Risk Premiums and Macroeconomic Dynamics in a Heterogenous Agent Model

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Motivation

- Asset prices contain useful information about private agents expectations on future growth, inflation and returns. In order to identify these expectations, we need to control for time varying risk premiums.
- In a standard DSGE model, these risk premiums are directly related to the stochastic discount factor of the representative consumer-investor. The structural model imposes many restrictions that can be useful to identify the contribution of risk premiums and expectations in the mean and the dynamics of the asset returns.
- Imposing that the DSGE model explains jointly the dynamics of the real and the financial variables of interest for monetary policy makers, implies a strong validation test for the model.

Motivation (continued)

- In a previous paper (De Graeve et al. 2007), we analyzed the yield curve in the context of the Smets Wouters model for the US. This standard monetary DSGE model does not generate significant risk premiums despite the presence of habits, investment adjustment costs and real wage rigidity. The average term premium in the yield curve was estimated as an unconstrained constant. The pure expectations hypothesis was driving the dynamics of the long bond returns.
- This paper evaluates which features of the DSGE can generate more significant risk premiums and at the same time produce realistic macro statistics. We start from a general heterogenous agent model, that incorporates the representative agent model, and the Guvenen (2003) and the Danthine & Donaldson (2002-2007) model as special cases.

Motivation (continued)

Why did we opt for an heterogoneous agent approach?

- With heterogeneous capital market participation across households, it is no longer the aggregate consumption stream that drives the pricing kernel for asset prices. The consumption of the more wealthy agents, who hold most of the capital stock, is more volatile than aggregate consumption.
- With heterogenous agents, the valuation of the financial assets will depend not only on aggregate risk, but also on distribution risk which is potentially important given the highly cyclical nature of the income distribution.

Motivation (continued)

Why did we opt for an heterogoneous agent approach?

- The risk sharing arrangements between different agents in the economy might also be useful to explain the observed rigidity in real wages, the countercyclical wage share and the highly volatile and procyclical profits.
- An explanation of the risk premium based on heterogeneous capital market participation has important consequences for wealth accumulation and wealth distribution. Therefore, this explanation for the risk premiums can be validated empirically more easily than alternative explantions based on unobserved features of the utility function.

Preliminary conclusions

- The heterogeneous agent setup offers an interesting alternative for the representative agent model: even with endogenous labour and capital.
- Heterogenous agent model is able to generate a significant risk premium and performs well in explaining aggregate statistics: the risk sharing considerations are able to generate endogenously the observed wage smoothness and the countercyclical wage share behavior.
- The combination of aggregate productivity risk and distribution risk further improves the results (inflation risk is more important for bonds than for stocks).
- But differentiating between equity and bond premiums remains difficult.
- The general model also produces a realistic wealth distribution.

Outline of the presentation

- Presentation of the general model
- Risk premium and macro implications in 3 special cases:
  1. Represenative agent model
  2. Guvenen model
  3. Danthine Donaldson
- Risk premium and macro implications in the general model
  1. aggregate, distribution and inflation risk
  2. risk premium on equity and bonds
  3. implications for the wealth distribution
- Preliminary conclusions + next steps

Properties of the general model

- 3 Types of agent/households with different participation in the capital market and different risk aversion, and all agents supply labour endogenously.
- Firms decide on the price setting and and on investment accumulation.
- With sticky prices, the monetary policy rule becomes important.
- Market clearing conditions in goods, labour, stock and bond market.
- Stochastic structure

Type 1 households: active shareholders

Objective function

$$\max E_0 \sum_{t=0}^{\infty} \beta^t U_1 \left(C_{1,t}, N_{1,t}\right)$$

Budget constraint

$$C_{1,t} + \frac{P_t^B}{P_t} B_{1,t+1} + \frac{P_t^{B,long}}{P_t} B_{1,t+1}^{long} + \frac{P_t^S}{P_t} S_{1,t+1}$$

$$= \frac{B_{1,t}}{P_t} + B_{1,t}^{long} \frac{\left(P_t^{B,long} + Coupon\right)}{P_t} + S_{1,t} \frac{\left(P_t^S + D_t\right)}{P_t} + \frac{W_t^s}{P_t} N_{1,t} + \frac{\Gamma_t}{P_t}$$

