Risky Jobs and Risky Business Cycles*

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Abstract

I develop a macro-finance model which can simultaneously resolve the equity premium puzzle and the unemployment volatility puzzle in a general equilibirum setting. The key friction is the presence of uninsurable job loss risk which households must reckon with when making consumption and asset allocation decisions. When jobs become more precarious, this increases risk premia since households endogenously become more risk averse due to the greater degree of background risk now present. When firms use the prevailing pricing kernel to make intertemporal decisions, I show that this leads to a negative feedback loop; since hiring a worker is a risky investment, the rise in risk premia causes a further drop in vacancy posting, which pushes up risk premia further via the unemployment risk channel. For a risk aversion of 5.5 and a realistic TFP process, the model can match the equity premium, the risk-free rate, and the volatility of unemployment, as well as a number of other asset pricing moments. When agents are risk-neutral, as in the standard Diamond-Mortensen-Pissarides model, the volatility of unemployment is four times lower.

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1 Introduction

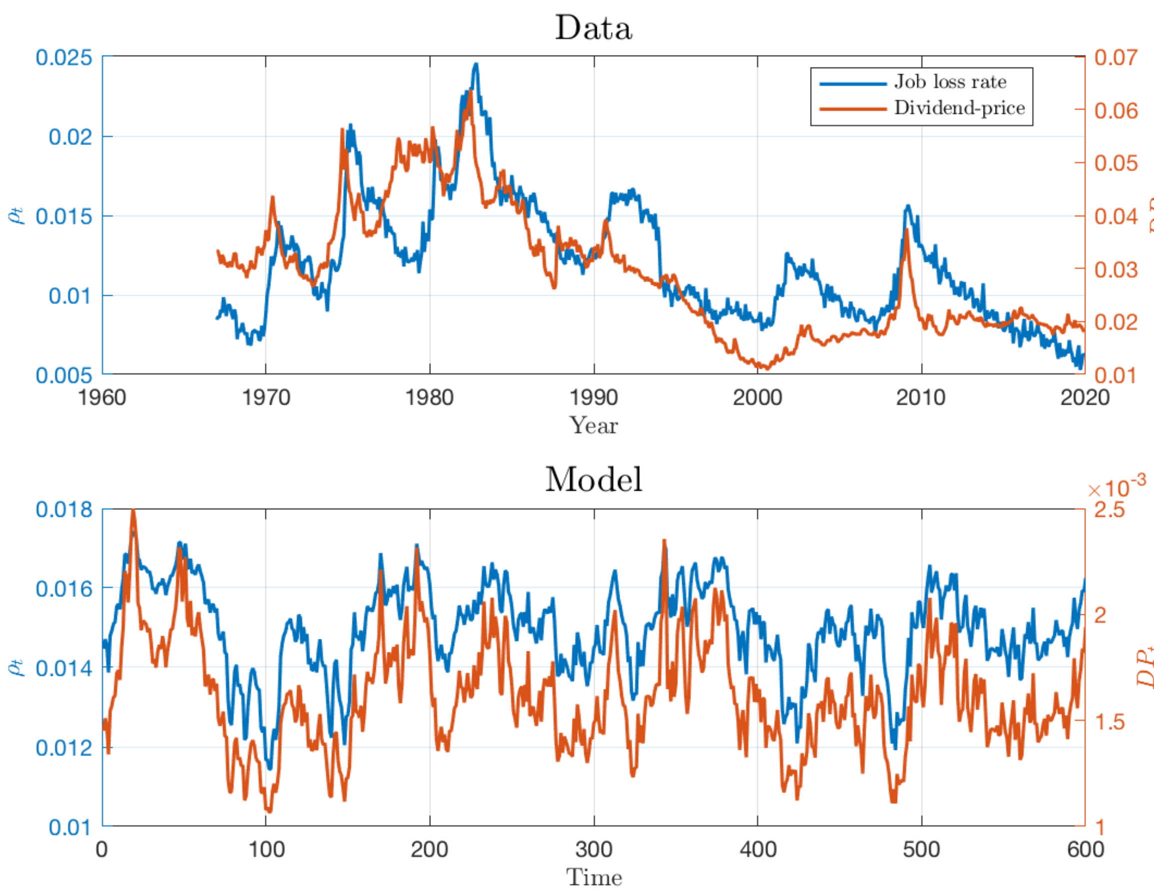
Two seemingly distinct puzzles have been identified in macroeconomics and finance respectively. The first is the Shimer (2005) unemployment volatility puzzle, which highlights the inability of the standard Diamond-Mortensen-Pissarides (DMP) model with search-and-matching frictions in the labour market to generate a realistic degree of volatility in the unemployment rate without an unrealistic degree of volatility in labour productivity. The second is the equity premium puzzle of Mehra and Prescott (1985), which refers to the inability of the standard consumption-based asset pricing model (CCAPM) to generate a realistic average excess return on stocks without an unrealistic degree of volatility in consumption growth. Proposed resolutions to the first puzzle typically revolve around diminishing the fundamental surplus (Ljungqvist and Sargent, 2017), for example via real wage rigidity (Hall, 2005) or a low, acyclical opportunity cost of unemployment (Hagedorn and Manovskii, 2008). Proposed solutions to the second puzzle are abundant, but include consumption habits (Campbell and Cochrane, 1999), rare disaster risk (Barro, 2006), long-run risk (Bansal and Yaron, 2004), and idiosyncratic income heteroskedasticity (Constantinides and Duffie, 1996). The first set of explanations have been criticised on the grounds that real wages are relatively flexible (Haefke et al., 2013), or the opportunity cost of unemployment is moderate-to-large and procyclical (Chodorow-Reich and Karabarbounis, 2016). The main criticism of the set of equity premium puzzle resolutions is that they rely on the dark matter problem, as highlighted by Chen et al. (2019), in the sense that they involve a key element that is latent and thus hard to falsify.

