Cardiff Economics Working Papers

Working Paper No. E2013/13

Fiscal Policy and the Nominal Term Premium

Lorant Kaszab and Ales Marsal

November 2013

Cardiff Business School
Aberconway Building
Colum Drive
Cardiff CF10 3EU
United Kingdom
t: +44 (0)29 2087 4000
f: +44 (0)29 2087 4419
business.cardiff.ac.uk

Fiscal Policy and the Nominal Term Premium*

Lorant Kaszab
Cardiff Business School

Ales Marsal
Charles University Prague

November 27, 2013

Abstract

Distortionary income taxation in a standard New Keynesian model substantially increases the nominal term-premium on long-term bonds relative to a model with lump-sum taxes. Also the empirical level of the nominal term premium can be matched with lower risk-aversion coefficient in case of a model with income taxes relative to a model with long-run inflation risks.

Keywords: zero-coupon bond, nominal term premium, third-order approximation, distortionary income taxation

JEL: E13, E31, E43, E44, E62

1 Introduction

Long-term nominal bonds deliver term-premium in order to compensate for future inflation and consumption risks the bond-holder has to bear. Rudebusch and Swanson (2012) make use of a basic New Keynesian model and finds that the term premium can be large and volatile. They assume the simplest fiscal scenario where government spending is financed with lump-sum taxes and deficits are not allowed. Further they show that long-run inflation risks like uncertainty about the inflation target substantially increase the term-premium. Van Binsbergen et al. (2012) estimate a simplified version of the model in Rudebusch and Swanson (2012) with Bayesian methods and points toward further investigation of the model

*Emails: kaszabl@cf.ac.uk; ales.marsal@seznam.cz.

We thank for the support of the Czech Academy of Sciences (GACR P402/12/1993). Ales/Lorant is grateful for the hospitality of the European Central Bank/Hungarian National Bank while writing this paper. We also thank for the comments we received in Budapest, Cardiff, Frankfurt and Prague.

with a fiscal structure added. There are several empirical papers like Engen and Hubbard (2004), Laubach (2003) and Canzoneri et al. (2002) who find a positive connection between deficit and long-term bond yields using various econometric methods.

This paper proposes a simple alternative way to generate long-run inflation risks. In particular, we introduce distortionary income taxation into the model of Rudebusch and Swanson (2012) and find that the term premium on nominal bonds is higher than with lump-sum taxes. Thus, fiscal policy provides another good reason why long-term nominal bonds are risky. Further we show that the model with income taxation is able to generate the mean level of the empirical nominal term premium with a risk-aversion coefficient that is much lower than the one needed in case of the model with long-run inflation risks.

Rudebusch and Swanson (2012) show that a basic New Keynesian model approximated to the third order in the sense of Taylor series is able to generate large and volatile term premium that is in line with US data. The term-premium is constant to the second order while it becomes time-varying to the third-order. The only asset in their model is a default-free government bond. These assets are risky as their real payoff covaries positively with consumption. In particular, shocks that result in low consumption, high inflation and, thus, low real yields are important sources of the term premia. There are no liquidity risks in their model.

The most important feature of Rudebusch and Swanson (2012) model are Epstein-Zin preferences. Earlier papers in the literature considered preferences with consumption habits (see, for instance, de Paoli et al. (2006) and the literature review in Rudebusch and Swanson (2008)). With habits households are mainly concerned about sudden changes in consumption. However, with Epstein-Zin preferences they are unhappy with changes in consumption over medium and long horizons as well as short horizons. The household can offset short-run changes in consumption by modifying its labor supply and savings (also known as precautionary savings) but its ability to smooth consumption at medium- and long-run is much more limited.

This paper departs from Rudebusch and Swanson (2012) who assume that government spending is financed by lump-sum taxes in each period. In their model there is no deficit allowed and, hence, no role for government debt. Below we show that allowing for government debt change properties of the term-premium to a small extent if deficit is financed by lump-sum taxes. As an alternative of lump-sum taxes we introduce distortionary taxation into the Rudebusch and Swanson (2012) model following Linnemann (2006) who postulates that government collect revenue by levying the same tax rate on labor and profit income. When government debt is paid back through income taxes the mean term-premium is substantially higher than with lump-sum taxes and similar in magnitude to what can be obtained using the long-run inflation risk version of Rudebusch and Swanson (2012). Also the fit of the model with our fiscal extension and the one with long-run inflation risks relative to US data are quite similar using the baseline calibration of Rudebusch and Swanson (2012).