Type 1 households: active shareholders

FOC for consumption, labour supply, bonds and equity

$$(\partial C_{1,t}) \qquad \frac{\partial U_1(C_{1,t},N_{1,t})}{\partial C_{1,t}} - \lambda_{1,t} = 0$$

$$(\partial N_{1,t}) \qquad \frac{\partial U_1(C_{1,t},N_{1,t})}{\partial N_{1,t}} + \lambda_{1,t}\frac{W_t^s}{P_t} = 0$$

$$(\partial B_{1,t+1}) \qquad \beta E_t\left\{\frac{\lambda_{1,t+1}}{\lambda_{1,t}}\frac{1}{P_t^B}\frac{P_t}{P_{t+1}}\right\} = \beta E_t\left\{\frac{\lambda_{1,t+1}}{\lambda_{1,t}}R_{t+1}^f\frac{1}{\pi_{t+1}}\right\} = 1$$

$$(\partial B_{1,t+1}^{long}) \qquad \beta E_t\left\{\frac{\lambda_{1,t+1}}{\lambda_{1,t}}\frac{(P_{t+1}^{B,long}+Coupon)}{P_t^B}\frac{1}{\pi_{t+1}}\right\} = \beta E_t\left\{\frac{\lambda_{1,t+1}}{\lambda_{1,t}}R_{t+1}^{f,long}\frac{1}{\pi_{t+1}}\right\}$$

$$(\partial S_{1,t+1}) \qquad \beta E_t\left\{\frac{\lambda_{1,t+1}}{\lambda_{1,t}}\frac{(P_{t+1}^S+D_{t+1})}{P_t^S}\frac{1}{\pi_{t+1}}\right\} = \beta E_t\left\{\frac{\lambda_{1,t+1}}{\lambda_{1,t}}R_{t+1}^S\frac{1}{\pi_{t+1}}\right\} = 1$$

Type 2 households: passive shareholders

Objective function

$$\max E_0 \sum_{t=0}^{\infty} \beta_2^t U_2 \left(C_{2,t}, N_{2,t} \right)$$

Budget constraint

$$C_{2,t} + \frac{\left[P_t^B B_{2,t+1} + P_t^S S_{2,t+1}\right]}{P_t} \frac{1}{\phi(B_{t+1})} \leqslant B_{2,t} \frac{1}{P_t} + S_{2,t} \frac{\left(P_t^S + D_t\right)}{P_t} + \frac{W_t^s}{P_t} N_{2,t}$$

$$P_t^B B_{2,t+1} = \alpha^B \left[P_t^B B_{2,t+1} + P_t^S S_{2,t+1}\right]$$

Type 2 households: passive shareholders

FOC for consumption, labour supply and bonds/funds

$$(\partial C_{2,t}) \qquad \frac{\partial U_2(C_{2,t}, N_{2,t})}{\partial C_{2,t}} - \lambda_{2,t} = 0$$

$$(\partial N_{2,t}) \qquad \frac{\partial U_2(C_{2,t}, N_{2,t})}{\partial N_{2,t}} + \lambda_{2,t} \frac{W_t^s}{P_t} = 0$$

$$(\partial B_{2,t+1}) \quad \beta E_t \left\{ \frac{\lambda_{2,t+1}}{\lambda_{2,t}} \phi(B_{t+1}) \frac{\left[\alpha^B + (1-\alpha^B)(P_{t+1}^S + D_{t+1})\right]}{\left[\alpha^B P_t^B + (1-\alpha^B) P_t^S\right]} \frac{1}{\pi_{t+1}} \right\} = 1$$

Type 3 households: workers

Objective function

$$\max E_0 \sum_{t=0}^{\infty} \beta^t U_3 \left(C_{3,t}, N_{3,t} \right)$$

Budget constraint

$$C_{3,t} = W_t^c N_{3,t}$$

With imperfect capital market participation, workers and firms (or the marginal shareholder) have an incentive to engage in a labour contract.