In this paper I provide a unified solution to both puzzles which does not rely on diminishing the fundamental surplus and is not subject to the dark matter critique. Building on Preston (2025), the key mechanism in the model stems from the interaction between countercyclical job loss risk and risk premia. Because unemployment is uninsurable for households, a rise in job loss risk implies a commensurate increase in background income risk, which in turn makes them behave in a more risk-averse manner (Gollier and Pratt, 1996). Risk premia rise consequently. Equity performs poorly during these periods, and earns high expected return as a result. From a firm's perspective, hiring a worker is a risky investment due to the presence of labour market frictions which mean that the firm may be burdened with an unproductive worker if aggregate productivity falls in the future. Under the assumption that firms use the prevailing stochastic discount factor (SDF) when making intertemporal decisions, the rise in risk premia generates a further reduction in hiring. This additionally increases risk premia, sparking a negative feedback loop that ultimately amplifies an aggregate productivity shock significantly, and produces risky business cycles.

Quantitatively, I show that a calibrated version of the model which exactly matches the stochastic process for US labour productivity can match the volatility of the unemployment rate, the equity premium and the average risk-free rate for a risk aversion parameter of 5.5. I contrast this to the standard DMP model, which is the limiting version of the model as risk-aversion tends to zero. For the same calibration, this generates unemployment volatility that is only around a quarter of the empirical level. The DMP model's deficiency stems from its inability to generate realisticaly high, time-varying risk premia. I show that the baseline model also generates a realistic degree of volatility in the dividend-price ratio and produces predictability between the job loss rate and future returns which is mirrored empirically. Real wage flexibility in the calibration closely matches the estimate in Haefke et al. (2013), while the model's mechanism for producing realistic risk premia has no dark matter component since it relies on fluctuations in job loss risk which are directly observable in the data.

The paper is most similar to Kehoe et al. (2023), who also demonstrate that time-varying risk premia offer a solution to the unemployment volatility puzzle. The main difference arises from the mechanism, which relies upon the aforementioned negative feedback loop between job loss risk and risk premia. Kehoe et al. (2023) instead use a form of habits in utility with complete markets, and thus generate time-varying risk premia in an exogenous way. In their framework, rising risk premia impact unemployment risk, but unemployment risk does not impact risk premia. In line with the mechanism presented in this paper, Figure 1 below shows that, empirically, there is a very strong relationship between the dividend-price ratio and the job loss rate in the US. The baseline model replicates this strong relationship. The model is similar to Ravn and Sterk (2017), who embed the household setup in a New Keynesian model with labour market frictions and no risk premia. They show that this can produce deep recessions. Crucially, nominal rigidities are completely absent in the model of the next section, and instead it is risk premia that produce amplification.

Figure 1: The job loss rate and dividend/price ratio in the data and model simulated data



2 Macroeconomic Model of Risky Business Cycles

In this section, I develop the macro-finance model, which features frictional labour markets, incomplete insurance markets, and two assets: a risk-free bond and risky equity.

2.1 Environment and Equilibrium

Environment: Time is discrete and infinite in horizon. There is a unit mass of households, each of whom consumes, invests in equities, and holds a risk-free one-period nominal asset. Additionally, they supply one unit of labour inelastically. These households are ex-ante homogeneous and are indexed by i. They maximize the expected present value of their utility stream, which is discounted at a subjective discount rate denoted by β:

$$\mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t \left(\frac{C_t(i)^{1-\gamma}}{1-\gamma} \right)$$

where $C_t(i)$ is a CES aggregator of consumption varieties:

$$C_t(i) = \left(\int_j (C_t(i,j))^{1-1/\Omega} \, dj \right)^{1/(1-1/\Omega)} \tag{1}$$

where $\Omega \geq 1$ is the elasticity of substitution between the varieties. Utility is CRRA, with $\gamma > 0$ representing the degree of relative risk aversion.

Households have a binary employment status each period. If employed they earn a real wage of W_t, while if unemployed they produce b_t units of the consumption good at home. All households pay lump-sum taxes, T_t. Employed household face the risk of losing their job and becoming unemployed, while unemployed households have the opportunity to find a job and become employed. There is a missing market for insurance that is contingent on a household's idiosyncratic employment status, and this means that unemployment is uninsurable. Household i holds $S_t(i)$ units of the market portfolio. This has a price of Q_t and pays a dividend d_t. They hold $B_t(i)$ nominal risk-free one-period bonds which has a price of q_t. They face two asset constraints. The first prevents them from borrowing in the nominal bond. The second restricts their equity holdings to be above a lower bound $\underline{S}$.

The household problem in full is then:

$$V\left(I_t^E(i), S_{t-1}(i), B_{t-1}(i), \Omega_t\right) = \max_{C_t(i), S_t(i), B_t(i)} \frac{C_t(i)^{1-\gamma}}{1-\gamma} + \beta \, \mathbb{E}_t \, V\left(I_{t+1}^E(i), S_t(i), B_{t-1}(i), \Omega_{t+1}\right)$$

s.t.

$$C_t(i) + Q_t S_t(i) + q_t B_t(i) = I_t^E(i) W_t + \left(1 - I_t^E(i)\right) b_t - T_t + (Q_t + d_t) S_{t-1}(i) + B_{t-1}(i)$$

$$S_t(i) \geq \underline{S}$$

$$B_t(i) \geq 0$$

Ω_t is a vector that contains the aggregate state variables.

Home production is assumed to be constant over time and equal to a fraction of the steady-state real wage:

$$b_t = \chi_U \overline{W} \tag{2}$$

A continuum of final goods producers indexed by j each produce a differentiated good according to:

$$Y_t(j) = A_t N_t(j) \tag{3}$$

where $N_t(j)$ is the total employment of firm j and A_t is TFP which follows an AR(1) in logs:

$$\log A_t = \rho_A \log A_{t-1} + \varepsilon_t; \qquad \rho_A \in (-1, 1) \qquad \varepsilon_t \sim N(0, \sigma_A^2) \tag{4}$$

Firms can only acquire workers by hiring in a frictional labour market. Each period begins with the resolution of a matching process and starts with a fraction $\omega \in (0, 1)$ of incumbent workers separating from the firm. After discovering the value of aggregate TFP, they then post vacancies at a cost of $\kappa > 0$ each. The probability of a given vacancy successfully leading to the formation of a match is given by $f_t \in (0, 1)$ which is the job-filling rate and is determined endogenously. Employment at firm j therefore follows the law of motion:

$$N_t(j) = (1 - \omega)N_{t-1}(j) + f_t v_t(j) \tag{5}$$

Where $v_t(j)$ is the number of vacancies posted by firm j in period t.