The paper is organised as follows. Section 2 describes the model. Section 3 is on calibration and solution method. Section 3 provides details about the main results. The last section concludes.

2 The model

The household maximises the continuation value of its utility (V):

$$V_t = \begin{cases} U(C_t, L_t) + \beta \left[E_t V_{t+1}^{1-\alpha}\right]^{\frac{1}{1-\alpha}} & \text{if } U(C_t, L_t) \geq 0 \\ U(C_t, L_t) - \beta \left[E_t(-V_{t+1})^{1-\alpha}\right]^{\frac{1}{1-\alpha}} & \text{if } U(C_t, L_t) < 0 \end{cases} \tag{1}$$

with respect to its flow budget constraint. β is the discount factor. Utility (U) at period t is derived from consumption (C_t) and leisure ($1 - L_t$). As the time frame is normalised to one leisure time ($1 - L_t$) is what we are left with after spending some time working (L_t). The recursive functional form in equation (1) is called Epstein-Zin preferences and is the same as the one used by Rudebusch and Swanson (2012). To be consistent with balanced growth Rudebusch and Swanson (2012) imposes the following functional form on U:

$$U(C_t, L_t) = \frac{C_t^{1-\varphi}}{1-\varphi} + \chi_0 Z_t^{1-\varphi} \frac{L_t^{1-\chi}}{1-\chi}, \qquad \varphi, \chi > 0.$$

where Z_t is an aggregate productivity trend and φ, χ, $\chi_0 > 0$. The intertemporal elasticity of substitution (IES) is $1/\varphi$ and the Frisch labor supply elasticity is given by $(1 - l)/\chi l$ where l is the steady-state of hours worked. Rudebusch and Swanson (2012) derives the following relationship between coefficient of relative risk-aversion ($CRRA$) and the curvature parameter α in the recursive utility (1):

$$CRRA = \frac{\varphi}{1 + \frac{\varphi}{\chi}} + \alpha \frac{1-\varphi}{1 + \frac{1-\varphi}{1-\chi}\frac{1-l}{l}}.$$

Nominal term premium on a long-term bond, say a 10 year-bond, is computed as the return on the risky 10-year bond minus the return on a bond that is rolled over 10 years. The yield on the latter strategy is often called as risk-neutral yield which is consistent with the expectations hypothesis of the term structure. The nominal term premium cannot be observed empirically. Therefore, we also calculate alternative measures of the term premium like the mean and standard deviation of slope of the term structure and excess holding period returns that are observable.

The intermediary firm produces output (Y_t) using the technology:

$$Y_t = A_t[K_t]^{1-\eta}[Z_t L_t]^{\eta}, \;\; 0 < \eta < 1$$

where $K_t = Z_t\bar{k}$ is the aggregate capital stock ($\bar{k}$ is fixed), η is the share of labor in production and A_t is a stationary aggregate productivity shock:

$$\log A_t = \rho_A \log A_{t-1} + \varepsilon_t^A,$$

where ε_t^A is an independently and identically distributed (iid) stochastic technology shock with mean zero and variance σ_A^2.

Intermediary firms which maximise their profits face price-setting frictions of Calvo style. With Calvo frictions a $1-\xi$ fraction of firms can set its price optimally in each period. Based on this we can derive the New Keynesian Phillips curve that establishes log-linear connection between inflation rate ($\hat{\pi}_t$) and the real marginal cost ($\widehat{mc}_t$)[1]:

$$\hat{\pi}_t = \tilde{\beta} E_t \hat{\pi}_{t+1} + \kappa \widehat{mc}_t. \tag{2}$$

where $\hat{\pi}_t \equiv \log(\pi_t/\pi)$, $\widehat{mc}_t \equiv \log(mc_t/mc)$. π_t and mc_t are de-trended inflation rate and real marginal cost i.e. $\pi_t \equiv \Pi_t/Z_t$ and $mc_t \equiv MC_t/Z_t$, respectively. The parameter $\kappa > 0$ is an inverse function of ξ, η and ε which is the elasticity of substitution among intermediary goods. Variables without a time index denote steady-states. $\tilde{\beta}$ stands for the discount factor that is corrected by the growth rate (γ) of the productivity trend (Z_t) i.e. $\beta\gamma^{-\varphi}$.