Type 3 households: workers

Under permanent firm-worker relationships, the Optimal Risk Sharing contract is the outcome of the following contract (with bargaining power v_t):

$$
\begin{aligned}
&\max E_t \left\{ v_t U_1 \left(C_{1,t}, N_{1,t} \right) + (1 - v_t) U_3 \left(C_{3,t}, N_{3,t} \right) \right\} \\
&\text{subject to:} \\
&C_{1,t} = F(K_t, N_t) - W_t^c N_{3,t} - W_t^s N_{2,t} - W_t^s N_{1,t} - I_t \\
&C_{3,t} = W_t^c N_{3,t}
\end{aligned}
$$

FOC for the contract wage and employment level:

$$(\partial W_t^c) \qquad U_{1,t}^C = ds_t U_{3,t}^C \text{ where } ds_t = \frac{(1 - v_t)}{v_t}$$

$$(\partial N_{3,t}) \qquad v_t U_{1,t}^C [F_t^N - W_t^c] + (1 - v_t) \left\{ U_{3,t}^C W_t^c + U_{3,t}^N \right\} = 0$$

$$\text{or } U_{1,t}^C F_t^N + U_{3,t}^N = 0$$

Firms

Objective function

$$\max E_t \left[\sum_{j=0}^{\infty} \beta^j \frac{\lambda_{t+j}}{\lambda_t} \frac{P_t}{P_{t+j}} D_{t+j} \right] \text{ where}$$

$$\frac{D_{t+j}}{P_{t+j}} = \left[\frac{P_{t+j}(i)}{P_{t+j}} Y_{t+j}(i) - W_{t+j} N_{t+j}(i) - \frac{\chi}{2} \left(\frac{P_{t+j}(i)}{P_{t+j-1}(i)} - 1 \right)^2 - I_{t+j} \right]$$

Subject to

$$K_{t+1} = (1-\delta) K_t + G\left(\frac{I_t}{K_t}\right) K_t \text{ with } G = a1 * \left(\frac{I}{K}\right)^{(1-1/\xi)} + a2$$

$$Y_{t+j}(i) = \left(\frac{P_{t+j}(i)}{P_{t+j}}\right)^{-\varepsilon} Y_{t+j},$$

Firms

FOC for capital accumulation and price setting

$$(\partial K) \quad G_t'^{-1} = \frac{\beta\lambda_{t+1}}{\lambda_t}\left[\theta\frac{Y_{t+j}(i)}{K_{t+1}^{\theta}} + G_{t+1}'^{-1}\left((1-\delta) + G_{t+1} - G_{t+1}'\frac{I_{t+1}}{K_{t+1}}\right)\right]$$

$$(\partial P) \quad 0 = (1-\varepsilon)\,Y_t + \varepsilon\left(\frac{W_t^s}{P_t} / \frac{(1-\theta)\,Y_t}{N_t}\right)Y_t$$
$$-\chi\,(\pi_t - 1)\,\pi_t + \frac{\beta\lambda_{t+1}}{\lambda_t}\chi\,(\pi_{t+1} - 1)\,\pi_{t+1}$$

for χ =0: $\frac{(1-\theta)\,Y_t}{N_t} = \frac{\varepsilon}{\varepsilon-1}\frac{W_t^s}{P_t}$

Market clearing conditions

goods market $Y_t = C_{1,t} + C_{2,t} + C_{3,t} + I_t + \frac{\chi}{2}\left(\pi_t - 1\right)^2$

labour market $N_{1,t} + N_{2,t} + N_{3,t} = N_t$

bond market $B_{1,t} + B_{2,t} = 0$

equity market $S_{1t} + S_{2t} = S_t = 1$

monetary policy $R_t = \overline{R_{natural}} + 1.5\left(\pi_t - \overline{\pi}\right) + 0.01\left(P_t - \overline{P}\right)$
under sticky prices
$\pi_t = 0$
under flexible prices

Stochastic structure + calibration

Aggregate productivity Risk

$$\log(Z_t) = (1-\rho_z)\log(\overline{Z}) + \rho_z \log(Z_{t-1}) + \varepsilon_t^z$$