Following separation, unemployed workers have the chance to match with a firm that is looking to hire. This occurs with probability $\eta_t \in (0, 1)$ which I call the job finding rate. The job finding and job filling rates are determined by a Cobb-Douglas matching function which takes the number of job searchers and vacancies posted as inputs:

$$m_t = e_t^{\alpha} v_t^{1-\alpha} \tag{6}$$

$$f_t = \frac{m_t}{v_t} = \eta_t^{-\frac{\alpha}{1-\alpha}} \tag{7}$$

$$\eta_t = \frac{m_t}{e_t} \tag{8}$$

where:

$$v_t = \int_j v_t(j) dj$$

and e_t is the aggregate measure of job searchers pinned down by:

$$e_t = 1 - N_{t-1} + \omega N_{t-1} \tag{9}$$

Aggregate employment, $N_t = \int_j N_t(j)dj$, follows the law of motion:

$$N_t = (1-\omega)N_{t-1} + \eta_t e_t \tag{10}$$

Firms operate in a monopolistically competitive environment, and set their product prices, $P_t(j)$. They maximise expected discounted dividends, and use the prevailing equilibrium stochastic discount factor which prices assets to do so. This is in line with the notion that firms maximise shareholder value as their governance objective, and aligns the firm's valuation of future cash flows with that of the market. The firm problem is given by:

$$\max_{P_t(j),N_t(j)} \mathbb{E}_0 \sum_{t=0}^{\infty} \beta^t M_{t,t+1} \left[\frac{P_t(j)}{P_t} Y_t(j) - W_t N_t(j) - \kappa v_t(j) \right]$$

s.t.

$$Y_t(j) = A_t N_t(j)$$

$$N_t(j) = (1-\omega)N_{t-1}(j) + f_t v_t(j)$$

$$Y_t(j) = \left(\frac{P_t(j)}{P_t} \right)^{-\Omega} Y_t$$

where $Y_t = \int_j Y_t(j)dj$, $P_t = (\int_j P_t(j)^{1-\Omega}dj)^{\frac{1}{1-\Omega}}$, and $M_{t,t+1}$ satisfies $1 = \mathbb{E}_t M_{t,t+1} R^j_{t+1}$ for any asset j. I focus on a symmetric equilibrium where all firms make the same decisions and $P_t(j)$ has a degenerate cross-sectional distribution each period.

Rather than explicitly modelling the wage determination process, for simplicity I assume that it is a function of TFP:

$$\widehat{W}_t = \rho_W \widehat{A}_t \tag{11}$$

where hatted variables denote log deviations from their steady-state values. $\rho_W \geq 0$ is the elasticity of real wages to TFP. The wage rule conveniently captures the fact that real wages respond positively to TFP innovations. I assume that in every period $W_t > b_t$ which implies that wages do not stray too far below their steady state value and it is always preferable to work rather than not.[1] Dividends are given by output net of hiring costs and the wage bill:

$$d_t = Y_t - \kappa v_t - W_t N_t \tag{12}$$

[1]I verify this is indeed the case in the calibration.

The model is closed by specifying a fiscal policy rule. The government raises tax revenue to fund spending, G_t, by taxing dividends:

$$T_t = d_t = G_t \tag{13}$$

Asset market clearing is satisfied if:

$$\int_0^1 B_t(i)di = 0 \tag{14}$$

$$\int_0^1 S_t(i)di = 1 \tag{15}$$

The labour market clears if labour market variables follow the laws of motion laid out above.

Equilibrium. Given a stochastic process for A_t, an equilibrium is a set of prices (q_t, Q_t, W_t, R_t), household policy functions $(C_t(i), S_t(i), B_t(i))$, firm policy functions $(v_t(j), N_t(j), P_t(j))$, government policy (T_t, G_t), and labour market variables (η_t, f_t, e_t, N_t) such that i) The household policy functions solve the household problem; ii) The firm policy functions solve the firm problem; iii) The goods and asset markets clear; iv) Aggregate labour market variables evolve according to their respective laws of motion; v) Fiscal policy is implemented according to the fiscal rule; vi) The equilibrium is symmetric across firms; vii) Actual and perceived laws of motion coincide.

Proposition 1: If $\underline{S} = 1$, there is an equilibrium where:

$$B_t(i) = 0, \qquad \forall i, \tag{16}$$

$$S_t(i) = 1, \qquad \forall i, \tag{17}$$

$$C_t^E(i) \equiv (C_t(i) \mid I_t^E(i) = 1) = W_t, \qquad \forall i, \tag{18}$$

$$C_t^U(i) \equiv (C_t(i) \mid I_t^E(i) = 0) = b_t, \qquad \forall i, \tag{19}$$

$$1 = \mathbb{E}_t\big[M_{t,t+1}^E\, R_{f,t}\big], \tag{20}$$

$$1 = \mathbb{E}_t\big[M_{t,t+1}^E\, R_{S,t+1}\big], \tag{21}$$

$$M_{t,t+1}^E = \beta\Big(\tfrac{C_{t+1}^E}{C_t^E}\Big)^{-\gamma}\big[1 + \rho_{t+1}(\chi_{U,t+1}^{-\gamma} - 1)\big], \tag{22}$$

$$\frac{\Omega}{A_t}\Big(W_t + \tfrac{\kappa}{f_t} - \mathbb{E}_t\big[M_{t,t+1}^E\,(1-\omega)\tfrac{\kappa}{f_{t+1}}\big]\Big) = \Omega - 1. \tag{23}$$

where $\chi_{U,t+1} = \frac{C_{t+1}^U}{C_{t+1}^E} < 1$ and $\rho_{t+1} = \omega(1-\eta_{t+1})$ is the job loss rate.[2]

[2]The job loss rate is defined as the employment-unemployment transition rate.

Proof: See Appendix A.

