and income effects. For example, if there is a financial shock that increases the stock price and monetary policy reacts by increasing the price level, then both terms in equation (17) are active and the equity premium is low. If however the monetary policy objective is price stability, then the first term of equation (17) is stronger and the equity premium is larger. We provide analytical results of those effects in the next section.

3.1 Equity Premium and Monetary Policy Considerations

In order to compute analytically the equity premium and understand the effects of monetary policy considerations, we use the logarithmic utility function, $u(c^i_t) = ln(c^i_t)$, for $i = T$, N.

We have derived analytical results for a constant relative risk aversion (CRRA) utility representation which are available in the Appendix A.3.[4] From equation (15) we calculate the real stock price, $\widehat{q}_t \equiv \frac{q_t}{p_t}$, as follows:

$$\hat{q}_t = \sum_{j=1}^{\infty} \mathrm{E}_t \beta^j \frac{c_t^T}{c_{t+j}^T} \frac{p_{t+j-1}}{p_{t+j}} \varepsilon_{t+j-1}, \tag{18}$$

or,

$$\hat{q}_t = \mathrm{E}_t \sum_{j=1}^{\infty} \beta^j \frac{\tilde{c}_t^T}{\tilde{c}_{t+j}^T} \frac{y_t}{y_{t+j}} \frac{1}{1+\pi_{t+j}} \varepsilon_{t+j-1},$$

where $\tilde{c}_t^T = \frac{c_t^T}{y_t}$ and $1 + \pi_t$ is the inflation rate in period t.

The real stock price depends on the stochastic discount factor and the payoff.[5] In our model, with limited stock market participation, the stochastic discount factor changes because of two reasons: First, it changes because of changes in the fraction of total consumption consumed by traders, i.e., the segmentation effect $(\frac{\tilde{c}_t^T}{\tilde{c}_{t+j}^T})$. In addition, it changes because of changes in aggregate consumption, i.e., the typical representative agent effect $(\frac{y_t}{y_{t+j}})$. For $\lambda = 1$, then all agents participate in financial markets, $c_t^T = y_t$ for each t, and the segmentation effect disappears. However, for For $\lambda < 1$ the segmentation effect is present.

We now compare the equity premium produced by various policy rules; specifically, we consider constant money supply, optimal, inflation targeting, and a policy that forces agents to consume their endowments. The main point of this exercise is to show that depending on the monetary policy rule considered, the equity premium is a different function of the dividend and the dividend volatility.

3.1.1 Constant Money Supply Policy

We start with the zero money growth policy, which we obtain by setting $\mu_t = 0$ for every period t. Then, using the expression for money supply (10), the quantity equation (11) and

[4]For the CRRA representation the analytical expressions are more complicated, but our main results concerning the effects of monetary policy consideration remain the same. The quantitative analysis is based on CRRA preferences.

[5]The payoff $\frac{1}{1+\pi_{t+j}}\varepsilon_{t+j-1}$ depends on the stream of dividends and on inflation. Inflation affects the real payoff because the dividends are received and sold in the current period, but they are used to buy consumption good a period after. Thus, an increase in inflation rate decreases the real value of the payoff.

the expression for traders' consumption (13), and substituting them in the real stock price equation (18) we have:

$$\widehat{q}_t^{\mu=0} = c_t^{T,\mu=0} \, \mathrm{E}_t \sum_{j=1}^{\infty} \beta^j \frac{\lambda \varepsilon_{t+j-1}}{\lambda \bar{y} + \varepsilon_{t+j-1} - \bar{\varepsilon}}. \tag{19}$$

We are computing the real equity premium, after linearizing the expression of real stock price (19) around the mean total dividend, and substituting it, together with the relevant expressions for consumption and prices, into the equation for the real equity premium (17).

Remark 1. *The real equity premium for the constant money supply policy is:*

$$\mathrm{E}_t \hat{\Pi}_{t+1}^{\mu=0} \simeq \frac{\beta(\lambda \bar{y} + \varepsilon_t - \bar{\varepsilon})(\lambda \bar{y} - \bar{\varepsilon})\sigma_\varepsilon^2}{\widehat{q}_t^{\mu=0} \lambda^2 \bar{y}^2 (\bar{y} + \varepsilon_t - \bar{\varepsilon})}, \tag{20}$$

which is an increasing function of the risky dividends' volatility σ_ε^2*.*

3.1.2 Optimal Monetary Policy

In this section, we consider a monetary authority that maximizes total welfare by choosing the money supply growth rate μ_t, to solve $\max_{\mu_t} \mathrm{E}_0 \sum_{t=0}^{\infty} \beta^t (\lambda u(c_t^T) + (1-\lambda) u(c_t^N))$. For a monetary authority that assigns equal weight to each agent, the first order conditions combined with the equilibrium consumption equations (12) and (13) imply equalizing marginal utility of consumption across agents, which translates into perfect consumption smoothing across agents. The optimal money growth rule is:

$$1 + \mu_t^* = \frac{\bar{y}}{\bar{y} + \varepsilon_{t-1} - \bar{\varepsilon}}. \tag{21}$$

This policy rule, similarly to Zervou (2013), reveals a risk-sharing role of optimal monetary policy: adverse dividend shocks decrease traders' consumption and command expansionary monetary policy. The expansion increases traders' consumption who were hit by the shock but increases prices and hurts the non-traders. On the contrary, after a high dividend shock traders' consumption increases; in that case optimal monetary policy tightens, withdraws part of the extra dividend traders' received, and benefits non-traders through lower prices. In this way, monetary policy perfectly shares the financial income risk that only traders face, among all agents in the economy.[6]

Using the optimal monetary policy rule (21), money supply equation (10), quantity equation (11) and traders' consumption (13), and substituting them in the expression for real stock price (18), we have:

$$\widehat{q}_t^* = c_t^{T*}\,\mathrm{E}_t \sum_{j=1}^{\infty} \beta^j \frac{\varepsilon_{t+j-1}}{\bar{y}} = \frac{\beta c_t^{T*}}{\bar{y}} \left[\varepsilon_t + \frac{\beta\bar{\varepsilon}}{1-\beta}\right]. \tag{22}$$

When monetary policy operates optimally, the segmentation effect of the real stochastic discount factor disappears. This is because under the optimal monetary policy rule the dividend shock is shared among financial market participants and non-participants and there is no variation of the relative consumption of the traders. Every period, traders and non-traders consume an equal part of total output and the discount factor is only affected by the change in total consumption, similarly to the representative agent model.

We calculate the equity premium using the real stock price under optimal policy equation (22), and substituting it in the real equity premium equation (17), together with the relevant expressions for consumption and prices.

Remark 2. *The real equity premium for the optimal monetary policy rule is:*

$$\mathrm{E}_t\hat{\Pi}_{t+1}^* = \frac{\beta\sigma_\varepsilon^2}{\widehat{q}_t^*\bar{y}} = \frac{(1-\beta)\sigma_\varepsilon^2}{(\bar{y}+\varepsilon_t-\bar{\varepsilon})[(1-\beta)\varepsilon_t+\beta\bar{\varepsilon}]}. \tag{23}$$

3.1.3 Inflation Targeting Policy

We now consider an inflation targeting monetary policy rule. Given the inflation rate below:

$$\pi_{t+1} = \frac{p_{t+1}}{p_t} - 1 = \frac{(1+\mu_{t+1})(\bar{y}+\varepsilon_t-\bar{\varepsilon})}{\bar{y}+\varepsilon_{t+1}-\bar{\varepsilon}} - 1,$$

a monetary authority that sets inflation target $\pi_{t+1} = \bar{\pi}$, uses the following money growth rule:

$$1+\mu_{t+1}^{\bar{\pi}} = (\bar{\pi}+1)\frac{\bar{y}+\varepsilon_{t+1}-\bar{\varepsilon}}{\bar{y}+\varepsilon_t-\bar{\varepsilon}}. \tag{24}$$

[6]Note that any monetary policy rule would result in redistribution in this model. Optimal policy does redistribution in a welfare maximizing way.

Using the money supply equation (10), quantity equation (11), traders' consumption (13) and the inflation targeting monetary policy rule (24), and substituting them in the real stock price equation (18), we have:

$$\begin{aligned}\widehat{q}_t^{\bar{\pi}} &= \sum_{j=1}^{\infty} \mathrm{E}_t \beta^j \frac{[(\lambda-1)\bar{y} + (1+\bar{\pi})(\bar{y} + \varepsilon_t - \bar{\varepsilon})]\varepsilon_{t+j-1} f(\varepsilon_{t+j})}{(1+\bar{\pi})} \\ &= \frac{\beta A[(\lambda-1)\bar{y} + (1+\bar{\pi})(\bar{y} + \varepsilon_t - \bar{\varepsilon})]}{(1+\bar{\pi})} \left[\varepsilon_t + \frac{\beta\bar{\varepsilon}}{1-\beta}\right],\end{aligned} \tag{25}$$

which is a function of ε_t. Note that we have assumed that the series of dividends $\{\varepsilon_t\}_{t=0}^{\infty}$ is *i.i.d*, and we have defined $f(\varepsilon_{t+j}) = \frac{1}{(\lambda-1)\bar{y} + (1+\bar{\pi})(\bar{y} + \varepsilon_{t+j} - \bar{\varepsilon})}$. Then for all $j \geq 1$, we have that $\mathrm{E}_t(f(\varepsilon_{t+j})) = A$, which is a constant.

We use the above equation to calculate the real equity premium.