Intermediary products are bundled into a final product through a Dixit-Stiglitz aggregator. Bundlers are perfectly competitive firms.

The New-Keynesian model is closed by a monetary policy rule (so called Taylor rule):

$$R_t = \rho R_{t-1} + (1-\rho)[R + \log\bar{\Pi}_t + g_\pi(\log\bar{\Pi}_t - \log\Pi_t^*) + g_y(Y_t - Y_t^*)/Y_t^*] + \varepsilon_t^i$$

where R_t is the policy rate, $\bar{\Pi}_t$ is a four-quarter moving average of inflation and Y_t^* is the trend level of output yZ_t (where y denotes the steady-state level of Y_t/Z_t). Π_t^* is the target rate of inflation, ε_t^i is an iid shock with mean zero and variance σ_i^2. In the baseline version of the Rudebusch and Swanson (2012) model without long-run inflation-risks the inflation target is constant ($\Pi_t^* = \Pi^*$ for all t).

[1] Here we use the log-linear version of the Phillips curve for illustration purposes the model is solved using the Phillips curve in its non-linear form.

The four-quarter moving average of inflation ($\bar{\Pi}_t$) can be approximated by a geometric moving average of inflation:

$$\log \bar{\Pi}_t = \theta_\pi \log \bar{\Pi}_t + (1 - \theta_\pi) \log \Pi_t, \tag{3}$$

where the choice of $\theta_\pi = 0.7$ ensures that the geometric average in equation (3) has an effective duration of about four quarters.

In the long-run inflation risk version of Rudebusch and Swanson (2012) model they make the inflation target stochastic:

$$\Pi_t^* = \rho_{\pi^*}^* \Pi_{t-1}^* + \vartheta_{\pi^*}(\bar{\Pi}_t - \Pi_t^*) + \varepsilon_t^{\pi^*}, \quad \vartheta_{\pi^*} > 0, \varepsilon_t^{\pi^*} > 0,$$

where $\varepsilon_t^{\pi^*}$ is an iid inflation target shock with mean zero and variance $\sigma_{\pi^*}^2$.

Note that in this paper we set $\vartheta_{\pi^*} = \rho_{\pi^*} = \varepsilon_t^{\pi^*} = 0$ when considering different sorts of fiscal scenarios.

The government spending follows the process:

$$\log(g_t/g) = \rho_G \log(g_{t-1}/g) + \varepsilon_t^G, \quad 0 < \rho_G < 1,$$

where g is the steady-state level of $g_t \equiv G_t/Z_t$, and ε_t^G is an iid shock with mean zero and variance σ_G^2.

Rudebusch and Swanson (2012) assume that government spending is financed through lump-sum taxes in each period i.e. government budget is balanced. Instead, we can allow for deficit that is retired through lump-sum taxes:

$$b_t + t_t = \frac{\gamma^{-1} r_{t-1} b_{t-1}}{\pi_t} + g_t \tag{4}$$

where b_t, t_t, r_t and π_t stand for the de-trended government debt, lump-sum taxes, short-term nominal interest rate and inflation, respectively. All quantities are expressed as real except for the nominal interest rate (r_t). $r_{t-1}b_{t-1}$ are interest-payments on the previous period debt. If one imposes the restriction of $b_t = b_{t-1} = 0$ for all t expression (4) boils down to the case of balanced budget ($g_t = t_t$ for all t).

The tax rule in case of lump-sum taxes is given by:

$$t_t = \psi \gamma^{-1} b_{t-1}$$

where $\psi \in (0, 2)$ ensures that fiscal policy is passive in the sense of Leeper (1991). When ψ is set to be close to zero debt is paid back in the very long-run. By contrast a coefficient of

ψ close to two roughly mimics the case of balanced budget.

An alternative way to retire government debt is through income tax revenue ($\tau_t y_t$):

$$b_t + \tau_t y_t = \frac{\gamma^{-1} r_{t-1} b_{t-1}}{\pi_t} + g_t. \tag{5}$$

where τ_t is the income tax rate. y_t is the de-trended level of output that equals to the sum of profit and labor income which are taxed at the same rate.