There is a no-trade equilibrium which exists, as in Constantinides and Duffie (1996), Krusell et al. (2011) and Preston (2025). In this equilibrium, all employed households consume the real wage, whereas all unemployed households consume the unemployment benefit each period. As a result, the distribution of asset holdings is degenerate for both the assets in the economy. The equilibrium pricing kernel is unique and is characterised by the SDF of the pseudo-representative employed household. The unemployed households are not marginal in either asset since, as the proof of Proposition 1 demonstrates, their Euler equation holds with inequality. The reason for this is that the employed households are currently in the best possible idiosyncratic state. This endows them with a precautionary saving motive, since they know they face the risk of losing their job and transitioning to a strictly worse idiosyncratic state in the future. As such, they wish to accumulate assets and their Euler equation holds with inequality. Unemployed households, on the other hand, have a consumption smoothing motive, as they are currently in the worst possible idiosyncratic state of the world and their future prospects are strictly better in expectation. They wish to borrow or go short in assets in order to smooth their consumption, but they cannot do so due to the presence of the asset holding constraints, which bind for them.

The no-trade equilibrium is advantageous for two reasons. The first is that it resolves the SDF non-uniqueness problem which is typical in models with incomplete markets. In an equilibrium with trade, there would be a continuum of valid SDFs, meaning that it would not be obvious which to choose in the firm's dynamic problem. This is not the case here, since the employed households' SDF is the only SDF consistent with maximising shareholder value. The second reason is computational. The no-trade equilibrium allows the model considered here to be solved very quickly with a projection method. As is well-known, incomplete market models with aggregate shocks exhibit the property that the infinite dimensional asset distributions are a state variable. This means that the imposition of some form of bounded rationality, as in Krusell and Smith (1997), is necessary to solve them. Preston (2025) does just this, but in a model with far fewer state variables that is more amenable to computation, and where the firm problem is static. The no-trade equilibrium is found to be a conservative assumption in the sense that risk premia *increase* when it is relaxed.

2.2 Resolving the Equity Premium and Risk-Free Rate Puzzles

How are the expected return on equity and the risk-free rate determined in the model? And what determines the gap between them, i.e. the equity premium? To examine these questions, I perform a first-order Taylor expansion of the SDF around the realisations of the variables in period t. As Preston (2025) demonstrates, this means that the equity premium can be approximated as:

$$\mathbb{E}(R^e_{t+1}) \approx \gamma \operatorname{Cov}(\Delta C^E_{t+1}, R^e_{t+1}) + (1 - \chi_U^{-\gamma}) \operatorname{Cov}(\rho_{t+1}, R^e_{t+1}) + \gamma \left(\chi_U^{-\gamma} - 1\right) \operatorname{Cov}\left(\rho_t \Delta C^E_{t+1}, R^e_{t+1}\right) \quad (24)$$

where $\Delta C^E_{t+1} = \frac{C^E_{t+1} - C^E_t}{C^E_t}$.

Three terms make up the approximated equity premium expression. The first is the sole term present in the CCAPM, and represents aggregate consumption risk.[3] As first highlighted by Mehra and Prescott (1985), the quantity of aggregate consumption risk (the covariance term) is small, which necessitates a high price of risk (γ) in the CCAPM. The second term represnts the direct effect of job loss risk; households are averse to holding equity if it pays off poorly when the risk of being laid off is high. This term is quantitatively unimportant in the model (and in the data), since the job loss rate is persistent while the excess return on equity is essentially independent over time, meaning that the covariance term is very weak. The third term is crucial, and captures the indirect effect of job loss risk; as jobs become riskier, households become more risk-averse due to the rise in background risk as in Gollier and Pratt (1996).[4] As such, they dislike assets which are riskier at times where their risk aversion is effectively heightened. In the model, equity exhibits this property, making this term quantitatively the most important. This endogenous risk aversion channel also means that risk premia are volatile in the model, and that times when the job loss rate is high are associated with high future expected excess returns. As discussed below, this is the case empirically also.

Under the same first-order approximation of the SDF, the risk-free rate is given by:

$$R^f_t \approx \frac{1}{\beta} \left[1 + (\chi_U^{-\gamma} - 1)\mathbb{E}_t \rho_{t+1} - \gamma \left(1 + \left(\chi_U^{-\gamma} - 1\right) \rho_t\right) \mathbb{E}_t \Delta C^E_{t+1}\right]^{-1} \quad (25)$$

[3] This is the case because as either $\chi_U \to 1$ or $\rho_t \to 0$, $\Delta C^E_{t+1} \to \Delta C_{t+1}$, where ΔC_{t+1} is aggregate consumption growth.

[4] This occurs because the risk is additive in nature, and households have CRRA preferences which exhibit decreasing absolute risk aversion, which are the conditions outlined in Gollier and Pratt (1996) for what they term risk vulnerability to be satisfied.

The presence of job loss risk gives employed households a precautionary saving motive, the strength of which is increasing in γ and decreasing in χ_U. The stronger this is, the higher is household demand for the safe asset, pushing the price up and the risk-free rate down. As such, unlike in the CCAPM, the risk-free rate is a *decreasing* function of γ under reasonable parameter values. This means the model is able to generate a realistically low risk-free rate for the value of γ needed to match the equity premium, which is not the case in the CCAPM. The model also does not need to resort to Epstein-Zin preferences in order to simultaneously match these two moments. Unlike many other frameworks which resolve these asset pricing puzzles (e.g. Bansal and Yaron (2004), Schmidt (2022)) the model does not require an elasticity of intertemporal substitution (EIS) above 1. This is of note since most empirical estimates of the EIS using microdata place it well below 1, see for example Best et al. (2020).

2.3 Resolving the Unemployment Volatility Puzzle

In the limit as $\Omega \to \infty$, the condition pinning down vacancy posting becomes:

$$\frac{\kappa}{f_t} = A_t - W_t + \mathbb{E}_t M^E_{t,t+1} \left[(1-\omega) \frac{\kappa}{f_{t+1}} \right] \tag{26}$$

Iterating this forward:

$$\frac{\kappa}{f_t} = \sum_{j=0}^{\infty} \mathbb{E}_t M^E_{t+j} \left[(1-\omega)^j \left(A_{t+j} - W_{t+j} \right) \right] \tag{27}$$

where $M^E_{t+j} = \prod_{k=0}^{j} M^E_{t+k,t+k+1}$ and $M^E_t = 1$. This condition tells us that the firm optimally equalises the price of hiring (the left-hand side) with the expected risk-adjusted cash flows of hiring (the right-hand-side). The equation is an asset pricing condition akin to how the stock price equals the expected sum of risk-adjusted dividends. A fall in the expected path of productivity reduces the marginal benefits of hiring a worker, representing a cash flow shock. The price of hiring falls accordingly, translating to a rise in the job filling rate and a fall in the job finding rate.