Remark 3. *The real equity premium under the inflation targeting monetary policy is:*

$$\mathrm{E}_t \hat{\Pi}_{t+1}^{\bar{\pi}} \simeq \frac{(\lambda+\bar{\pi})\bar{y}\bar{\varepsilon} + (1-\beta)(1+\bar{\pi})\sigma_\varepsilon^2 - \frac{\bar{\varepsilon}\bar{y}^3(\lambda+\bar{\pi})^3}{\bar{y}^2(\lambda+\bar{\pi})^2 + (1+\bar{\pi})^2\sigma_\varepsilon^2}}{[(\lambda-1)\bar{y} + (1+\bar{\pi})(\bar{y} + \varepsilon_t - \bar{\varepsilon})][(1-\beta)\varepsilon_t + \beta\bar{\varepsilon}]}. \tag{26}$$

3.1.4 Endowment Sustaining Monetary Policy

We are computing equity premium for the policy that does not intervene in agent's endowment allocations and thus does not redistribute resources across them. Under that policy, the non-traders consume always their endowment, and the traders consume their endowment and dividends. That is:

$$c_t^{N,E} = y^N, \quad c_t^{T,E} = y^T + \frac{\varepsilon_t}{\lambda}.$$

Using the equilibrium consumption equations for non-traders and traders, (12) and (13), and given that $y^T + \frac{\bar{\varepsilon}}{\lambda} = y^N$, we get that the policy that lets non-traders consume their endowments, and traders consume their endowment and dividends, is not surprisingly, the zero inflation targeting policy. This is because, through the cash-in-advance constraint, it is inflation what prevents agents from consuming their real earnings. If inflation is zero, then non-traders consume their whole real endowment and traders consume their whole real endowment and dividends, even if they need to wait a period to do so. Similarly with the inflation targeting monetary policy rule (24), we have that:

$$1 + \mu_{t+1}^{E} = \frac{\bar{y} + \varepsilon_{t+1} - \bar{\varepsilon}}{\bar{y} + \varepsilon_{t} - \bar{\varepsilon}}.$$

Then the equity premium is as calculated in equation (26), having inflation target of $\bar{\pi} = 0$.

Note that for constant non-traders' endowment, only inflation affects their consumption volatility. The zero inflation targeting policy smooths non-traders consumption over time. On the other hand, traders who are the ones hit by dividend shocks, are not allowed to smooth and have to sustain high consumption volatility under this policy.

3.2 Comparing Equity Premia

Comparing across the real equity premia produced by different policy rules is not straightforward. Before we proceed with our quantitative analysis, we use an example. Specifically, we let the mean income $\bar{y} = 1$, traders' endowment $y^T = 0.9$ and the financial market participation rate $\lambda = 35\%$ (parameter values are summarized in Table 1); we leave the variance of the dividend shock free.[7]

Figure 1 shows how the equity premia produced by various policies change with the dividend's variance. There we see that the equity premium increases with the dividend variance, under any monetary policy rule. However, the change is steeper for the inflation targeting policy, under either 2% or 0% inflation target.

In general, the equity premium is much higher under the inflation targeting policy than what it is under the optimal and constant money supply policy rules.[8] The key intuition comes from the fact that the optimal policy is risk-sharing, and thus smooths consumption volatility of traders hit by dividend shocks. Under the optimal policy, equity premium is higher for a more volatile stream of dividends, but not much higher, as monetary policy shares that risk with the non-traders. On the other hand, if an inflation targeting rule is followed, then traders' consumption volatility sharply increases with dividends' volatility. Specifically, an increase in dividends increases total output and puts downwards pressure

[7] $\lambda = 35\%$ is approximately the percentage of the US population that Vissing-Jørgensen (2002) classifies as bondholders.

[8] Similar results are obtained when we use a constant relative risk aversion utility function with coefficient equal to two.

to prices through the quantity equation. Inflation targeting policy would imply a sharp increase in money supply, resulting in cyclical monetary policy response. At its extreme, zero inflation targeting forces traders to consume their real dividend and endowment, holding all the dividend risk.

4 Quantitative Analysis

4.1 Parametrization

In this section we quantify the differences in the real equity premium produced between an economy that follows a 2% inflation targeting policy and an economy that follows optimal monetary policy. We are interested in studying mean equity premia observed over a long period horizon. In the recent history monetary authorities in the developed world had been primarily concerned with inflation and thus we chose inflation targeting as an approximated policy during a long period horizon of the recent past. Also, 2% inflation targeting is often considered in policy talks, in academic work and has been stated as the inflation target of the Federal Reserve.[9,10]

To quantify the dividend shock we use the mean and variance of the total dividend income in the US.[11] We estimate an $AR(1)$ process for the de-trended part of the dividend income from which we use the persistence coefficient.[12] We calibrate total endowment to match the 1997 average labor share of 66.1% from Ríos-Rull and Santaeulàlia-Llopis (2010). The equations we use in the quantitative exercise can be found in Table 2. We take from Walentin (2010) the estimates of the shareholders' share of labor income, being $\frac{\lambda y^T}{\lambda y^T + (1-\lambda) y^N} \equiv \eta^T = 45.1\%$ in 1997, and also the stock market participation rate for the same year, $\lambda = 27.3\%$.[13]

[9] For example, Leigh (2008) estimates the implicit inflation target which although unstable, is found to be 2% on average for a period of 25 years.

[10] Chairman Bernanke's Press Conference, January 25, 2012.

[11] We define dividend income as the sum of Rental income of persons with CCAdj, Corporate profits with IVA and CCAdj, Net interest and miscellaneous payments and Current surplus of government enterprises from the Bureau of Economic Analysis, which we convert to real per capita values using CPI and Civilian population from FRED. We use quarterly, per capita data from the first quarter of 1960 until the second quarter of 2012.

[12] For deriving the cyclical component we de-trend the data with HP filtering before estimating the $AR(1)$ process.

[13] Walentin (2010) uses the Survey of Consumer Finances data to calculate λ, including in the definition

The equations of the shock structure can be found in Table 2. The estimated process for the de-trended dividend income implies persistence $\rho^{\varepsilon} = 0.8$. The mean of the dividend series data is $\bar{\varepsilon} = \$3.671$ and the standard deviation $\sigma^{\varepsilon} = 0.758$. Then, we derive that $a^{\varepsilon} = 0.734$ and $\sigma^{\zeta} = 0.4548$ so to match the mean and standard deviation of the dividend series in the data. The only shock in our economy is the shock to the dividends, ζ_t^{ε}, which has mean zero and standard deviation σ^{ζ}.[14] We let $\beta = 0.99$. We use a constant relative risk aversion utility function with coefficient set to $\alpha = 2$. Also, given that $y_t = l + \varepsilon_t$ and $l = 0.661 y_t$, then $\bar{y} = 0.661\bar{y} + 3.671$, and thus $\bar{y} = 10.83$ and $l = 7.16$.

4.2 Results for Steady State and Means

The results for our quantitative exercise at the steady state are shown in the third column of Table 3. At the steady state, under both the inflation targeting and optimal policy, the stock and bond returns are equal to each other, and thus there is no premium. Equity premium develops when there is uncertainty about the stream of future dividends in the economy.

The results for the model economy after we introduce uncertainty are summarized in the fourth column of Table 3. From there we see that the real stock returns increase under both policies, compared to the steady state. That's because uncertainty introduces risk for the financial market participants, who ask for high return in order to keep stock. Notice that the returns are much higher under the inflation targeting policy than under the optimal policy. This is because the optimal policy shares the risk across traders and non-traders, smoothing the consumption of the traders hit by dividend shocks. On the contrary, inflation targeting leaves the financial market participants exposed, asking for higher stock return in order to hold that asset.

We find that the semiannual standard deviation of traders' consumption growth is 0.14 under inflation targeting; Vissing-Jørgensen (2002) documents 0.101 as middle-range stock

households that hold stock indirectly, in mutual funds, but not pension savings locked in retirement accounts. This calculation is close to Vissing-Jørgensen (2002)'s one of 21.75%, which uses the U.S. Consumer Expenditure Survey, but cannot differentiate between households that hold stock in pension funds or not. Guiso et al. (2003) uses the Survey of Consumer Finances and reports for 1998 that 0.48% of US households were holding stock directly, or indirectly. We have done sensitivity analysis for $\lambda = 0.5$ and $\lambda = 0.1$, which we discuss in the text.

[14] We perform robustness checks with respect to that shock, presented towards the end of the following section (Section 4.2).

holders consumption volatility, i.e., 27% less volatility than what we assume. Note that the semiannual consumption volatility of the traders under the optimal policy is 0.089, i.e., it is lower, but not much lower. This result emphasizes that it is the correlation of consumption growth with the dividend that is fundamentally different across the two policies, and not just the volatility of traders' consumption. In a robustness exercise below, we use a smaller dividend shock that produces lower consumption growth volatility under both policies.

From Table 3 we also see the behavior of the real return of the bond after uncertainty is introduced, which decreases compared to the steady state under the inflation targeting policy. Note that in our model we have nominal bonds that expire and return one unit of money; price changes are important for deciding bond holdings. However, if monetary policy follows inflation targeting, then agents do not have uncertainty about next period's prices; one-period bonds are very safe assets and their demand increases after uncertainty is introduced. The same is not true under the optimal policy, where agents are uncertain about future prices; under optimal policy, one-period bonds are not that safe assets.

Given that uncertainty increases stock returns and decreases bond returns, or increases them less, the real equity premium becomes positive under both policies. The mean equity premium under the inflation targeting policy is 6.96% yearly although it is only 1.56% under the optimal policy. The large difference that the inflation targeting policy generates in the equity premium, compared to the optimal policy, originates to the fact that the inflation targeting policy exposes financial market participants to higher dividend risk and to lower inflation risk compared to the optimal policy. Then, two things happen: First, the financial market participants ask for higher stock returns under the inflation targeting policy compared to the optimal one. Second, they value the risk free asset more in the world of inflation targeting than what they do under the optimal policy. The return of the risky asset is higher under the inflation targeting policy compared to the optimal one, and the return of the risk-free asset is smaller under the inflation targeting policy compared to the optimal one.

For robustness, we redo the quantitative exercise using a dividend shock with lower volatility than the initial shock, aiming to match Vissing-Jørgensen (2002)'s middle-range stock holders consumption volatility of 0.101. The model produces annual equity premium of 0.8% under the optimal policy and 3.7% under inflation targeting, i.e., four and a half times more. This results emphasizes the role of policy in affecting the correlation of traders' consumption with the dividend return, even for relatively low dividend shocks.

To discover the influence of the choice of target, we repeat the baseline exercise for 0% and 10% inflation targets; we find minor changes in the premium produced compared to the 2% inflation target. This is in line with the data (see Table 4), that do not suggest correlation between inflation and equity premium. The fact that the 0% inflation target does not associate with low premium signifies the importance of the segmentation friction. That is, the 0% inflation targeting policy which would be the optimal one for a class of New Keynesian models, does not minimize the equity premium. On the contrary, the risk-sharing policy which is optimal considering segmentation effects, produces minimal equity premium.

In addition, the fact that the 10% inflation targeting policy does not achieve significantly higher (or lower) premium than what the 2% inflation targeting policy does, shows that the equity premium is not really affected by the specific choice of target. It is the policy consideration that affects the premium. The optimal monetary policy rule shares the risk across agents and implies low equity premium, unlike the inflation targeting policy that leaves financial market participants exposed to financial income risk, encourages segmentation effects and implies high equity premium.