Distribution Risk

$$\log(v_t) = (1-\rho_v)\log(\overline{v}) + \rho_v \log(v_{t-1}) + \varepsilon_t^v$$

β	δ	θ	ξ	ρ_z	σ_z	ρ_ν	σ_ν	χ
0.99	0.02	0.30	0.5	0.95	0.01	0.95	0.25	120

Special cases of the general model

First, We analyse the implications for the risk premiums and the main macrostatistics in three specific cases of the general model:

- Type 1 agents only: Representative Agent model: habit and wage rigidity (Uhlig 2007)
- Type 1 and 2 agents: Guvenen (2003)
- Type 1 and 3 agents: Danthine Donaldson (2002)

In all models, labour and capital adjustment are endogenous !
Results depend on the specification of the utility function.
For the moment, we concentrate on aggregate productivity risk to compare the results with the literature (no distribution risk, no inflation risk (flexible prices).

Three specifications for the utility function

SEP $$U_t = \frac{(C_t - hC_{t-1})^{1-\sigma}}{1-\sigma} - \psi \frac{N_t^{\phi}}{\phi}$$

KPR $$U_t = \frac{((C_t - hC_{t-1})(1-\psi N_t^{\phi}))^{1-\sigma}}{1-\sigma}$$

GHH $$U_t = \frac{(C_t - hC_{t-1} - \psi N_t^{\phi}(X_t - hX_{t-1)})^{1-\sigma}}{1-\sigma}$$

Three specifications for the utility function

Implications for SR and labour supply condition:

$$SR_t = \rho_{rs,\Delta c} * \eta_{cc} * \sigma_{\Delta c} - \rho_{rs,\Delta n} * \eta_{cn,n} * \sigma_{\Delta n}$$

$$(\eta_{cc} + \eta_{nc,c}) * \widehat{c}_t - (\eta_{nn} + \eta_{cn,n}) * \hat{n}_t = \widehat{w}_t$$

	η_{cc}	$\eta_{cn,n}$	$\frac{\partial w}{w} / \frac{\partial c}{c}$ $\eta_{cc} + \eta_{nc,c}$	$\frac{\partial w}{w} / \frac{\partial n}{n}$ -$(\eta_{nn} + \eta_{cn,n})$
SEP	$\frac{\sigma}{1-h}$	0	$\frac{\sigma}{1-h}$	$(\phi - 1)$
KPR	$\frac{\sigma}{1-h}$	$\frac{(\sigma-1)}{1-h}$	$\frac{1}{1-h}$	$(\phi - 1 + \frac{1}{1-h})$
GHH	$\frac{\sigma}{(1-h-\frac{1}{\phi})}$	$\frac{\sigma}{(1-h-\frac{1}{\phi})}$	0	$(\phi - 1)$

Expressions are evaluated at c=w*n

Financial and Macro Statistics: Representative Agents

	SR^A	EP^A	BP^A	R^f	σ_{R^f}	σ_{R^S}
SEP σ_c=4, N exo	0.072	0.41/0.40	0.41	3.76/3.78	1.04	5.65
SEP σ_c=10, N exo	0.136	1.17/1.15	1.30	3.11/3.11	1.71	8.62
SEP σ_c=10	0.044	0.14/0.14	0.158	3.92/3.94	0.67	3.25
KPR σ_c=10	0.140	1.28/1.26	1.38	3.06/3.06	1.76	9.18
GHH σ_c=10	0.194	2.24/2.21	2.34	2.18/2.16	2.12	11.58
Data	0.33	6.33	0.78	1	0.308	19.41

	σ_Y	$\sigma_I/\rho_{I,Y}$	$\sigma_C/\rho_{C,Y}$	$\sigma_N/\rho_{N,Y}$	$\sigma_W/\rho_{W,Y}$	$\sigma_{WN/Y}$
SEP σ_1=4, N exo	1.28	1.75/1	1.16/1	0/0	1.28/1	0
SEP σ_1=10, N exo	1.27	2.90/1	0.87/1	0/0	1.27/1	0
SEP σ_1=10	0.44	1.06/1	0.28/1	1.20/-1	1.64/1	0
KPR σ_1=10	1.36	2.85/1	0.96/1	0.13/1	1.24/1	0
GHH σ_1=10	1.96	3.59/1	1.55/1	0.98/1	0.98/1	0
Data	2.24	4.40/0.81	0.86/0.75	1.88/0.88	0.96/0.31	3.80