The tax revenue rule for the latter case is given by:

$$\tau_t y_t = \psi \gamma^{-1} b_{t-1}. \tag{6}$$

To observe the role of steady-state debt we linearise equation (5) to the first-order:

$$\hat{b}_t + d\tau_t + \tau \hat{y}_t = \gamma^{-1}(\gamma_b dr_{t-1} + r\hat{b}_{t-1} - \gamma_b r \hat{\pi}_t) + \hat{g}_t \tag{7}$$

where $\hat{b}_t \equiv (b_t - b)/y$, $d\tau_t \equiv \tau_t - \tau$, $dr_t \equiv r_t - r$, $\hat{y}_t \equiv (y_t - y)/y$, $\hat{g}_t \equiv (g_t - g)/y$ and γ_b is the government debt-to-GDP ratio. Variables without a time index denote steady-state values. Note that the deviations of debt and government spending from their respective steady-states is defined relative to the steady-state output, which is standard in the literature (see, e.g., Linnemann (2006)). When steady-state debt is zero i.e. $\gamma_b = 0$ real interest rate $(dr_{t-1} - r\pi_t)$ does not have a direct effect on taxes $(d\tau_t)$. More intuition is provided below.

Finally we note that goods and labor markets clear in equilibrium and the transversality condition regarding the bond-holdings is satisfied.

3 Calibration and solution method

Calibration can be found in Table (1) that follow the baseline parameter values of Rudebusch and Swanson (2012). The coefficient in the lump-sum tax rule (ψ) is the one of Corsetti et al. (2012). Unlike Linnemann (2006) who linearises his model to the first-order we make use of the tax-rule in its non-linear form so that ψ is needed to pin down the steady-state tax rate which is given by $\tau = ((1/\beta)(b/y)(1/\gamma) + g/y)/(1 + \gamma/\psi)$. The quarterly steady-state debt-to-GDP ratio (b/y) of sixty per cent is based on Rossi (2012). As a baseline we set $\psi = 0.12$ so that the steady-state tax rate is 0.2767 which is slightly higher than that of Linnemann (2006)[2]. The whole model is approximated to the third order using Dynare (Adjemian et al. 2011) in Matlab when calculating all the moments in table (2) and (3). To speed up calculations for figure (1) we used second-order approximation as unconditional

[2] The choice of $\psi = 0.02$ implies a steady-state tax rate of less than 1 percent that is empirically implausible.

means—unlike standard deviations—are quite similar in magnitude for second- and third-order approximations.

4 Results

Figure (1) shows that there is positive linear relationship between the risk-aversion coefficient and mean of the nominal term premium. The straight line reproduces the baseline model of Rudebusch and Swanson (2012) without debt and long-run risks. The introduction of debt into the baseline model with lump-sum taxes raises the term-premium (see dashed line). The baseline model with long-run risks is depicted with dots. The model with debt and income taxes are demonstrated for two different values of the coefficient in the policy rule, ψ (see the circles and diamonds). One can see that the extension of the Rudebusch and Swanson (2012) model with debt and distortionary taxes generates a term-premium close to the one obtained with long-run risks for both values of ψ. When taxation is distortionary the curve is steeper than with lump-sum taxes implying higher inflation/real risks in case of income taxation.

Binsbergen et al. (2012) and Piazzesi and Schneider (2006) show that a DSGE model successfully replicates several properties of the term-structure when consumption growth and inflation are negatively correlated contemporaneously and forecast each other with a negative sign. The Rudebusch and Swanson (2012) model features temporary productivity shocks in order to generate the previous patterns. In particular, a temporary negative shock to productivity leads to a fall in consumption and an increase in inflation due to the rise in marginal cost. As a result, nominal bonds carry positive term premia as depressed consumption is associated with a time of low real bond yields due to higher inflation.

Our fiscal extension with income taxation has the implication similar to that of productivity shocks. To shed light on the mechanism let us study what happens after a positive innovation to government spending that needs to be financed sooner (ψ is close to two) or later (ψ is close to zero) with income taxes. Higher taxes on income imply less hours worked and lower output because households substitute away from labor to leisure. Also higher income taxes means higher real marginal cost and higher inflation through the New Keynesian Phillips curve (see equation (2)). The effect of the previous channel is magnified by positive steady-state debt (see $\gamma_b > 0$ in equation (7)) establishing direct connection between taxes and real interest rate which surely rises after a stimulative shock according to the logic of the Taylor rule to curb inflation expectations (Linnemann, 2006). It would be of interest to test the significance of the size of the steady-state debt-to-GDP ratio. However, it is impractical to carry out an experiment with zero steady-state debt-to-GDP ratio because this would result in a steady-state tax rate that is extremely low (around 1.8 percent).