We look at the effects of the specific choice of λ, using alternative values. The main results regarding the relative equity premium under the two policies do not change. The initial positions of the two types of agents and their consumption under inflation targeting change, but neither the responses to the shock, nor the optimal and inflation targeting policies change. This can be seen from equations (21) and (24), which show that optimal and inflation targeting money growth do not depend on the degree of segmentation. Specifically, the optimal policy implies risk sharing, as soon as there is some degree of segmentation, but is not affected by the exact extent of segmentation. The inflation targeting policy on the other hand, cares about keeping inflation on its target, and again, the extent of segmentation does not affect the money growth rule.

Examining the variation that our model produces, we see that under the optimal policy, the standard deviation of the equity premium over the course of a year is about 5 basis points.[15] Under the 2% inflation targeting, this variation is much larger, about 35 basis points (which is not far from what Swanson (2014) estimates as a response after a productivity shock).

Looking at the data, Mehra and Prescott (2008) reports that the average equity premium for the US for the period 1889 to 2005 is 6.36%. Similarly, high equity premia are reported in developed countries worldwide by Dimson et al. (2009) (see Table 4). Also, Mehra and Prescott (2008) documents that the equity premium has been increasing over time, from 4.5% from 1900 to 1950, to 7.42% from 1951 to 2005. This is due to the diminishing return on the risk-free asset, which it is found to decrease from 2.95% that it was on average from 1900 to 1950, to 1.11% from 1951 to 2005.

In order to compare the model's estimated risk with that of the data, we calculate the implied Sharpe ratio for the premium over the return of the one-period bond, i.e., $\frac{\widehat{\Pi}^{\bar{\pi}}_{t+1}}{\sigma_{\hat{R}^{\bar{\pi}}_{t+1}}}$, where σ denotes standard deviation. We find that the implied Sharpe ratio for the inflation targeting policy is $1.740/4.741 = 0.367$, which is close to the data estimates of around 0.4 (see Lettau and Ludvigson, 2010).

These data facts are in line with our finding, given that in the recent history monetary authorities in the developed world had been primarily concerned with inflation. The equity premium produced under the inflation targeting policy through our model, is similar to the reported equity premium in the developed world. The same is true for the Sharpe ratio. Also, in our model, under inflation targeting, the equity premium is high mostly because of the low return of the risk-free asset, as also found in the recent data.

4.3 Impulse Responses

Figures 2-3 present the model's response after a 1% dividend shock. Figure 2 shows that a negative dividend shock of 13.6% decreases output, and thus agents' consumption under the optimal policy, by more than 4%. It decreases traders' consumption by almost 7% under the inflation targeting policy. Although traders' consumption decreases under both policies, the optimal monetary policy rule implies smaller decrease. This is because the optimal

[15]This calculation is obtained by summing the squares of the impulse responses for the first four quarters, and then taking the square root.

policy smoothes the dividend shock across traders and non-traders. On the contrary, the 2% inflation targeting policy directs all the dividend volatility towards the traders. As a result, traders consumption is more responsive to dividend shocks under the inflation targeting policy compared to the optimal policy.

Our analysis suggests that the two policies respond differently to the negative dividend shock. Specifically, the negative dividend shock decreases current total output, increasing in turns the price level; the inflation targeting policy tightens by 4.34% in order to keep inflation at the 2% target. However, under optimal monetary policy money growth increases in response to the negative dividend shock, in order to redistribute the dividend shock among traders and non-traders. The decrease in per capita dividend income increases the money growth by more than 4%. The optimal monetary policy rule implies higher inflation, transferring money to traders who suffer the low dividend shock.

From Figure 2 we see that the real stock price decreases under both policies. This is because lower dividend decreases the payoffs and thus decreases real stock price. Also, current consumption decreases more than future consumption and thus the real stochastic discount factor decreases as well, decreasing the real stock price.

The real stock returns increase after the shock. This is expected given that the negative dividend shock makes the stock a less attractive asset. The real stock return under inflation targeting is more responsive than under the optimal policy. This is because after a negative dividend shock, in order to hold the stock, the traders need a higher increase in stock returns in the inflation targeting world where policy does not share risk, compared to the risk-sharing, optimal monetary policy world.

Calculating the impulse response function for the real equity premium, we find that the premium of the stock return over the one-period bond return increases under both policies, as the stock becomes a less desirable asset. However, the effect is much stronger, almost 5 times higher, for the inflation targeting policy, as we see in Figure 3. This is because the dividend shock affects the traders more severely under the inflation targeting policy than under the optimal policy.

5 Concluding Remarks

We use a segmented financial markets model in order to study the effect of monetary policy on the equity premium. In our model, financial market participants are trading stock and are subject to financial income risk, although non-participants are not exposed to such risk. We find that the optimal monetary policy rule minimizes the equity premium compared to other policy rules that emphasize other objectives that the central banks might have, as for example, keeping inflation at its target, keeping money supply constant, or not interfering in the financial markets. The reason for that is intuitive: the objective for the optimal monetary policy rule is to share the risk that the financial market participants are subject to, among all the agents in the economy, discouraging in this way the segmentation effect. Given risk sharing, the return on equity is low under the optimal policy. On the other hand, equity return is high under inflation targeting, as that policy is not concerned with sharing financial income risk. However, bond returns are higher under the optimal policy, compared to what they are under inflation targeting. This is because the inflation targeting policy removes price uncertainty, and thus makes the nominal bond safe. Overall, our work suggests that optimal monetary policy can lower the equity premium, while the observed high premium might be the result of policies that focus on inflation stability.

Our work also contributes towards the identification of a macroeconomic model that connects to the finance literature. Monetary policy is an important ingredient in macroeconomic models, and is directly connected with the financial markets. The segmented markets monetary model provides an intuitive linkage of macro and finance ideas, given that it implies that monetary policy is non-neutral and has real effects exactly because of financial markets frictions. Thus, this class of models provide a useful vehicle for studying the interlinks of the macroeconomy with the financial markets, as we also attempt to do in the present work.

Appendix

Tables

Parameter	Symbol	Value
Mean income	$\bar{y}$	1
Trader's endowment	y^T	0.9
Mean Dividend	$\bar{\varepsilon}$	0.035
Discount factor	β	0.99
Participation fraction	λ	0.35

Table 1: Parameter Values for Example (Section 3.2).

$$
\begin{aligned}
\varepsilon_t &= a^{\varepsilon} + \rho^{\varepsilon}\varepsilon_{t-1} + \zeta_t^{\varepsilon} \\
l &\equiv \lambda y^T + (1-\lambda) y^N \\
y_t &= l + \varepsilon_t \\
\eta^T &\equiv \frac{\lambda y^T}{l} \\
y^N &= \frac{1-\eta^T}{1-\lambda} l \\
y^T &= \frac{\eta^T}{\lambda} l \\
c_t^{N,\bar{\pi}} &= \frac{y^N}{1+\bar{\pi}} \\
c_t^{T,\bar{\pi}} &= y^T + \frac{\varepsilon_t}{\lambda} + \frac{1-\lambda}{\lambda}(y^N - c_t^{N,\bar{\pi}}) \\
1+\mu_t^{\bar{\pi}} &= (1+\bar{\pi})\frac{y_t}{y_{t-1}} \\
1+\mu_t^{*} &= \frac{y^N}{y_{t-1}} \\
1+\pi_t^{*} &= (1+\mu_t^{*})\frac{y_{t-1}}{y_t} \\
\widehat{q}_t^{\bar{\pi}} &= \beta \mathrm{E}_t \left[\left(\frac{c_t^{T,\bar{\pi}}}{c_{t+1}^{T,\bar{\pi}}} \right)^{\alpha} \left[\widehat{q}_{t+1}^{\bar{\pi}} + \frac{\varepsilon_t}{1+\bar{\pi}} \right] \right] \\
\widehat{q}_t^{*} &= \beta \mathrm{E}_t \left[\left(\frac{y_t}{y_{t+1}} \right)^{\alpha} \left[\widehat{q}_{t+1}^{*} + \frac{\varepsilon_t}{1+\pi_{t+1}^{*}} \right] \right] \\
\mathrm{E}_t \hat{R}_{t+1}^{\bar{\pi}} &= \mathrm{E}_t \frac{\widehat{q}_{t+1}^{\bar{\pi}} + \frac{\varepsilon_t}{1+\bar{\pi}}}{\widehat{q}_t^{\bar{\pi}}} \\
\mathrm{E}_t \hat{R}_{t+1}^{*} &= \mathrm{E}_t \frac{\widehat{q}_{t+1}^{*} + \frac{\varepsilon_t}{1+\pi_{t+1}^{*}}}{\widehat{q}_t^{*}} \\
\mathrm{E}_t \hat{r}_{t+1}^{*} &= \frac{\mathrm{E}_t \frac{1}{p_{t+1}}}{\frac{s_t^{*,1}}{p_t}} = \mathrm{E}_t \frac{1}{(1+\pi_{t+1}^{*}) s_t^{*,1}} \\
\widehat{\Pi}_{t+1}^{\bar{\pi}} &= \mathrm{E}_t[\hat{R}_{t+1}^{\bar{\pi}} - \hat{r}_{t+1}^{\bar{\pi}}] \\
\widehat{\Pi}_{t+1}^{*} &= \mathrm{E}_t[\hat{R}_{t+1}^{*} - \hat{r}_{t+1}^{*}]
\end{aligned}
$$

Table 2: Equations used in the Quantitative Exercise (Section 4).

Variable	Symbol	Steady State	Simulation Mean
Net real bond return, optimal policy	$E_t \hat{r}^*_{t+1} - 1$	4.04%	4.152%
Net real bond return, 2% inflation target	$E_t \hat{r}^{\bar{\pi}}_{t+1} - 1$	4.04%	0.856%
Net real stock return, optimal policy	$E_t \hat{R}^{*,e}_{t+1} - 1$	4.04%	5.708%
Net real stock return, 2% inflation target	$E_t \hat{R}^{\bar{\pi},e}_{t+1} - 1$	4.04%	7.816%
Real premium, optimal monetary policy	$E_t \widehat{\Pi}^*_{t+1}$	0	1.556 %
Real premium, 2% inflation target	$E_t \widehat{\Pi}^{\bar{\pi}}_{t+1}$	0	6.96%
Real premium diff. targeting & optimal policy	$E_t[\widehat{\Pi}^{\bar{\pi}}_{t+1} - \widehat{\Pi}^*_{t+1}]$	0	5.404%

Table 3: Steady state and simulated mean values from the Quantitative Exercise (Section 4), all annualized values.