With habit in the utility function

σ_1=10; ϕ=2	SR^Q	EP^A	BP^A	R^f	σ_{R^f}	σ_{R^S}	PD	σ_{PD}
With habit								
SEP h=0.75	0.049	0.18/0.18	0.19	3.90/3.92	0.80	3.71	99.85	8.03
KPR h=0.75	0.208	3.49/3.26	3.44	1.85/2.07	4.96	16.79	107.81	25.1
GHH h=0.40	0.228	4.18/3.79	3.85	1.82/1.43	6.44	18.45	106.89	22.4

σ_1=10; ϕ=2	σ_Y	σ_I	$\rho_{I/,Y}$	σ_C	$\rho_{C,Y}$	σ_N	$\rho_{N,Y}$	σ_W	$\rho_{W,Y}$	$\sigma_{WN/Y}$
With habit										
SEP h=0.75	0.34	1.12	0.96	0.18	0.90	1.35	-0.95	1.68	0.96	0
KPR h=0.75	1.31	4.51	0.94	0.69	0.83	0.05	0.49	1.28	1	0
GHH h=0.40	1.98	4.41	0.93	1.50	0.97	0.99	1	0.99	1	0

With real wage rigidity

σ_1=10; ϕ=2	SR^Q	EP^A	BP^A	R^f	σ_{R^f}	σ_{R^S}	PD	σ_{PD}
With wage rigidity (0.8)								
SEP	0.120	1.33/1.01	1.05	3.29/3.63	5.71	11.03	100.19	9.80
KPR	0.148	1.47/1.44	1.56	2.92/2.96	2.04	9.97	106.75	21.24
GHH	0.194	2.25/2.22	2.34	2.13/2.16	2.11	11.63	113.76	25.72

σ_1=10; ϕ=2	σ_Y	σ_I	$\rho_{I/,Y}$	σ_C	$\rho_{C,Y}$	σ_N	$\rho_{N,Y}$	σ_W	$\rho_{W,Y}$	$\sigma_{WN/Y}$
With wage rigidity (0.8)										
SEP	0.85	2.22	1	0.50	1	1.10	-0.27	1.56	0.74	0
KPR	1.77	2.94	0.96	1.52	0.99	0.98	0.81	1.13	0.86	0
GHH	2.59	3.59	0.96	2.39	0.99	2.02	0.97	0.81	0.79	0

Relative successful calibration

Representative agent model with GHH preferences and endogenous labour produces relative successful results.

	SR^Q	EP^A	BP^A	R^f	σ_{R^f}	σ_{R^S}	PD	σ_{PD}
σ_1=20 no habit	0.294	4.02/3.99	4.39	-0.29/-0.36	2.55	13.71	146.54	38.36

	σ_Y	σ_I	$\rho_{I,Y}$	σ_C	$\rho_{C,Y}$	σ_N	$\rho_{N,Y}$	σ_W	$\rho_{W,Y}$	$\sigma_{WN/Y}$
σ_1=20 no habit	1.96	4.25	1	1.38	1	0.98	1	0.98	1	0

Risk sharing arrangement in the heterogeous agent models

- Complete markets with perfect risk sharing across agents yields constant relative marginal utilities: $\frac{U'_{c1,t}}{U'_{c2,t}} = \frac{U'_{c1,t+1}}{U'_{c2,t+1}} = \mu$
- In our model there are no complete markets:
- Combining Type 1 and Type 2 agents (Guvenen model), the bond/fund market with financial costs provides a partial risk sharing instrument. Type 2 agents have a strong precautionary savings motive and accumulate bond/funds. They will save in good times, which lowers their effective interest rate.
- Combining Type 1 and Type 3 agents (Danthine Donaldson model), the labour contract provides a strong risk sharing device. The ratio of the marginal utilities will depend on the bargaining power of the workers vs. firms.