Table (2) summarises means and standard deviations of selected macro and finance variables using the baseline calibration of Rudebusch and Swanson (2012). Note that the mean value of the nominal term premium is very similar across the four versions of the baseline model. Regarding the standard deviations of finance variables it is the model with inflation risks that fits the data best. With the introduction of lump-sum taxes and endogenous debt (column three) we improve upon the performance of the baseline model. The macro and finance moments derived using the model with long-run inflation risks (column four) and the one with fiscal extension (column five) are roughly similar. The moments reported in column one (called RS) are directly comparable with those in Rudebusch and Swanson (2012).

We note that the standard deviations of macro and finance moments in column one (called RS) are slightly lower than those of Rudebusch and Swanson (2012, pp. 124, column 3 of table 2) for at least two reasons. First, they calculate theoretical moments while we obtain simulated moments. Second, they use a numerical precision of 90 digits available in software Mathematica while we have only sixteen digits available in Matlab.

Rudebusch and Swanson (2012) decrease their baseline values of IES and Frisch elasticity and increase the CRRA parameter in order to match US data[3]. A lower IES means that households dislike changes in consumption over time more than with a higher IES. A lower Frisch elasticity implies that households are less able to use their labor supply to offset negative shocks to consumption. As a consequence consumption stream is more volatile for relatively low values of IES and Frisch elasticity. Also a higher risk-aversion coefficient represents that households are more concerned about changes in future consumption flow and, therefore, require higher compensation in order to hold risky bonds whose real return co-moves positively with the consumption stream.

In Table (3) we lower the IES from 0.5 to 0.09 and the Frisch elasticity from 2/3 to 0.28 leaving other parameters at the level of the baseline calibration. The risk-aversion coefficient of 106 is chosen so that the model with fiscal policy can match a nominal term premium of 1.06 inferred from US data. Indeed after a reduction in the values of IES and Frisch elasticity the macro and finance variables exhibit higher standard deviations. Still some of the simulated moments like the standard deviation of the excess holding period return and the slope for a 10-year bond (denoted by $\mathrm{SD}(x^{(40)})$ and $\mathrm{SD}(R^{(40)} - R)$ respectively) are below the corresponding US data.

[3] To be precise, Rudebusch and Swanson (2012) change not only the IES and Frisch parameters when they consider their best-fit experiments but also properties of the stochastic processes and duration of the price rigidity. Instead, here, we focus only on changes in the IES, Frisch and CRRA parameters whose effects are well documented in the literature (see, e.g., van Binsbergen et al. (2012)). de Paoli et al. (2006) describes how a shorter duration of price rigidity raises the term-premium. However, we do not intend to deviate from the price-stickiness of a duration of 4 quarters on average (this is the baseline calibration).

Also importantly, the model with fiscal policy produces a mean of the nominal term premium (1.06) that is higher than the one with inflation-risks (0.72). The version of the model with inflation risks is able to generate the empirical mean of the term premium (1.06) only if the risk-aversion coefficient is 155. Thus, it follows that a particular level of the average nominal term premium can be achieved with lower CRRA using the fiscal extension compared to the inflation risk alternative. However, it is also true that the inflation-risk model performs better in terms of matching standard deviations of US data.

5 Conclusion

Fiscal policy can be an important source of long-run nominal risks in the sense that nominal term premium on government bonds rises substantially when spending is financed through income taxes relative to lump-sum taxes. Also employing the model with income taxes we can match the empirical level of the nominal term premium with lower risk-aversion coefficient than the one needed in case of the model with long-run inflation risks. In a companion paper we augment the above model with physical capital as in de Paoli et al. (2006) and find our main message to be robust.

References

[1] Canzoneri, Matthew B., Robert E. Cumby, and Behzad Diba (2002), "Should the European Central Bank and the Federal Reserve be Concerned About Fiscal Policy?" in Rethinking Stabilization Policy, proceedings of the symposium sponsored of the Federal Reserve Bank of Kansas City, Jackson Hole, Wyoming August 29 - 31, 2002, pp. 333-389

[2] de Paoli Bianca, Scott Alasdair and Olaf Weeken (2010), "Asset Pricing Implications of a New Keynesian Model", Journal of Economic Dynamics and Control 34:2056-2073.