Country	Equities	Bills	Equity Premium	Inflation
Australia	9.0	0.6	8.5	4.2
Belgium	4.8	0.0	5.1	5.9
Canada	7.7	1.8	5.9	3.2
Denmark	6.2	3.0	3.4	4.3
France	6.3	-2.6	9.8	8.8
Germany	8.8	0.1	10.3	6
Ireland	7	1.4	5.4	4.7
Italy	6.8	-2.9	11.0	11.7
Japan	9.3	-0.3	9.9	11.0
Netherlands	7.7	0.8	7.1	3.1
South Africa	9.1	1.0	8.1	5.1
Spain	5.8	0.6	5.3	6.4
Sweden	9.9	2.2	7.7	3.9
Switzerland	6.9	1.2	6.1	2.4
United Kingdom	7.6	1.2	6.5	4.3
United States	8.7	1.0	7.7	3.3

Table 4: Arithmetic means of yearly % real returns, real equity premium and inflation for 1900-2000 (Section 4). Table taken from Dimson et al. (2009).

Figures

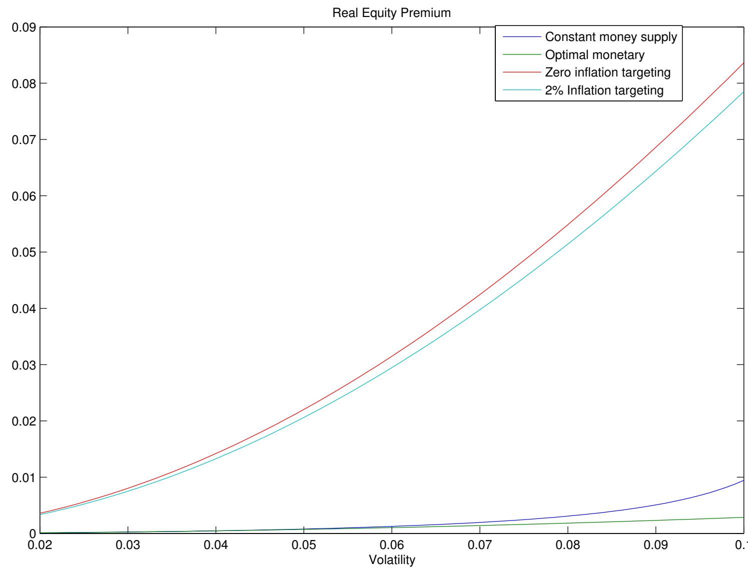

Figure 1: Real equity premium for different monetary policy rules, as a function of dividend volatility. Parameters values are from Table 1. Blue curve denotes real equity premium under constant money growth; green curve denotes real equity premium under optimal monetary policy; red curve denotes real equity premium under 2% inflation targeting; light green curve denotes real equity premium under 0% inflation targeting (Section 3.2).

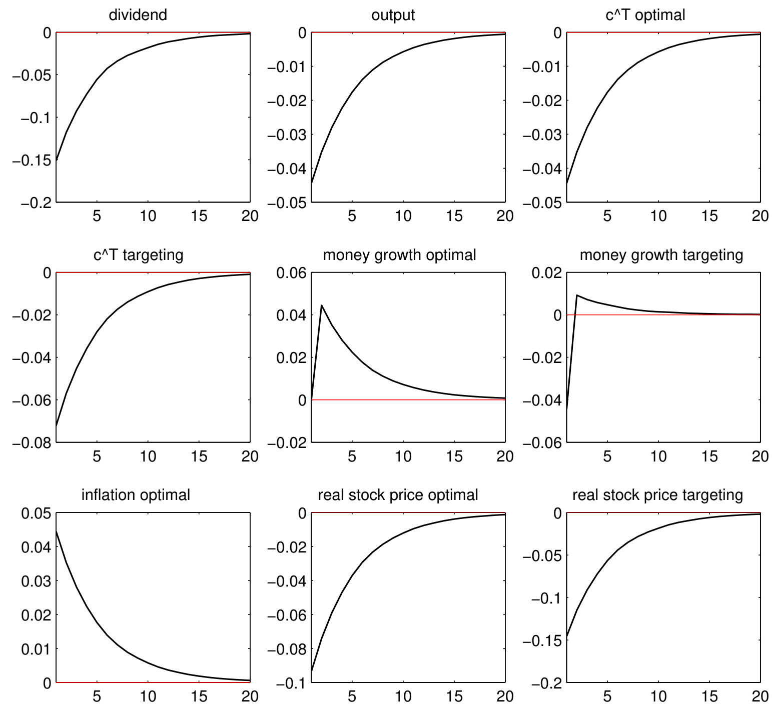

Figure 2: Percentage deviations from steady state after a 1% dividend shock for the dividend, output, traders' consumption under the optimal policy, traders' consumption under 2% inflation targeting, money growth under the optimal policy, money growth under 2% inflation targeting, inflation rate under the optimal policy, real stock price under the optimal policy and real stock price under 2% inflation targeting (Section 4).

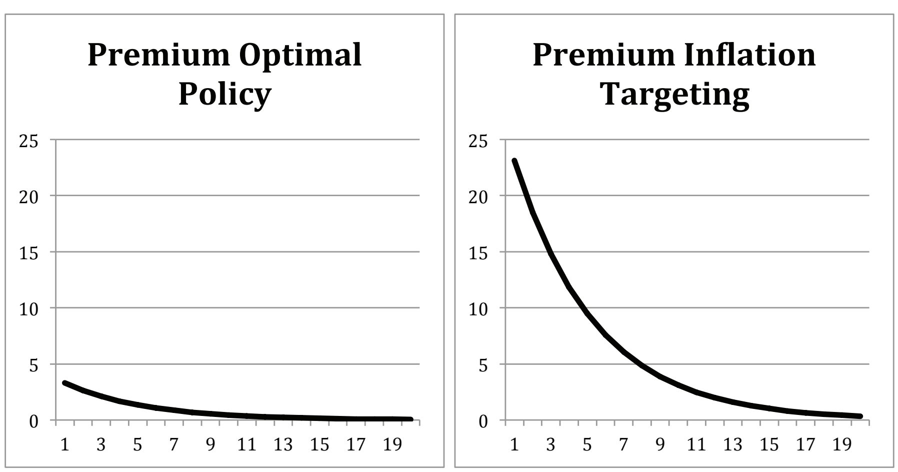

Figure 3: Deviations from steady state after a 1% dividend shock for the equity premium over the 1-quarter bond produced under 2% inflation targeting compared to the optimal policy, in basis points (Section 4).

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A Mathematical Appendix

In this appendix we include notes for deriving the equilibrium conditions. We also show analytical solutions for the real equity premium under the constant money supply, optimal and inflation targeting monetary policy rules. We do so using the logarithmic utility function and the constant relative risk aversion utility function.

A.1 Model's Equilibrium

Total output in period t equals $y_t \equiv \varepsilon_t + \lambda y^T + (1-\lambda)y^N$, which implies that mean income is:

$$\bar{y} = \bar{\varepsilon} + \lambda y^T + (1-\lambda)y^N.$$

The economy's resource constraint is as follows:

$$\varepsilon_t + \lambda y^T + (1-\lambda)y^N = \lambda c_t^T + (1-\lambda)c_t^N,$$

which in combination with the mean income equation from above implies that the goods market clearing condition can be written as follows:

$$\bar{y} + \varepsilon_t - \bar{\varepsilon} = \lambda c_t^T + (1-\lambda)c_t^N. \tag{A.1}$$

Since only traders can participate in the stock market at each period t, the stock market clearing condition is:

$$\lambda z_{t+1} = 1 \Rightarrow z_{t+1} = \frac{1}{\lambda}. \tag{A.2}$$

The bond market clearing condition is:

$$\lambda b_t = 0. \tag{A.3}$$

Since total money demand in period t is $\lambda m_{t+1}^T + (1-\lambda)m_{t+1}^N$, the money market clearing condition is:

$$\lambda m_{t+1}^T + (1-\lambda)m_{t+1}^N = \bar{M}_t. \tag{A.4}$$

Given the financial markets' participating fraction λ, endowments y^T and y^N, the dividend process $\{\varepsilon_t\}$, a rule that specifies the monetary transfer $\{\tau_t\}$, and the initial conditions $\{M_0, b_0, z_0, m_0^N, m_0^T\}$, an equilibrium is a collection $\{c_t^T, c_t^N, z_{t+1}, b_{t+1} m_{t+1}^T, m_{t+1}^N, p_t, b_t, q_t, s_t\}$ such that for each t: i. traders optimize with respect to $\{c_t^T, m_{t+1}^T, b_{t+1}, z_{t+1}\}$ in order to maximize utility, subject to the cash-in-advance constraint (2) and budget constraint (4), taking prices $\{p_t, s_t, q_t\}$ and the policy processes as given; non-traders optimize with respect to $\{c_t^N, m_{t+1}^N\}$ in order to maximize their utility, subject to the cash-in-advance constraint (3) and budget constraint (5), taking the price $\{p_t\}$ and the policy processes as given; ii. goods market, bond market, stock market and money market clear.

Using the equilibrium conditions (A.1), (A.2), (A.3), (A.4), the money supply equation (10) and the cash-in-advance constraints (2) and (3) holding with equality, we derive the goods price, which is given by the quantity equation:

$$p_t = \frac{\bar{M}_t}{\bar{y} + \varepsilon_t - \bar{\varepsilon}}, \tag{A.5}$$

which is equation (11) in the text. In order for total output to be independent from the financial market participation rate λ, we assume that the traders' mean income equals that of the non-traders', that is $y^T + \frac{\bar{\varepsilon}}{\lambda} = y^N$. Combining the non-traders binding cash-in-advance constraint (3) with their binding budget constraint that results in equation (7) and the goods price equation (11), we find that the non-traders consumption is given as follows:

$$c_t^N = \frac{p_{t-1}}{p_t}\bar{y} = \frac{\bar{y} + \varepsilon_t - \bar{\varepsilon}}{\bar{y} + \varepsilon_{t-1} - \bar{\varepsilon}} \frac{\bar{y}}{1 + \mu_t}, \tag{A.6}$$

which is equation (12) in the text. The above equation, together with the goods market clearing condition (A.1), results in traders' consumption equation which can be written as follows:

$$c_t^T = \frac{\bar{y} + \varepsilon_t - \bar{\varepsilon}}{\lambda} \frac{(\varepsilon_{t-1} - \bar{\varepsilon})(1 + \mu_t) + \bar{y}(\lambda + \mu_t)}{(\bar{y} + \varepsilon_{t-1} - \bar{\varepsilon})(1 + \mu_t)}, \tag{A.7}$$

which is equation (13) in the text.