Risk sharing arrangement in the heterogeous agent models

- With the same risk aversion for the different types of agents, the heterogeneous agent models will approximate the representative agent case.
- With more risk averse Type 2 and Type 3 agents, the risk is shifted to the Type 1 agents: in good times, the available resources for the Type 1 agents will increase and their consumption will become more volatile and highly cyclical. As Type 1 agents are the marginal shareholders, the SR and the RP will increase both for equity and long term bonds.

Combining Type 1 and 2 agents (Guvenen model)

σ_1=4, σ_2= 10	SR^A	EP^A	BP^A	R^f	σ_{R^f}	σ_{R^S}	PD	σ_{PD}
SEP	0.038	0.12/0.11	0.12	3.95/3.97	0.62	3.04	99.12	5.78
SEP, N exo	0.082	0.60/0.58	0.59	3.70/3.72	1.41	7.27	100.86	13.10
Guvenen calibration	0.222	4.48/4.33	4.29	1.55/1.69	3.85	20.16	106.57	26.23
KPR	0.084	0.61/0.59	0.60	3.69/3.71	1.41	7.32	100.82	12.84
GHH	0.110	1.06/1.05	1.04	3.43/3.44	1.76	9.66	101.95	16.14

σ_1=4, σ_2= 10	σ_Y	σ_I	$\rho_{I,Y}$	σ_C	$\rho_{C,Y}$	σ_{C1}	σ_{C2}	σ_N	$\rho_{N,Y}$	σ_W	$\rho_{W,Y}$	$\sigma_{WN/Y}$
SEP	0.51	0.97	1	0.39	1	0.60	0.28	1.16	-1	1.66	1	0
SEP, N exo	1.29	2.28	1	1.04	1	1.34	0.95	0	-	1.29	1	0
Guvenen calibration	2.61	2.95	1	2.53	1	3.61	2.08	0	-	2.61	1	0
KPR	1.36	2.30	1	1.12	1	1.33	1.04	0.09	1	1.27	1	0
GHH	1.94	2.96	1	1.68	1	1.84	1.67	0.97	1	0.97	1	0

Combining Type 1 and 3 agents (Danthine Donaldson model)

σ_1=4, σ_3=10	SR^A	EP^A	BP^A	R^f	σ_{R^f}	σ_{R^S}	PD	σ_{PD}
SEP	0.042	0.16/0.15	0.14	3.94/3.95	0.64	3.72	99.18	3.76
SEP, N exo	0.110	1.01/0.97	0.87	3.43/3.46	1.45	9.11	100.36	9.41
KPR	0.110	1.02/0.98	0.87	3.43/3.46	1.15	9.14	100.28	9.12
GHH	0.148	1.72/1.66	1.47	2.94/2.97	1.79	11.46	102.29	13.42

σ_1=4, σ_3=10	σ_Y	σ_I	$\rho_{I,Y}$	σ_C	$\rho_{C,Y}$	σ_{C_1}	σ_{C_3}	σ_N	$\rho_{N,Y}$	σ_W	$\rho_{W,Y}$	$\sigma_{WN/Y}$	$\rho_{WN/Y}$
SEP	0.52	1.02	1	0.40	1	0.69	0.28	1.12	-1	1.44	1	0.41	-0.44
SEP, N exo	1.31	2.42	1	1.03	1	1.77	0.71	0	-	0.83	1	1.05	-0.41
KPR	1.39	2.45	1	1.13	1	1.67	0.89	0.11	1	0.81	1	1.08	-0.40
GHH	2.06	3.24	1	1.77	1	2.34	1.52	1.03	1	0.60	1	1.06	-0.37

Danthine Donaldson with distribution risk

- In a heterogeneous agent model, with workers and shareholders, the pricing of assets depends not only on aggregate risk but also on distribution risk.
- Distribution risk reduces the cyclicality of wages, and increases the volatility of profits.
- Allowing for a negative correlation between aggregate and distribution riks reinforces the countercyclical nature of the wage share / procyclical nature of profits.
- The marginal utility of the shareholders becomes more volatile and the dividend/payout uncertainty increases also.
- Distribution risk (or operational risk) increases the SR and the RP, especially for equity:

$$RP(d_{t+k}) = -cov(E_{t+1}\lambda_{t+k} - \lambda_{t+1}, \lambda_{t+1}) - cov(E_{t+1}d_{t+k}, \lambda_{t+1})$$

- Financial leverage (or financial risk) may further help to differentiate between bonds and equity premiums.