[3] Adjemian Stéphane , Houtan Bastani, Michel Juillard, Frédéric Karamé, Ferhat Mihoubi, George Perendia, Johannes Pfeifer, Marco Ratto and Sébastien Villemot (2011), "Dynare: Reference Manual, Version 4," Dynare Working Papers, 1, CEPREMAP

[4] Engen, Eric M. and Glenn R. Hubbard (2004), "Federal Government Debt and Interest Rates," in Mark Gertler and Kenneth Rogoff, editors, "NBER Macroeconomics Annual 2004, Volume 19" MIT Press

[5] Gürkaynak Refet, Sack Brian and Eric Swanson (2005), "The Sensitivity of Long-Term Interest Rates to Economic News: Evidence and Implications for Macroeconomic Models." American Economic Review, 95(1): 425-36.

[6] Laubach Thomas (2009), "New Evidence on the Interest Rate Effects of Budget Deficits and Debt," Journal of the European Economic Association, MIT Press, vol. 7(4), pages 858-885, 06.

[7] Leeper, Eric (1991), "Equilibria Under 'Active' and 'Passive' Monetary and Fiscal Policies," Journal of Monetary Economics. vol. 27. pp. 129-147.

[8] Linnemann, Ludger (2006), "Interest rate policy, debt and indeterminacy with distortionary taxation," Journal of Economic Dynamics and Control. 30, 487-510.

[9] Piazzesi Monika and Martin Schneider (2006), "Equilibrium Yield Curves," NBER Macroeconomic Annual.

[10] Rossi, Raffaele (2012), "Designing Monetary and Fiscal Policy Rules in a New Keynesian Model with Rule-of-Thumb Consumers", Forthcoming in Macroeconomic Dynamics.

[11] Rudebusch and Swanson (2008) "Examining the Bond Premium Puzzle with a DSGE Model," Journal of Monetary Economics, 55:S111-S116.

[12] Rudebusch and Swanson (2012) "The Bond Premium in a DSGE Model With Long-Run Real and Nominal Risks." American Economics Journal of Macroeconomics, 4(1):105-143.

[13] van Binsbergen, Jules, Jesus Fernández-Villaverde, Ralph S. Koijen, and Juan F. Rubio-Ramírez (2012) "The Term Structure of Interest Rates in a DSGE Model with Recursive Preferences. " Journal of Monetary Economics.

[14] Corsetti Giancarlo, Meier A and Gernot Müller, 2012 "Fiscal Stimulus with Spending Reversals," Review of Economics and Statistics.

Table 1: Calibration

γ	1.0025	φ	2	ρ_i	0.73	ρ_A	.95
$\tilde{\beta}$	0.99	χ	3	g_π	0.53	ρ_G	.95
δ	0.02	CRRA	75	g_y	0.93	σ_A^2	0.005^2
l	1/3	η	2/3	Π^*	1	σ_G^2	0.005^2
K/Y	10	θ	0.2	ρ_{π^*}	0.99	ψ	0.12
G/Y	0.17	ξ	0.75	$\sigma_{\pi^*}^2$	$.0005^2$	γ_b	2.4
ε	6			ϑ_{π^*}	0.01		

where G/Y is the government spending-GDP ratio, K/Y is the share of fixed capital in GDP, δ is the depreciation rate of fixed capital. The rest of the parameters are explained above.

Figure 1: The relationship between the coefficient of relative risk-aversion (CRRA) and the mean of the nominal term premium using different versions of the Rudebusch and Swanson (2012) (=RS) model.