A.2 Derivations for Log Utility

A.2.1 Constant Money Supply Policy

For the zero money growth policy, the relevant equations for prices and traders' consumption are computed using equations (10), (11) and (13):

$$c_{t+1}^{T,\mu=0} = \frac{(\bar{y} + \varepsilon_{t+1} - \bar{\varepsilon})(\lambda\bar{y} + \varepsilon_t - \bar{\varepsilon})}{\lambda(\bar{y} + \varepsilon_t - \bar{\varepsilon})},$$

$$p_{t+1}^{\mu=0} = \frac{\bar{M}_t}{\bar{y} + \varepsilon_{t+1} - \bar{\varepsilon}},$$

$$1 + \pi_{t+1}^{\mu=0} = \frac{\bar{y} + \varepsilon_t - \bar{\varepsilon}}{\bar{y} + \varepsilon_{t+1} - \bar{\varepsilon}}.$$

Then it is true that:

$$\frac{u^{'}(c_{t+1}^{T,\mu=0})}{p_{t+1}^{\mu=0}} = \frac{\lambda}{\bar{M}_t}\left[1 + \frac{(1-\lambda)\bar{y}}{\lambda\bar{y} + \varepsilon_t - \bar{\varepsilon}}\right].$$

The above equations show that in the case of constant money supply policy an increase in future dividend increases future consumption and decreases future prices so that the nominal value of the future marginal utility of consumption does not change with future dividend. In addition, the constant money supply monetary policy does not distort future consumption or prices. Only predetermined variables affect future nominal marginal utility of consumption, which makes it a predetermined variable itself.

We compute the real equity premium (20), by linearizing the expression of real stock price (19) around the mean total dividend and using the relevant equations for prices and traders' consumption above. Then we have:

$$
\begin{aligned}
\widehat{q}_t^{\mu=0} &\simeq \beta\lambda c_t^{T,\mu=0}\left[\frac{\varepsilon_t}{\lambda\bar{y}+\varepsilon_t-\bar{\varepsilon}}+\frac{\beta}{1-\beta}\left(\frac{\bar{\varepsilon}}{\lambda\bar{y}}+\frac{(\bar{\varepsilon}-\lambda\bar{y})\sigma_\varepsilon^2}{\lambda^3\bar{y}^3}\right)\right],\\
\mathrm{E}_t\widehat{q}_{t+1}^{\mu=0} &\simeq \frac{\beta(\lambda\bar{y}+\varepsilon_t-\bar{\varepsilon})}{\lambda(\bar{y}+\varepsilon_t-\bar{\varepsilon})}\left[\frac{\bar{\varepsilon}}{1-\beta}+\frac{(\bar{\varepsilon}-\lambda\bar{y})\sigma_\varepsilon^2}{\lambda^2\bar{y}^2}\left(\frac{1}{1-\beta}-\lambda\right)\right],\\
\mathrm{E}_t\frac{u^{'}(c_{t+1}^{T,\mu=0})}{p_{t+1}^{\mu=0}} &= \frac{\lambda(\bar{y}+\varepsilon_t-\bar{\varepsilon})}{\bar{M}_t(\lambda\bar{y}+\varepsilon_t-\bar{\varepsilon})},\\
\mathrm{E}_t\frac{1}{p_{t+1}^{\mu=0}} &= \frac{\bar{y}}{\bar{M}_t},\\
\mathrm{E}_t u^{'}(c_{t+1}^{T,\mu=0})\widehat{q}_{t+1}^{\mu=0} &= \frac{\beta\lambda}{1-\beta}\mathrm{E}_t\frac{\varepsilon_{t+1}}{\lambda\bar{y}+\varepsilon_{t+1}-\bar{\varepsilon}}\\
&\simeq \frac{\beta\lambda}{1-\beta}\left[\frac{\bar{\varepsilon}}{\lambda\bar{y}}+\frac{(\bar{\varepsilon}-\lambda\bar{y})\sigma_\varepsilon^2}{\lambda^3\bar{y}^3}\right].
\end{aligned}
$$

Using the above equations and substituting them in the expression for the real equity premium (17), we compute the real equity premium under the constant money supply policy, given by equation (20).

A.2.2 Optimal Monetary Policy

Using the optimal monetary policy rule (21) and equations (10), (11) and (13), the optimal traders' consumption, goods price and inflation rate are:

$$
\begin{aligned}
c_{t+1}^{T*} &= \bar{y}+\varepsilon_{t+1}-\bar{\varepsilon},\\
p_{t+1}^{*} &= \frac{\bar{M}_t\bar{y}}{(\bar{y}+\varepsilon_{t+1}-\bar{\varepsilon})(\bar{y}+\varepsilon_t-\bar{\varepsilon})},\\
1+\pi_{t+1}^{*} &= \frac{\bar{y}}{\bar{y}+\varepsilon_{t+1}-\bar{\varepsilon}}.
\end{aligned}
$$

Then, we get:

$$
\frac{u^{'}(c_{t+1}^{T*})}{p_{t+1}^{*}} = \frac{1}{\bar{M}_{t+1}^{*}} = \frac{\bar{y}+\varepsilon_t-\bar{\varepsilon}}{\bar{M}_t\bar{y}}.
$$

We see that increases in future dividends increase future consumption and decreases future prices. In addition, under optimal monetary policy, only current dividends matter although the effect of the previous period's shocks do not matter for inflation.

We compute the stock price under the assumption that monetary policy is conducted optimally. Substituting in the expression for real stock price (18) the above equations for consumption and prices, and the optimal policy rule (21), we have the value of the real stock price under optimal monetary policy, given by (22).

We calculate the real equity premium under optimal monetary policy using the real stock price under optimal policy equation (22), together with the equations for goods price and traders' consumption above, to get:

$$\mathrm{E}_t \widehat{q}^*_{t+1} = \frac{\beta\bar{\varepsilon}}{1-\beta} + \frac{\beta\sigma_\varepsilon^2}{\bar{y}},$$
$$\mathrm{E}_t u^{'}(c^{T*}_{t+1})\widehat{q}^*_{t+1} = \frac{\beta\bar{\varepsilon}}{(1-\beta)\bar{y}}.$$

Substituting the above equations into equation (17), the real equity premium is as seen in equation (23).

A.2.3 Inflation Targeting Policy

For the inflation targeting policy, using equations (10), (11) and (13), and the inflation targeting monetary policy rule (24), we have:

$$c^T_{t+j} = \frac{(1+\bar{\pi})(\bar{y}+\varepsilon_{t+j}-\bar{\varepsilon}) + \bar{y}(\lambda-1)}{\lambda(1+\bar{\pi})},$$

$$\begin{aligned}\frac{u^{'}(c^T_{t+1})}{p_{t+1}} &= \frac{\lambda(\bar{y}+\varepsilon_t-\bar{\varepsilon})}{\bar{M}_t[(\lambda-1)\bar{y} + (1+\mu^{\bar{\pi}}_{t+1})(\bar{y}+\varepsilon_t-\bar{\varepsilon})]} \\ &= \frac{\lambda(\bar{y}+\varepsilon_t-\bar{\varepsilon})}{\bar{M}_t[(\lambda-1)\bar{y} + (1+\bar{\pi})(\bar{y}+\varepsilon_{t+1}-\bar{\varepsilon})]},\end{aligned}$$

and thus:

$$\frac{c^T_t}{c^T_{t+j}}\frac{p_{t+j-1}}{p_{t+j}} = \frac{(\lambda-1)\bar{y} + (1+\bar{\pi})(\bar{y}+\varepsilon_t-\bar{\varepsilon})}{[(\lambda-1)\bar{y} + (1+\bar{\pi})(\bar{y}+\varepsilon_{t+j}-\bar{\varepsilon})](1+\bar{\pi})}.$$

Given the above equations, combining with the real stock price equation (18), we calculate the value of real stock price as given by equation (25).

Letting $\widehat{q}^{\bar{\pi}}_t = g(\varepsilon_t)$, we rewrite the expression of the nominal stock return as below:

$$1 + R_{t+1} = \frac{g(\varepsilon_{t+1})(1+\bar{\pi}) + \varepsilon_t}{g(\varepsilon_t)},$$

Together with the equation of real marginal utility above and the definition of f in the main text, the covariance between the marginal utility from an extra unit of money, and the stock return is:

$$\begin{aligned}\mathrm{Cov}_t\left(\frac{u^{'}(c^T_{t+1})}{p_{t+1}}, R_{t+1}\right) &= \mathrm{Cov}_t\left(\frac{\lambda(\bar{y}+\varepsilon_t-\bar{\varepsilon})f(\varepsilon_{t+1})}{\bar{M}_t}, \frac{g(\varepsilon_{t+1})(1+\bar{\pi})+\varepsilon_t}{g(\varepsilon_t)}\right) \\ &= \frac{\lambda(\bar{y}+\varepsilon_t-\bar{\varepsilon})(1+\bar{\pi})}{\bar{M}_t g(\varepsilon_t)}\mathrm{Cov}_t(f(\varepsilon_{t+1}), g(\varepsilon_{t+1})).\end{aligned}$$

Thus, the expected nominal equity premium for the inflation targeting policy becomes:

$$\begin{aligned}\Pi^{\bar{\pi}}_{t+1} &= -\frac{(1+\bar{\pi})\mathrm{Cov}_t(f(\varepsilon_{t+1}), g(\varepsilon_{t+1}))}{g(\varepsilon_t)\mathrm{E}_t(f(\varepsilon_{t+1}))} \\ &= -\frac{1+\bar{\pi}}{g(\varepsilon_t)}[\frac{\mathrm{E}_t[f(\varepsilon_{t+1})g(\varepsilon_{t+1})]}{\mathrm{E}_t(f(\varepsilon_{t+1}))} - \mathrm{E}_t(g(\varepsilon_{t+1}))] \\ &= -\frac{1+\bar{\pi}}{g(\varepsilon_t)}\left[\frac{\mathrm{E}_t[f(\varepsilon_{t+1})g(\varepsilon_{t+1})]}{A} - \mathrm{E}_t(g(\varepsilon_{t+1}))\right].\end{aligned}$$