Danthine Donaldson: distribution risk

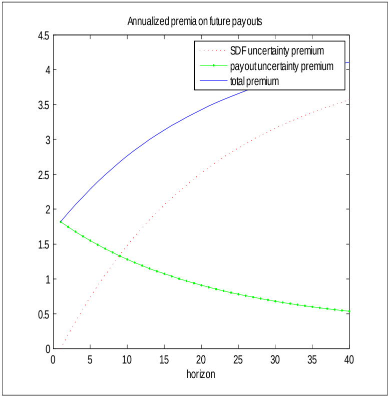
(1): distribution risk only, (2) distribution & productivity risk , (3) distribution & productivity risk (ρ =-0.65), (4) including financial leverage (30%)

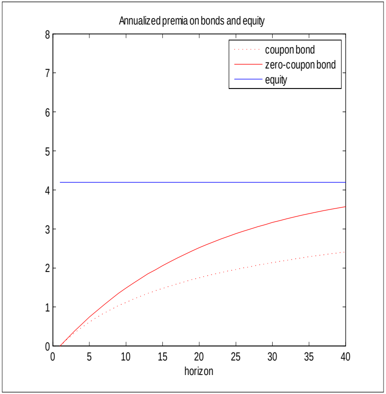
GHH σ_1=4;σ_3=10;	SR^A	EP^A	BP^A	R^f	σ_{R^f}	σ_{R^S}	PD	σ_{PD}
(1)	0.106	0.93/0.95	0.82	3.45/3.46	1.36	8.86	100.20	7.92
(2)	0.184	2.66/2.61	2.29	2.34/2.39	2.25	14.48	103.49	15.58
(3)	0.234	4.32/4.24	3.71	1.28/1.36	2.86	18.49	106.08	19.52
(4)	0.244	7.07/6.93	3.97	1.05/1.16	2.96	28.96	135.83	58.47

GHH σ_1=4;σ_3=10;	σ_Y	$\sigma_I / \rho_{I,Y}$	$\sigma_C / \rho_{C,Y}$	$\sigma_{C_1} / \sigma_{C_3}$	$\sigma_N / \rho_{N,Y}$	$\sigma_W / \rho_{W,Y}$	$\sigma_{WN/Y} / \rho_{WN/Y}$
(1)	0.07	2.04/-0.07	0.52/0.23	1.23/1.27	0.03/1	1.01/0.14	1.99/0.03
(2)	2.01	3.73/0.83	1.81/0.96	2.57/0.87	1.00/1	1.19/0.51	2.26/-0.16
(3)	1.97	4.67/0.94	1.42/1.96	3.17/1.15	0.98/1	0.77/-0.10	2.88/-0.34
(4)	2.03	4.98/0.94	1.44/0.96	3.61/1.21	1.02/1	0.82/-0.12	3.15/-0.33

Danthine Donaldson: distribution risk

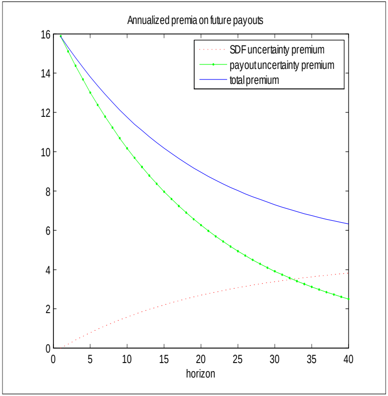
Graph 1: Decomposition of the term premium on bonds and the equity risk premium for the model without leverage

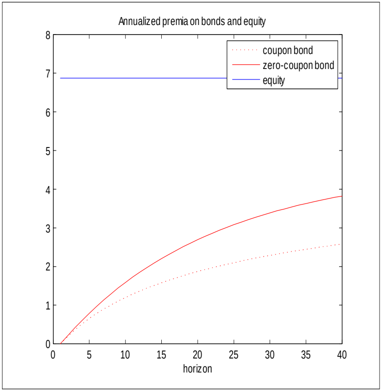




Danthine Donaldson: distribution risk

Graph 2: Decomposition of the term premium on bonds and the equity risk premium for the model with leverage





General Model with the three types of agents simultaneously

- We consider the following calibration: 60% Type 3, 30% Type 2 and 10% Type 1 agents.
- The corresponding wealth distribution is 0% for Type 3, 22% for Type 2, 78% for Type 1 agents.