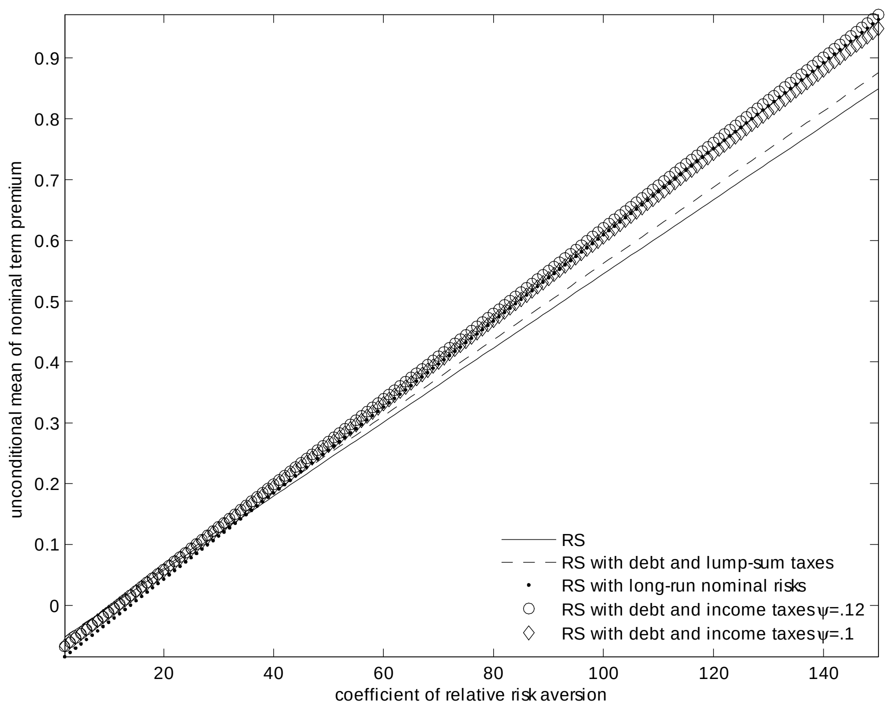

Table 2: Moments from variants of the Rudebusch and Swanson (=RS) (2012) model compared to US data

Unconditional Moment	US data, 1996-2007	RS	RS with debt and lump-sum taxes	RS with long-run risks*	RS with debt and income taxes
SD(C)	0.83	1.42	1.46	1.35	1.49
SD(L)	1.71	1.5	1.54	1.44	1.46
SD(W)	0.82	1.32	1.32	1.35	1.21
SD(π)	2.52	1.64	1.64	2.11	1.86
SD(R)	2.71	1.6	1.61	2.01	1.76
SD(R^{real})	2.30	0.93	0.93	0.98	0.98
SD ($R^{(40)}$)	2.41	0.85	0.85	1.33	0.95
Mean($NTP^{(40)}$)	1.06	0.39	0.4	0.42	0.44
SD($NTP^{(40)}$)	0.54	0.04	0.04	0.1	0.05
Mean($R^{(40)} - R$)	1.43	0.43	0.45	0.48	0.49
SD($R^{(40)} - R$)	1.33	0.9	0.89	0.87	0.96
Mean($x^{(40)}$)	1.76	0.69	0.72	0.81	0.79
SD($x^{(40)}$)	23.43	7.81	7.98	10.14	8.88

where SD=standard deviation, $NTP^{(40)}$=nominal term premium on a 40-quarter bond, Mean=Unconditional Mean, $R^{(40)} - R$ is the slope and $x^{(40)}$ is the excess holding period return for a 40-quarter bond. Each version of the models listed above utilises the baseline calibration of Rudebusch and Swanson (2012) that does not fit macro and finance moments of US data (neither here nor in their paper).
*Note that the results in this column are obtained using the baseline calibration of RS while they provide results using their best-fit calibration (see column 3 of table 3 on pp. 136 in Rudebusch and Swanson (2012)). In this paper we deem it important to compare the performance of the long-run inflation risk version with other versions making use of the baseline calibration of RS.

Table 3: Moments from variants of the Rudebusch and Swanson (=RS) (2012) model compared to US data

Unconditional Moment	US data, 1996-2007	RS with long-run risks	RS with debt and income taxes
SD(C)	0.83	0.44	0.65
SD(L)	1.71	1.41	1.83
SD(W)	0.82	2.77	2.35
SD(π)	2.52	2.57	2.20
SD(R)	2.71	2.24	2.42
SD(R^{real})	2.30	1.55	1.42
SD ($R^{(40)}$)	2.41	1.92	1.51
Mean($NTP^{(40)}$)	1.06	0.72	1.06
SD($NTP^{(40)}$)	0.54	0.57	0.25
Mean($R^{(40)} - R$)	1.43	0.79	0.68
SD($R^{(40)} - R$)	1.33	1.13	1.25
Mean($x^{(40)}$)	1.76	1.41	2.01
SD($x^{(40)}$)	23.43	16.18	14.58

In this table we used $CRRA = 106$, $Frisch = 0.28$ and $IES = 0.09$. The rest of the parameters follow the baseline calibration of Rudebusch and Swanson (2012).