In a standard DMP model, where the firms are typically modelled as being risk-neutral and markets are complete, this cash flow effect comprises the entirety of the mechanism. In the model here, because households cannot insure against unemployment, the shock leads to a rise in idiosyncratic job loss risk which raises risk premia. Because hiring a worker is a risky investment with uncertain cash flows, this increase in the price of risk causes a further fall in vacancy posting via a risk premium effect. This further raises the level of unemployment risk, and a vicious cycle emerges. To see this further, (26) can be rearranged as:

$$1 = \mathbb{E}_t M^E_{t+1} R^H_{t+1}; \qquad R^H_{t+1} = \frac{(1-\omega)(\kappa/f_{t+1})}{\kappa/f_t - (A_t - W_t)} \tag{28}$$

and then using a common asset pricing decomposition:

$$\mathbb{E}_t R^H_{t+1} = R^f_t \left[1 + \Lambda_t\right] \tag{29}$$

where:

$$\Lambda_t = -\operatorname{Cov}_t\left(M^E_{t+1}, R^H_{t+1}\right) \tag{30}$$

An increase in the expected return on hiring is associated with a labour market contraction i.e. a rise in f_t and a fall in η_t. As with stocks, in a reasonable calibration the realised return on hiring is moves inversely with the expected return because the price of hiring is strongly mean-reverting.

The above expression highlights two competing effects which occur after an aggregate shock that raises the expected job loss rate. The first of these is a discount rate effect: via the precautionary saving channel, the increase in job loss risk pushes down the risk-free rate which stimulates hiring all else equal. Thus this effect is stabilising. The second of these is a risk premium effect: an increase in job loss risk raises extrinsic risk aversion which raises the price of risk (Λ_t increases). This induces a desire to shift away from risky assets, reducing hiring since, from the firm's perspective, workers are a risky asset. Thus this effect amplifies the shock, and is stronger when χ_U is further below 1 i.e. when consumption insurance is more limited. In the Appendix, I use a Campbell-Shiller approximation to analytically characterise the log-linear dynamics of the job finding rate.

The lack of amplification of the productivity shock is typically the case in DMP models as Shimer (2005) documents. Hall (2017) was perhaps the first paper to highlight the possibility of volatility in the SDF to resolve the Shimer (2005) puzzle. Kehoe et al. (2023) develop a model where time-varying risk premia also produces a resolution of the unemployment volatility puzzle. However, because markets are complete in their framework, there is essentially no feedback between unemployment risk and risk premia. This is illustrated in the DAG below. Variation in risk premia is instead generated via habit formation in preferences as in Campbell and Cochrane (1999), meaning the utility function still requires a high degree of curvature.[5] Contrary to the empirical evidence discussed earlier, unemployment leads to no drop in

[5] Kehoe et al. (2023) also explore extensions with Epstein-Zin preferences and disaster risk and demonstrate this serves essentially the same role of increasing the price of risk.

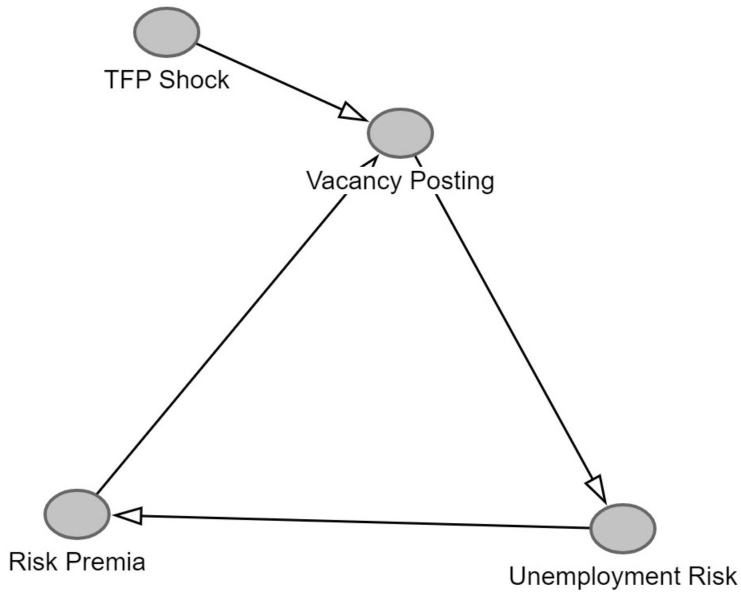


Figure 2: DAG of Feedback Loop in Model

consumption relative to being employed as a consequence of full insurance in the model. Borovička and Borovičková (2018) emphasise that the SDF used to discount the cash flows of the employment match should be consistent with other asset pricing moments. I show that the calibrated model avoids this critique by jointly matching several moments of the equity premium, risk-free rate and dividend-price ratio.

2.4 Quantitative Results

I now calibrate the model and demonstrate its ability to fit both macroeconomic and asset price data. The model is solved via a projection method to ensure a high degree of accuracy in the presence of non-linearities. Each time period represents one month. The set of calibrated parameter values can be found in the table below, and I now provide a rationale for each.

The subjective discount factor, β, is set to match the average value of the risk-free rate. A low value is needed due to the presence of idiosyncratic risk. The matching function elasticity, α, is set to 0.45 which is in the range of values highlighted by Pissarides and Petrongolo (2001). The risk aversion parameter is set to 5.5 — a value in the range deemed plausible by Mehra and Prescott (1985) and less than what is typically necessary in most asset pricing models.[6] Ω is set to a standard value of 6. This leads to profits comprising

[6] For example, Bansal and Yaron (2004) set $\gamma = 10$, Nakamura et al. (2013) set $\gamma = 6.4$, Schmidt (2022) sets $\gamma = 11$. Campbell and Cochrane (1999) set $\gamma = 2$ but acknowledge that the habits in their preference imply significantly more curvature in the utility function than this.