GHH σ_1=4;σ_2=10;σ_3=10	SR^A	EP^A	BP^A	R^f	σ_{R^f}	σ_{R^S}	PD	σ_{PD}
distr. & prodty risk (ρ=-0.65)	0.210	3.48/3.46	3.11	1.85/1.86	2.65	16.75	105.74	20.38
incl. financial leverage	0.220	5.80/5.68	3.35	1.58/1.68	2.74	26.21	127.12	50.99

GHH σ_1=4;σ_2=10;σ_3=10	σ_Y	$\sigma_I/\rho_{I,Y}$	$\sigma_C/\rho_{C,Y}$	$\sigma_{C_1}/\sigma_{C_3}/\sigma_{C_3}$	$\sigma_N/\rho_{N,Y}$	$\sigma_W/\rho_{W,Y}$	$\sigma_{WN/Y}/\rho$
distr. & prodty risk (ρ =-0.65)	1.98	4.44/0.96	1.45/0.98	3.10/1.86/1.18	0.99/1	0.64/0.23	2.11/-0.36
incl. financial leverage	2.03	4.65/0.96	1.46/0.97	3.62/1.92/1.24	1.02/1	0.67/0.21	2.36/-0.35

Add Inflation risk

- sticky prices $(\chi = 120)$
- policy rule: $R_t = RN_t + 1.5\left(\pi_t - \overline{\pi}\right) + 0.01\left(P_t - \overline{P}\right)$
- or $R_t = RN_{ave,t} + 1.5\left(\pi_t - \overline{\pi}\right) + 0.01\left(P_t - \overline{P}\right)$

	SR^A	EP^A	BP^A	R^f	σ_{R^f}	R^N	σ_{R^N}	σ_{R^S}	PD	σ_{PD}	σ_π
(1)	0.220	5.80/5.68	3.35	1.58/1.68	2.74	-	-	26.21	127.12	50.99	0
(2)	0.220	5.45/4.90	3.73	1.59/1.67	2.75	2.08	5.74	24.65	119.36	43.50	3.78
(3)	0.216	5.29/4.87	5.02	1.63/1.67	2.75	2.16	6.56	24.77	120.11	44.37	4.32

	σ_Y	$\sigma_I/\rho_{I,Y}$	$\sigma_C/\rho_{C,Y}$	$\sigma_{C_1}/\sigma_{C_3}/\sigma_{C_3}$	$\sigma_N/\rho_{N,Y}$	$\sigma_W/\rho_{W,Y}$	$\sigma_{WN/Y}/\rho_{WN/Y}$
(1)	2.03	4.65/0.96	1.46/0.97	3.62/1.92/1.24	1.02/1	0.67/0.21	2.36/-0.35
(2)	1.97	4.59/0.96	1.41/0.97	3.55/1.84/1.21	0.945/1	0.66/0.18	2.21/-0.37
(3)	1.93	4.51/0.95	1.39/0.97	3.49/1.81/1.25	0.94/1	0.68/0.19	2.47/-0.33

Preliminary conclusions

- The heterogeneous agent setup offers an interesting alternative for the representative agent model: even with endogenous labour and capital.
- Heterogenous agent model is able to generate a significant risk premium and performs well in explaining aggregate statistics: the risk sharing considerations are able to generate endogenously the observed wage smoothness and the countercyclical wage share behavior.
- The combination of aggregate productivity risk and distribution risk further improves the results (inflation risk is more important for bonds than for stocks).
- The general model also produces a realistic wealth distribution.
- But differentiating between equity and bond premiums remains difficult.
- Next: analyze time variation in the risk premium