In addition:

$$\mathrm{E}_t[f(\varepsilon_{t+1})g(\varepsilon_{t+1})] = \frac{\beta A\bar{\varepsilon}}{(1-\beta)(1+\bar{\pi})},$$

$$\mathrm{E}_t(g(\varepsilon_{t+1})) = \frac{\beta A[(\lambda+\bar{\pi})\bar{y}\bar{\varepsilon}+(1-\beta)(1+\bar{\pi})\sigma^2_\varepsilon]}{(1-\beta)(1+\bar{\pi})}.$$

Here, σ^2_ε denotes the variance of ε. After substituting the expressions for $\mathrm{E}_t[f(\varepsilon_{t+1})g(\varepsilon_{t+1})]$ and $\mathrm{E}_t(g(\varepsilon_{t+1}))$, we find the following expression for the value of expected equity premium:

$$\begin{aligned}\Pi^{\bar{\pi}}_{t+1} &= \frac{\beta A[(\lambda+\bar{\pi})\bar{y}\bar{\varepsilon}+(1-\beta)(1+\bar{\pi})\sigma^2_\varepsilon]-\beta\bar{\varepsilon}}{(1-\beta)\hat{q}^{\bar{\pi}}_t} \\ &= \frac{(1+\bar{\pi})\left[(\lambda+\bar{\pi})\bar{y}\bar{\varepsilon}+(1-\beta)(1+\bar{\pi})\sigma^2_\varepsilon-\frac{\bar{\varepsilon}}{A}\right]}{[(\lambda-1)\bar{y}+(1+\bar{\pi})(\bar{y}+\varepsilon_t-\bar{\varepsilon})][(1-\beta)\varepsilon_t+\beta\bar{\varepsilon}]}.\end{aligned}$$

Linearizing $A = \mathrm{E}_t(f(\varepsilon_{t+j}))$ around the mean dividend, we get:

$$A \simeq \frac{1}{\bar{y}(\lambda+\bar{\pi})} + \frac{(1+\bar{\pi})^2\sigma^2_\varepsilon}{\bar{y}^3(\lambda+\bar{\pi})^3}.$$

Replacing the expression A found above, we have the nominal equity premium equation for the inflation targeting policy, under log utility as below:

$$\Pi^{\bar{\pi}}_{t+1} \simeq \frac{(1+\bar{\pi})\left[(\lambda+\bar{\pi})\bar{y}\bar{\varepsilon} + (1-\beta)(1+\bar{\pi})\sigma^2_{\varepsilon} - \frac{\bar{\varepsilon}\bar{y}^3(\lambda+\bar{\pi})^3}{\bar{y}^2(\lambda+\bar{\pi})^2+(1+\bar{\pi})^2\sigma^2_{\varepsilon}}\right]}{[(\lambda-1)\bar{y} + (1+\bar{\pi})(\bar{y}+\varepsilon_t-\bar{\varepsilon})][(1-\beta)\varepsilon_t + \beta\bar{\varepsilon}]}.$$

Given that the real equity premium is $\mathrm{E}_t\hat{\Pi}_{t+1} = \mathrm{E}_t\frac{p_t}{p_{t+1}}\Pi_{t+1}$, then we get the expression for the real equity premium as it is in the main text.

A.3 Derivation for Constant Relative Risk Aversion Utility

We use the more general constant relative risk aversion utility function $u(c_t) = \frac{c_t^{1-\alpha}}{1-\alpha}$ to calculate the equity premium. Combing with equation (15) and solving for the recursive form of the real stock price, we have the following expression for the real stock price:

$$\widehat{q}_t = \sum_{j=1}^{\infty} \mathrm{E}_t\beta^j \left(\frac{c^T_t}{c^T_{t+j}}\right)^{\alpha} \frac{p_{t+j-1}}{p_{t+j}}\varepsilon_{t+j-1}. \tag{A.8}$$

We now substitute into the above equation various monetary policy rules assumptions and calculate the implied equity premia.

A.3.1 Constant Money Supply Policy

If the monetary growth rate μ_t is zero for every period t, combing with equation (13), for $j > 1$, the term inside the expectation in equation (A.8) becomes:

$$\mathrm{E}_t\left(\frac{c^T_t}{c^T_{t+j}}\right)^{\alpha}\frac{p_{t+j-1}}{p_{t+j}}\varepsilon_{t+j-1} = (\lambda c^T_t)^{\alpha}\mathrm{E}_t\frac{(\bar{y}+\varepsilon_{t+j-1}-\bar{\varepsilon})^{\alpha-1}\varepsilon_{t+j-1}}{(\lambda\bar{y}+\varepsilon_{t+j-1}-\bar{\varepsilon})^{\alpha}}(\bar{y}+\varepsilon_{t+j}-\bar{\varepsilon})^{1-\alpha}.$$

Assume that the series of dividends $\{\varepsilon_t\}^{\infty}_{t=0}$ is $i.i.d$, then:

$$\begin{aligned}\mathrm{E}_t\frac{(\bar{y}+\varepsilon_{t+j-1}-\bar{\varepsilon})^{\alpha-1}\varepsilon_{t+j-1}}{(\lambda\bar{y}+\varepsilon_{t+j-1}-\bar{\varepsilon})^{\alpha}}(\bar{y}+\varepsilon_{t+j}-\bar{\varepsilon})^{1-\alpha} &= \mathrm{E}_t\frac{(\bar{y}+\varepsilon_{t+j-1}-\bar{\varepsilon})^{\alpha-1}\varepsilon_{t+j-1}}{(\lambda\bar{y}+\varepsilon_{t+j-1}-\bar{\varepsilon})^{\alpha}}\mathrm{E}_t(\bar{y}+\varepsilon_{t+j}-\bar{\varepsilon})^{1-\alpha}\\ &= B_1B_2.\end{aligned}$$

Here, defining $f_1(\varepsilon_{t+j-1}) = \frac{(\bar{y}+\varepsilon_{t+j-1}-\bar{\varepsilon})^{\alpha-1}\varepsilon_{t+j-1}}{(\lambda\bar{y}+\varepsilon_{t+j-1}-\bar{\varepsilon})^{\alpha}}$ and $f_2(\varepsilon_{t+j}) = (\bar{y}+\varepsilon_{t+j}-\bar{\varepsilon})^{1-\alpha}$, then $B_1 = \mathrm{E}_tf_1(\varepsilon_{t+j-1})$ and $B_2 = \mathrm{E}_tf_2(\varepsilon_{t+j})$ are constant for all $j > 1$. The expression of the stock price is as follows:

$$
\begin{aligned}
\widehat{q}_t^{\mu=0} &= \beta(\lambda c_t^T)^\alpha \frac{(\bar{y}+\varepsilon_t-\bar{\varepsilon})^{\alpha-1}\varepsilon_t}{(\lambda\bar{y}+\varepsilon_t-\bar{\varepsilon})^\alpha} \mathrm{E}_t(\bar{y}+\varepsilon_{t+1}-\bar{\varepsilon})^{1-\alpha} + \frac{\beta^2(\lambda c_t^T)^\alpha B_1 B_2}{1-\beta} \\
&= \beta(\lambda c_t^T)^\alpha B_2 \left[\frac{(\bar{y}+\varepsilon_t-\bar{\varepsilon})^{\alpha-1}\varepsilon_t}{(\lambda\bar{y}+\varepsilon_t-\bar{\varepsilon})^\alpha} + \frac{\beta B_1}{1-\beta} \right] \\
&= \beta(\lambda c_t^T)^\alpha B_2 \left[f_1(\varepsilon_t) + \frac{\beta B_1}{1-\beta} \right].
\end{aligned}
$$

We see that the real stock price $\widehat{q}_t^{\mu=0}$ depends on the present dividend ε_t and is an increasing function of it.

Also,

$$
\begin{aligned}
\frac{u'(c_{t+1}^T)}{p_{t+1}} &= \frac{1}{(c_{t+1}^T)^\alpha p_{t+1}} = \frac{\lambda^\alpha}{\bar{M}} \left[\frac{\bar{y}+\varepsilon_t-\bar{\varepsilon}}{\lambda\bar{y}+\varepsilon_t-\bar{\varepsilon}} \right]^\alpha (\bar{y}+\varepsilon_{t+1}-\bar{\varepsilon})^{1-\alpha} \\
&= \frac{\lambda^\alpha}{\bar{M}} \left[\frac{\bar{y}+\varepsilon_t-\bar{\varepsilon}}{\lambda\bar{y}+\varepsilon_t-\bar{\varepsilon}} \right]^\alpha f_2(\varepsilon_{t+1}).
\end{aligned}
$$

Then, we get $\mathrm{E}_t \frac{u'(c_{t+1}^T)}{p_{t+1}} = \frac{\lambda^\alpha}{\bar{M}} \left[\frac{\bar{y}+\varepsilon_t-\bar{\varepsilon}}{\lambda\bar{y}+\varepsilon_t-\bar{\varepsilon}} \right]^\alpha B_2$, which in combination with the equation for the nominal premium $\mathrm{E}_t \Pi_{t+1} = -\frac{\mathrm{Cov}_t\left(\frac{u'(c_{t+1}^T)}{p_{t+1}}, R_{t+1}\right)}{\mathrm{E}_t \frac{u'(c_{t+1}^T)}{p_{t+1}}}$, and the equation of real stock price above, gives us the value of equity premium as:

$$
\begin{aligned}
\Pi_{t+1}^{\mu=0} &= -\frac{\mathrm{Cov}_t\left(\frac{u'(c_{t+1}^T)}{p_{t+1}}, \frac{\widehat{q}_{t+1}^{\mu=0}(1+\Pi_{t+1})+\varepsilon_t}{\widehat{q}_t^{\mu=0}}\right)}{E_t \frac{u'(c_{t+1}^T)}{p_{t+1}}} = -\frac{\mathrm{Cov}_t\left(\frac{u'(c_{t+1}^T)}{p_{t+1}}, \widehat{q}_{t+1}^{\mu=0} p_{t+1}\right)}{p_t \widehat{q}_t^{\mu=0} E_t \frac{u'(c_{t+1}^T)}{p_{t+1}}} \\
&= -\frac{\beta\varepsilon_t \mathrm{Cov}_t\left(\frac{1}{(c_{t+1}^T)^\alpha p_{t+1}}, (c_{t+1}^T)^\alpha p_{t+1}\left[f_1(\varepsilon_{t+1}) + \frac{\beta B_1}{1-\beta}\right]\right)}{\widehat{q}_t^{\mu=0} f_1(\varepsilon_t)} \\
&= -\frac{\beta\varepsilon_t \mathrm{Cov}_t\left(f_2(\varepsilon_{t+1}), \frac{1}{f_2(\varepsilon_{t+1})}\left[f_1(\varepsilon_{t+1}) + \frac{\beta B_1}{1-\beta}\right]\right)}{\widehat{q}_t^{\mu=0} f_1(\varepsilon_t)} \\
&= -\frac{\beta\varepsilon_t \left[B_1 - (1-\beta)B_2 \mathrm{E}\frac{f_1(\varepsilon_{t+1})}{f_2(\varepsilon_{t+1})} - \beta B_1 B_2 \mathrm{E}\frac{1}{f_2(\varepsilon_{t+1})}\right]}{(1-\beta)\widehat{q}_t^{\mu=0} f_1(\varepsilon_t)}.
\end{aligned}
$$

For relative risk aversion rate α greater than one, $f_2(\varepsilon_{t+1})$ is a decreasing function of ε_{t+1}, while $f_1(\varepsilon_{t+1})$ is an increasing function of ε_{t+1}. Thus, the covariance between them is negative, which means that the value of the nominal equity premium is positive.