Table 1: Calibrated Parameter Values

Parameter	Calibrated Value	Description
β	0.97	Subjective discount factor
α	0.45	Matching function elasticity
γ	5.50	Risk aversion
Ω	6.00	Elasticity of substitution between varieties
χ_U	0.83	Home production of unemployed relative to wage
ρ_W	0.90	Wage flexibility parameter
κ	2.26	Vacancy cost
ω	0.02	Job separation rate
$\overline{N}$	0.95	Steady-state employment rate
ρ_A	0.95	Autoregressive parameter for productivity
σ_A	0.01	Standard deviation of productivity shocks

around 16% of output in steady state, close to the empirical analogue.[7] The home production-wage ratio, χ_U, is set to 0.83, implying a consumption decline upon job loss of around 18%. This is lower than the estimate of Chodorow-Reich and Karabarbounis (2016) and so is somewhat conservative. The wage flexibility parameter, ρ_W, is set to 0.9. This implies a high degree of wage flexibility, avoiding the critique of Kudlyak (2014) and others who argue that a reliance on very rigid wages is unrealistsic in DMP models. The choice of this parameter generates an elasticity of the real wage to productivity that is close to the estimate of 0.8 in Haefke et al. (2013) for new hires. The vacancy posting cost κ is set such that aggregate hiring costs are around 1.5% of steady state output. The job separation rate, ω, is set to generate a mean quarterly job loss rate of around 4%, approximately in line with the average job loss rate in the data but slightly lower to once again err on the side of conservativism. I set the deterministic steady state unemployment rate to 5.5%, in line with US data post-war. Finally, I set the parameters governing the stochastic process for A_t such that, after the series is aggregated to a quarterly frequency, it matches the persistence and standard deviation of quarterly labour productivity in the US for all workers from 1947-2019.

The table below gives the mean, standard deviation and AR(1) regression coefficient for several macroeconomic and asset price variables in the data and from simulated data from the model. A description of how each data series is constructed can be found in the appendix.

Starting with the asset price variables, the model generates an annualised equity premium of 4.43%, in

[7] In 2019, corporate profits (after tax with inventory valuation and capital consumption adjustments) were 7.6% of GDP, while proprietors' income (with inventory valuation and capital consumption adjustments) was 7.2% of GDP. Combining the two yields a model-consistent measure of profits as 14.8% of GDP.

Table 2: Moments in the Model vs the Data

	Data			Model		
Variable	**Mean**	**Std. Dev.**	**AR(1)**	**Mean**	**Std. Dev.**	**AR(1)**
Real Risk-Free Rate (%)	0.05	0.21	0.78	0.06	1.13	0.96
Real Excess Equity Return (%)	0.44	2.82	0.06	0.37	7.08	-0.03
Log Dividend-Price Ratio	-3.50	0.20	0.96	-6.46	0.19	0.93
Log Dividends	-	0.09	0.95	-	0.04	0.99
Unemployment Rate (%)	5.73	1.65	0.99	5.77	1.67	0.99
Real Consumption Growth (Quarterly, %)	0.72	0.60	0.34	0.00*	1.27	0.17

Note: The table compares the moments of several variables in the model with their empirical analogues. Averaging over 100 simulations of 2,000 periods is used to compute the moments in the model. See appendix B for a full description of how each empirical series is obtained. The AR(1) column displays the coefficient in a regression of the variable on one lag of itself and a constant. In both the data and the model, dividends are the 12-month backward-looking moving average of aggregate dividends. An asterisk means that the moment is zero by construction given the lack of trend growth in the model. The mean of log dividends is missing due to the fact that it is detrended in the data. The excess equity return is unlevered using a leverage factor of 1.5.

line with empirical estimates for the US with the well-known caveat that it is difficult to estimate this moment precisely. The model does this by generating a realistically low value for the average risk-free rate and a high value for the average return on equity. The volatility of both of these is slightly too high in the model, however. The model naturally generates persistence in the risk-free rate without resorting to ad-hoc smoothing in the monetary policy rule. The model also closely matches the persistence and volatility of the log dividend-price ratio. The numerator of this variable, dividends, is smooth and persistent in the model as is the case in the data. In fact, dividends are excessively smooth in the model. Returns are much more volatile than dividends, as highlighted originally by Shiller (1981), which occurs due to the discount rate variation induced by job loss risk.

Turning to macroeconomic variables, the model almost exactly matches the mean, persistence, and volatility of the unemployment rate. It is well known that matching the latter with a realistic labour productivity process and degree of wage flexibility in DMP models is challenging (Shimer, 2005). This is not the case here, however, as unemployment volatility is slightly too high rather than too low in fact despite the high degree of wage flexibility and productivity process that is calibrated to its empirical analogue. The average unemployment rate lies 0.23 p.p. above its deterministic steady state level, as the riskiness of hiring depresses employment in equilibrium. Consumption growth displays a level of volatility that is about twice what is observed in the data, but this is still far below the level of volatility that the CCAPM would require to match the equity premium for a reasonable value of γ.[8] Other asset pricing models, such as the Bansal and Yaron (2004) model, also require excessive consumption growth volatility to match the equity premium as highlighted by Beeler and Campbell (2012).

Figure 1 plots a time series of the job loss rate and the dividend-price ratio in the model. As in the data, there is strong positive comovement between the two; the correlation between the two variables is 0.97 in the model vs 0.73 in the data. In the model, there is simultaneity between the level of unemployment risk and risk premia. A higher job loss rate produces increased risk premia (and in turn, an elevated dividend-price ratio), which further heightens unemployment risk, which then increases risk premia and so on. Higher values of the job loss rate thus forecasts high returns in the future. To test this formally, I run the classic return prediction regression with the log job loss rate as the regressor:

$$r^s_{t,t+h} = \alpha_h + \beta_h \log(\rho_t) + \epsilon_{t,t+h}$$

where $r^s_{t,t+h} = \sum_{j=1}^{h} r^s_{t+j}$, with $r^s_{t+j} = \log(R_{s,t+j})$. I run this regression both in the model and in the data, setting $h = 120$ for the 10-year-ahead real stock return. In the data, I obtain $\beta_{120} = 1.09$ with a Newey-West adjusted t-statistic of 6.59 ($p < 0.001$).[9] In the model simulated data, I obtain $\beta_{120} = 1.85$. As such, the model generates a realistic degree of return predictability. Repeating the regressions with the log dividend-price ratio as the regressor yields $\beta_{120} = 0.70$ empirically ($p < 0.001$) and $\beta_{120} = 1.26$ in the model.

I now contrast these quantitative results to the standard DMP model by setting $\gamma = 0$ and re-calibrating β to match the risk-free rate. Table 3 compares the set of moments in this model to those in the baseline version. As would be expected, the model produces no equity premium due to the lack of risk aversion. The volatility of the log dividend-price ratio is only a quarter of that in the baseline model, highlighting the importance of fluctuations in risk premia for matching this moment. Crucially, the DMP model generates unemployment volatility that is 75% lower than in the data and baseline model. This is the Shimer (2005) puzzle. TFP shocks are not sufficiently amplified in the model which lacks endogenous risk premia; this

[8] In the CCAPM, the equity premium can be approximately expressed as:

$$\mathbb{E}_t(R^e_{t+1}) \approx \gamma\rho(R^e_{t+1}, \Delta C_{t+1})\ \sigma(R^e_{t+1})\ \sigma(\Delta C_{t+1})$$

In the data, the correlation term, $\rho(R^e_{t+1}, \Delta C_{t+1})$, is around 0.2 at the quarterly level. The volatility of unlevered quarterly excess returns is around 5%. Putting this together means that a volatility of consumption of around 20% would be necessary to match the equity premium for a risk aversion of 5.5 as in the model.

[9] I use $h - 1$ lags in the Newey-West adjustment.

Table 3: Moments in the baseline model vs. the standard DMP model

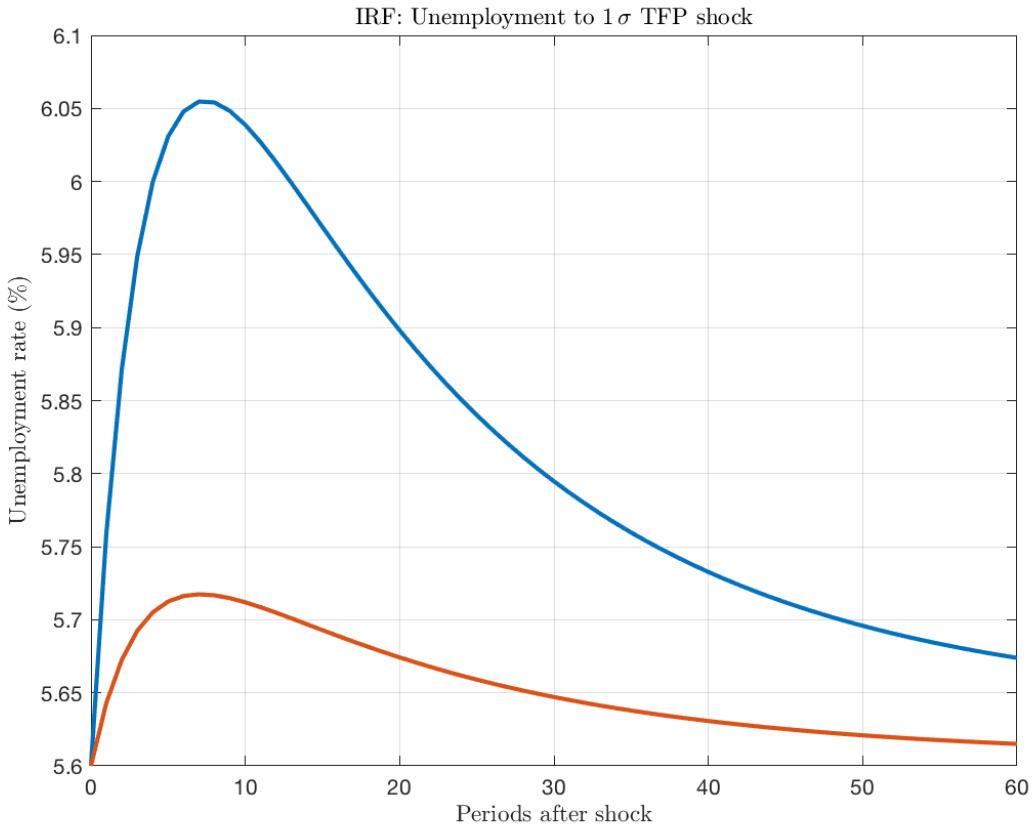
	Baseline ($\gamma = 5.5$)			Standard DMP ($\gamma = 0$)		
Variable	**Mean**	**Std. Dev.**	**AR(1)**	**Mean**	**Std. Dev.**	**AR(1)**
Real Risk-Free Rate (%)	0.06	1.13	0.96	0.06	0.00	1.00
Real Excess Equity Return (%)	0.37	7.08	-0.03	0.00	0.02	0.00
Log Dividend–Price Ratio	-6.46	0.19	0.93	-7.27	0.04	0.99
Log Dividends	–	0.04	0.99	–	0.09	0.99
Unemployment Rate (%)	5.77	1.67	0.99	5.62	0.45	0.99
Real Consumption Growth (Quarterly, %)	0.00*	1.27	0.17	0.00*	1.20	0.13

Notes: Moments for each model are averaged over 100 simulations of 2,000 periods. AR(1) is the coefficient from a regression of the variable on one lag and a constant. Dividends are the 12-month backward-looking moving average. An asterisk indicates a moment that is zero by construction given the absence of trend growth in the model.

is illustrated in Figure 3. Unemployment responds tepidly to a TFP shock in the standard DMP model, but experiences a large increase in the baseline model. The impact response is around 12 times larger in the latter versus the former. The baseline model also generates much greater persistence, meaning it can produce jobless recoveries.