Linearizing the functions $f_1(.)$ and $f_2(.)$ around the mean dividend $\bar{\varepsilon}$, we get:

$$\begin{aligned}
B_1 &\simeq \frac{\bar{\varepsilon}}{\lambda^\alpha \bar{y}} + \frac{[\alpha\bar{\varepsilon}(1-\lambda)(1+\alpha+\lambda(3-\alpha)) + 2\lambda^2\bar{\varepsilon} + 2\lambda\bar{y}(\lambda(\alpha-1)-\alpha)]\sigma_\varepsilon^2}{2\lambda^{2+\alpha}\bar{y}^3}, \\
B_2 &\simeq \bar{y}^{1-\alpha} + \frac{\alpha(\alpha-1)\sigma_\varepsilon^2}{2\bar{y}^{1+\alpha}}, \\
\mathrm{E}\frac{f_1(\varepsilon_{t+1})}{f_2(\varepsilon_{t+1})} &\simeq \frac{\bar{\varepsilon}\bar{y}^{\alpha-2}}{\lambda^\alpha} + \frac{\bar{y}^{\alpha-3}\sigma_\varepsilon^2}{\lambda^\alpha}\left[2(\alpha-1) - \frac{\alpha}{\lambda} + \frac{\bar{\varepsilon}}{\bar{y}}\left((\alpha-1)(2\alpha-3)\bar{y} + \frac{\alpha(\alpha+1)}{2\lambda^2} - \frac{2\alpha(\alpha-1)}{\lambda}\right)\right], \\
\mathrm{E}\frac{1}{f_2(\varepsilon_{t+1})} &\simeq \bar{y}^{\alpha-1} + \frac{(\alpha-1)(\alpha-2)\bar{y}^{\alpha-3}\sigma_\varepsilon^2}{2}.
\end{aligned}$$

Replacing the value of related elements in the equation of nominal equity premium above, we have the expression of $\Pi_{t+1}^{\mu=0}$. We calculate real equity premium under the constant money supply policy, using equation (17). To do so, we first calculate the following expressions:

$$\begin{aligned}
\mathrm{E}_t\frac{u'(c_{t+1}^{T,\mu=0})}{p_{t+1}^{\mu=0}} &= \frac{\lambda^\alpha(\bar{y}+\varepsilon_t-\bar{\varepsilon})^\alpha}{\bar{M}_t(\lambda\bar{y}+\varepsilon_t-\bar{\varepsilon})^\alpha}\mathrm{E}_t(\bar{y}+\varepsilon_{t+1}-\bar{\varepsilon})^{1-\alpha} \\
&= \frac{\lambda^\alpha(\bar{y}+\varepsilon_t-\bar{\varepsilon})^\alpha}{\bar{M}_t(\lambda\bar{y}+\varepsilon_t-\bar{\varepsilon})^\alpha}B_2, \\
\mathrm{E}_t\frac{1}{p_{t+1}^{\mu=0}} &= \frac{\bar{y}}{\bar{M}_t}, \\
\mathrm{E}_t u'(c_{t+1}^{T,\mu=0})\hat{q}_{t+1}^{\mu=0} &= \beta\lambda^\alpha B_2\left[\mathrm{E}_t f_1(\varepsilon_{t+1}) + \frac{\beta B_1}{1-\beta}\right] \\
&= \frac{\beta\lambda^\alpha B_1 B_2}{1-\beta}.
\end{aligned}$$

Remark 4. *The Real Equity Premium*
Replacing the value of related elements in equation (17), the expression of real equity premium is:

$$\hat{\Pi}_{t+1}^{\mu=0} = \frac{1}{\hat{q}_t^{\mu=0}}\left[\mathrm{E}_t\hat{q}_{t+1}^{\mu=0} - \frac{\beta B_1\bar{y}(\lambda\bar{y}+\varepsilon_t-\bar{\varepsilon})^\alpha}{(1-\beta)(\bar{y}+\varepsilon_t-\bar{\varepsilon})^\alpha}\right],$$

where

$$\begin{aligned}
\mathrm{E}_t\hat{q}_{t+1}^{\mu=0} \simeq{}& \beta B_2\left(\frac{\lambda\bar{y}+\varepsilon_t-\bar{\varepsilon}}{\bar{y}+\varepsilon_t-\bar{\varepsilon}}\right)^\alpha [\frac{\beta B_1\left(\bar{y}^\alpha + \frac{\alpha(\alpha-1)\bar{y}^{\alpha-2}\sigma_\varepsilon^2}{2}\right)}{1-\beta} + \frac{\bar{\varepsilon}\bar{y}^{\alpha-1}}{\lambda^\alpha} + \\
& \frac{\bar{y}^{\alpha-3}\sigma_\varepsilon^2[\bar{\varepsilon}(\alpha^2(1-2\lambda)^2 + \alpha(-6\lambda^2+2\lambda+1) + 2\lambda^2) + 2\lambda\bar{y}(\alpha(2\lambda-1)-\lambda)]}{2\lambda^{\alpha+2}}].
\end{aligned}$$

A.3.2 Optimal Monetary Policy

When the monetary authority acts optimally and aims to maximize total welfare, the optimal money growth rate follows equation (21). Combing with equations (21) and (A.8) and assuming that the series of dividends $\{\varepsilon_t\}_{t=0}^{\infty}$ is *i.i.d*, we find the value of real stock price:

$$\begin{aligned}
\widehat{q}_t^* &= \frac{(c_t^T)^\alpha}{\bar{y}} \sum_{j=1}^{\infty} \mathrm{E}_t \beta^j (\bar{y} + \varepsilon_{t+j} - \bar{\varepsilon})^{1-\alpha} \varepsilon_{t+j-1} \\
&= \frac{(c_t^T)^\alpha}{\bar{y}} \sum_{j=1}^{\infty} \mathrm{E}_t \beta^j f_2(\varepsilon_{t+j}) \varepsilon_{t+j-1} \\
&= \frac{\beta B_2 (c_t^T)^\alpha}{\bar{y}} \left[\varepsilon_t + \frac{\beta \bar{\varepsilon}}{1-\beta} \right].
\end{aligned}$$

From the above equation, we see that the real stock price is an increasing function of current dividend ε_t. Also, using Jensen's Inequality, we get $B_2 = \mathrm{E}_t(\bar{y} + \varepsilon_{t+1} - \bar{\varepsilon})^{1-\alpha} \geq \bar{y}^{1-\alpha}$; then the real stock price is:

$$\widehat{q}_t^* \geq \beta \left(\frac{\bar{y} + \varepsilon_t - \bar{\varepsilon}}{\bar{y}} \right)^\alpha \left[\varepsilon_t + \frac{\beta \bar{\varepsilon}}{1-\beta} \right] = \beta \left(\frac{1}{1 + \mu_{t+1}^*} \right)^\alpha \left[\varepsilon_t + \frac{\beta \bar{\varepsilon}}{1-\beta} \right].$$

The lower bound of the stock price is a decreasing function of mean income $\bar{y}$. When the monetary policy is conducted optimally, the money growth rate is an increasing function of mean income level so as the inflation level, which will lower the real stock price.

Since $\frac{u'(c_{t+1}^T)}{p_{t+1}} = \frac{(\bar{y}+\varepsilon_{t+1}-\bar{\varepsilon})^{1-\alpha}}{M_{t+1}} = \frac{f_2(\varepsilon_{t+1})}{M_{t+1}}$, then $\mathrm{E}_t \frac{u'(c_{t+1}^T)}{p_{t+1}} = \frac{B_2}{M_{t+1}}$, which together with the nominal equity premium equation $\mathrm{E}_t \Pi_{t+1} = -\frac{\mathrm{Cov}_t\left(\frac{u'(c_{t+1}^T)}{p_{t+1}}, R_{t+1}\right)}{\mathrm{E}_t \frac{u'(c_{t+1}^T)}{p_{t+1}}}$ implies:

$$\begin{aligned}
\Pi_{t+1}^* &= -\frac{\mathrm{Cov}_t\left(\frac{u'(c_{t+1}^T)}{p_{t+1}}, \frac{\widehat{q}_{t+1}^*(1+\Pi_{t+1})+\varepsilon_t}{\widehat{q_t}^*}\right)}{\mathrm{E}_t \frac{u'(c_{t+1}^T)}{p_{t+1}}} = -\frac{\mathrm{Cov}_t\left(\frac{u'(c_{t+1}^T)}{p_{t+1}}, \widehat{q}_{t+1}^* p_{t+1}\right)}{p_t \widehat{q_t}^* \mathrm{E}_t \frac{u'(c_{t+1}^T)}{p_{t+1}}} \\
&= -\frac{\beta}{\widehat{q_t}^*} \mathrm{Cov}_t\left(f_2(\varepsilon_{t+1}), \frac{1}{f_2(\varepsilon_{t+1})} \left(\varepsilon_{t+1} + \frac{\beta \bar{\varepsilon}}{1-\beta} \right) \right) \\
&= \frac{\beta}{\widehat{q_t}^*} \left[B_2 \mathrm{E}_t \frac{1}{f_2(\varepsilon_{t+1})} \left(\varepsilon_{t+1} + \frac{\beta \bar{\varepsilon}}{1-\beta} \right) - \frac{\bar{\varepsilon}}{1-\beta} \right].
\end{aligned}$$

Since $\mathrm{Cov}_t(f_2(\varepsilon_{t+1}), \varepsilon_{t+1} + \frac{\beta \bar{\varepsilon}}{1-\beta})$ is positive, the equity premium is always positive, and is an increasing function of mean income $\bar{y}$.

Also, the real stock price becomes:

$$\widehat{q}_t^* \simeq \frac{\beta}{\bar{y}^\alpha}\left[1+\frac{\alpha(\alpha-1)\sigma_\varepsilon^2}{2\bar{y}^2}\right][\bar{y}+\varepsilon_t-\bar{\varepsilon}]^\alpha\left[\varepsilon_t+\frac{\beta\bar{\varepsilon}}{1-\beta}\right].$$

We see that the real stock price is an increasing function of the relatively risk aversion rate α under optimal monetary policy.

Linearizing the equation of nominal equity premium above, around the mean dividend, we get the nominal equity premium:

$$\Pi_{t+1}^* \simeq \frac{\beta(\alpha-1)\sigma_\varepsilon^2}{\widehat{q}_t{}^*\bar{y}}\left[1+\frac{(\alpha-1)\bar{\varepsilon}}{(1-\beta)\bar{y}}+\frac{\alpha(\alpha-1)\sigma_\varepsilon^2}{2\bar{y}^2}\left(1+\frac{(\alpha-2)\bar{\varepsilon}}{2(1-\beta)\bar{y}}\right)\right].$$

Also, we have that under the optimal policy:

$$\begin{aligned}
\mathrm{E}_t\frac{u'(c_{t+1}^{T*})}{p_{t+1}^*} &= \mathrm{E}_t\frac{(\bar{y}+\varepsilon_{t+1}-\bar{\varepsilon})^{1-\alpha}}{\bar{M}_t(1+\mu_{t+1}^*)} = \frac{\bar{y}+\varepsilon_t-\bar{\varepsilon}}{\bar{M}_t\bar{y}}\mathrm{E}_t(\bar{y}+\varepsilon_{t+1}-\bar{\varepsilon})^{1-\alpha} \\
&= \frac{\bar{y}+\varepsilon_t-\bar{\varepsilon}}{\bar{M}_t\bar{y}}B_2, \\
\mathrm{E}_t\frac{1}{p_{t+1}^*} &= \frac{\bar{y}+\varepsilon_t-\bar{\varepsilon}}{\bar{M}_t}, \\
\mathrm{E}_t u'(c_{t+1}^{T*})\widehat{q}_{t+1}^* &= \frac{\beta B_2\bar{\varepsilon}}{(1-\beta)\bar{y}}.
\end{aligned}$$

Remark 5. *The Real Equity Premium*
Replacing the value of the related elements computed above, in equation (17), the expression of real equity premium under the optimal monetary policy is:

$$\hat{\Pi}_{t+1}^* = \frac{1}{\hat{q}_t^*}\left[\mathrm{E}_t\hat{q}_{t+1}^* - \frac{\beta\bar{\varepsilon}}{1-\beta}\right],$$

here,

$$\mathrm{E}_t\hat{q}_{t+1}^* \simeq \beta B_2\bar{y}^{\alpha-3}\left[\frac{\bar{\varepsilon}\bar{y}^2}{1-\beta}+\left(\bar{y}+\frac{(\alpha-1)\bar{\varepsilon}}{2(1-\beta)}\right)\alpha\sigma_\varepsilon^2\right].$$

A.3.3 Inflation Targeting Policy

When monetary authorities target inflation, equation (24) reveals the way monetary policy operates. Trader's consumption level given by (13), can be written as follows:

$$c_{t+j}^T = \frac{(1+\bar{\pi})(\bar{y}+\varepsilon_{t+j}-\bar{\varepsilon})+\bar{y}(\lambda-1)}{\lambda(1+\bar{\pi})} = \frac{1}{\lambda(1+\bar{\pi})f(\varepsilon_{t+j})},$$

which is an increasing function of ε_{t+j}. $f(\varepsilon_{t+j}) = \frac{1}{(\lambda-1)\bar{y}+(1+\bar{\pi})(\bar{y}+\varepsilon_{t+j}-\bar{\varepsilon})}$ is as defined in the previous section. For $j > 1$, we have:

$$\mathrm{E}_t\left(\frac{c_t^T}{c_{t+j}^T}\right)^{\alpha}\frac{p_{t+j-1}}{p_{t+j}}\varepsilon_{t+j-1} = \frac{(c_t^T)^{\alpha}\bar{\varepsilon}}{1+\bar{\pi}}\mathrm{E}_t\frac{1}{(c_{t+j}^T)^{\alpha}} = \frac{\bar{\varepsilon}}{(1+\bar{\pi})f(\varepsilon_t)^{\alpha}}\mathrm{E}_t f(\varepsilon_{t+j})^{\alpha}.$$

Assuming that the series of dividends $\{\varepsilon_t\}_{t=0}^{\infty}$ is $i.i.d$, then $E_t f(\varepsilon_{t+j})^{\alpha} = C$ is constant for all $j \geq 1$. Therefore, we have the expression of real stock price given below:

$$\widehat{q}_t^{\bar{\pi}} = \frac{\beta C}{(1+\bar{\pi})f(\varepsilon_t)^{\alpha}}\left[\varepsilon_t + \frac{\beta\bar{\varepsilon}}{1-\beta}\right].$$

We define the nominal equity premium as $\Pi_{t+1} \equiv R_{t+1} - r_{t+1}$, with the gross nominal return of the short-term bond being $r_{t+1} \equiv \frac{1}{s_t}$, and the gross nominal return of the risky asset being $R_{t+1} \equiv \frac{q_{t+1}+p_t\varepsilon_t}{q_t}$. Then it turns out that the nominal equity premium $\mathrm{E}_t\Pi_{t+1} = -\frac{\mathrm{Cov}_t\left(\frac{u'(c_{t+1}^T)}{p_{t+1}}, R_{t+1}\right)}{\mathrm{E}_t\frac{u'(c_{t+1}^T)}{p_{t+1}}}$. Using the above equations on consumption we get:

$$\begin{aligned}
\Pi_{t+1}^{\bar{\pi}} &= -\frac{\mathrm{Cov}_t\left(\frac{u'(c_{t+1}^T)}{p_{t+1}}, \frac{\widehat{q}_{t+1}^{\bar{\pi}}(1+\bar{\pi})+\varepsilon_t}{\widehat{q}_t^{\bar{\pi}}}\right)}{\mathrm{E}_t\frac{u'(c_{t+1}^T)}{p_{t+1}}} = -\frac{\mathrm{Cov}_t\left(\frac{u'(c_{t+1}^T)}{p_{t+1}}, \widehat{q}_{t+1}^{\bar{\pi}}(1+\bar{\pi})\right)}{\widehat{q}_t^{\bar{\pi}}E_t\frac{u'(c_{t+1}^T)}{p_{t+1}}} \\
&= -\frac{\beta}{\widehat{q}_t^{\bar{\pi}}}\mathrm{Cov}_t\left(f(\varepsilon_{t+1})^{\alpha}, \frac{1}{f(\varepsilon_{t+1})^{\alpha}}\left(\varepsilon_{t+1}+\frac{\beta\bar{\varepsilon}}{1-\beta}\right)\right) \\
&= \frac{\beta}{\widehat{q}_t^{\bar{\pi}}}\left[C\mathrm{E}_t\frac{1}{f(\varepsilon_{t+1})^{\alpha}}\left(\varepsilon_{t+1}+\frac{\beta\bar{\varepsilon}}{1-\beta}\right) - \frac{\bar{\varepsilon}}{1-\beta}\right].
\end{aligned}$$

Linearizing function $f(.)$ around the mean dividend, we have:

$$C \simeq \frac{1}{[(\lambda+\bar{\pi})\bar{y}]^{\alpha}} + \frac{\alpha(\alpha+1)(1+\bar{\pi})^2\sigma_{\varepsilon}^2}{2[(\lambda+\bar{\pi})\bar{y}]^{\alpha+2}},$$

$$\mathrm{E}_t \frac{1}{f(\varepsilon_{t+1})^{\alpha}}\left(\varepsilon_{t+1} + \frac{\beta\bar{\varepsilon}}{1-\beta}\right) \simeq \frac{\bar{\varepsilon}[\bar{y}(\lambda+\bar{\pi})]}{1-\beta} + \frac{\alpha(1+\bar{\pi})[(\lambda+\bar{\pi})\bar{y}]^{\alpha-2}\sigma_{\varepsilon}^2[2(1-\beta)\bar{y}(\lambda+\bar{\pi})+(\alpha-1)(1+\bar{\pi})\bar{\varepsilon}]}{2(1-\beta)}.$$

Replacing the expression of C in the real stock price equation above, we get:

$$\widehat{q}_t^{\bar{\pi}} \simeq \frac{\beta[(\lambda-1)\bar{y}+(1+\bar{\pi})(\bar{y}+\varepsilon_t-\bar{\varepsilon})]^{\alpha}}{(1+\bar{\pi})[(\lambda+\bar{\pi})\bar{y}]^{\alpha}}\left[1+\frac{\alpha(\alpha+1)(1+\bar{\pi})^2\sigma_{\varepsilon}^2}{2[(\lambda+\bar{\pi})\bar{y}]^{\alpha}}\right]\left[\varepsilon_t + \frac{\beta\bar{\varepsilon}}{1-\beta}\right].$$

We get the expression of $\Pi_{t+1}^{\bar{\pi}}$ by substituting in the nominal equity premium equation, the equation of real stock price.

Remark 6. *The Real Equity Premium*
Since $\mathrm{E}_t\hat{\Pi}_{t+1} = \mathrm{E}_t\frac{p_t}{p_{t+1}}\Pi_{t+1}$*, under the inflation targeting policy, the real equity premium is as follows:*

$$\begin{aligned}\mathrm{E}_t\hat{\Pi}_{t+1}^{\bar{\pi}} &= \mathrm{E}_t\frac{\Pi_{t+1}^{\bar{\pi}}}{1+\bar{\pi}} \\ &= \frac{\beta}{(1+\bar{\pi})\widehat{q}_t^{\bar{\pi}}}\left[CE_t\frac{1}{f(\varepsilon_{t+1})^{\alpha}}\left(\varepsilon_{t+1}+\frac{\beta\bar{\varepsilon}}{1-\beta}\right) - \frac{\bar{\varepsilon}}{1-\beta}\right],\end{aligned}$$

where C *is as defined above.*