The model purposefully contains only one shock, and its ability to better match the set of moments considered as well as others could of course be improved by adding further shocks. However, Basu et al. (2021) find that the single shock which explains the highest proportion of the equity premium also explains a large fraction of business cycle fluctuations in output and unemployment. As such, the model here replicates this property and generates risky business cycles to borrow their terminology.

Figure 3: IRF comparison in the two models.



Note: The blue line is the IRF of the unemployment rate to a negative one standard deviation TFP shock in the baseline model. The red line is for the standard DMP model.

3 Conclusion

In this paper, I develop a general equilibrium model that provides a unified resolution to the equity premium puzzle and the unemployment volatility puzzle. The central mechanism is a powerful feedback loop between uninsurable job loss risk, endogenous household risk aversion, and firms' hiring decisions. When jobs become more precarious following a negative productivity shock, households' greater exposure to background risk causes risk premia to rise. Because hiring a worker is a risky investment, firms use the prevailing, now higher, market price of risk to discount future cash flows, leading them to reduce vacancy posting. This reduction in hiring further elevates unemployment risk, amplifying the initial shock through a vicious cycle.

The model is shown to be quantitatively successful. For a plausible coefficient of risk aversion and a realistic TFP process, it simultaneously matches the equity premium, the risk-free rate, and the volatility of unemployment. In contrast, a risk-neutral version of the model, analogous to the standard Diamond-Mortensen-Pissarides framework, fails to generate sufficient amplification and produces unemployment volatility that is four times lower than observed in the data. The results illustrate that the interaction between labour market frictions and risk premia is key to understanding the magnitude of economic fluctuations, generating the "risky business cycles" that characterise the economy.

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Risky Jobs and Risky Business Cycles

Appendix

Andrew Preston

A Proof of Proposition 1

Proof. The proof closely follows the proof of Proposition 1 in Preston (2025). An equilibrium must satisfy the following conditions, which represent, respectively, asset market clearing and utility maximisation of the employed and unemployed households:

$$\int_0^1 S_t(i)\,di = 1 \qquad \forall t \tag{31}$$

$$\int_0^1 B_t(i)\,di = 0 \qquad \forall t \tag{32}$$

$$C_t^E(i)^{-\gamma} \geq \beta\,\mathbb{E}_t R_{S,t+1}\big[(1-\rho_{t+1})\,C_{t+1}^E(i)^{-\gamma} + \rho_{t+1}\,C_{t+1}^U(i)^{-\gamma}\big] \qquad \forall t, i \tag{33}$$

$$C_t^E(i)^{-\gamma} \geq \beta\,\mathbb{E}_t R_{f,t}\big[(1-\rho_{t+1})\,C_{t+1}^E(i)^{-\gamma} + \rho_{t+1}\,C_{t+1}^U(i)^{-\gamma}\big] \qquad \forall t, i \tag{34}$$

$$C_t^U(i)^{-\gamma} \geq \beta\,\mathbb{E}_t R_{S,t+1}\big[(1-\eta_{t+1})\,C_{t+1}^U(i)^{-\gamma} + \eta_{t+1}\,C_{t+1}^E(i)^{-\gamma}\big] \qquad \forall t, i \tag{35}$$

$$C_t^U(i)^{-\gamma} \geq \beta\,\mathbb{E}_t R_{f,t}\big[(1-\eta_{t+1})\,C_{t+1}^U(i)^{-\gamma} + \eta_{t+1}\,C_{t+1}^E(i)^{-\gamma}\big] \qquad \forall t, i \tag{36}$$

I guess and verify that the conditions outlined in Proposition 1 are a valid equilibrium. Asset market clearing is trivially satisfied. Under the hand-to-mouth behaviour of all households, the employed SDF is uniform across this set of agents. Thus, (33) and (34) hold with equality:

$$C_t^E(i)^{-\gamma} = \beta\,\mathbb{E}_t R_{f,t}\big[(1-\rho_{t+1})\,C_{t+1}^E(i)^{-\gamma} + \rho_{t+1}\,C_{t+1}^U(i)^{-\gamma}\big] \qquad \forall t, i \tag{37}$$

$$C_t^E(i)^{-\gamma} = \beta\,\mathbb{E}_t R_{s,t+1}\big[(1-\rho_{t+1})\,C_{t+1}^E(i)^{-\gamma} + \rho_{t+1}\,C_{t+1}^U(i)^{-\gamma}\big] \qquad \forall t, i \tag{38}$$

Written equivalently:

$$1 = \mathbb{E}_t\big[M_{t,t+1}^E\,R_{f,t}\big], \tag{39}$$

$$1 = \mathbb{E}_t\big[M_{t,t+1}^E\,R_{S,t+1}\big], \tag{40}$$

$$M_{t,t+1}^E = \beta\Big(\frac{C_{t+1}^E}{C_t^E}\Big)^{-\gamma}\big[1 + \rho_{t+1}(\chi_{U,t+1}^{-\gamma} - 1)\big], \tag{41}$$

The last conditions to verify are the unemployed households' optimality conditions. Using the fact that consumption is equal to income in the equilibrium, this will hold if:

$$1 > \mathbb{E}_t\big[M^U_{t,t+1}\, R_{f,t}\big], \tag{42}$$

$$1 > \mathbb{E}_t\big[M^U_{t,t+1}\, R_{S,t+1}\big], \tag{43}$$

$$M^U_{t,t+1} = \beta\Big(\frac{C^U_{t+1}}{C^U_t}\Big)^{-\gamma}\big[1+\eta_{t+1}(\chi^{\gamma}_{U,t+1}-1)\big]. \tag{44}$$

where the strict inequality comes from the asset-holding constraints both binding for the unemployed household. The above will hold if:

$$\mathbb{E}_t\big[M^E_{t,t+1} - M^U_{t,t+1}\big]R_{f,t} > 0$$

$$\mathbb{E}_t\big[M^E_{t,t+1} - M^U_{t,t+1}\big]R_{S,t+1} > 0$$

Because both $R_{f,t}$ and $R_{S,t+1}$ are strictly positive, bounded random variables, the above holds if $M^E_{t,t+1} > M^U_{t,t+1}$ almost surely. This is satisfied if :

$$\frac{M^E_{t,t+1}}{M^U_{t,t+1}} = \left(\frac{C^E_{t+1}/C^E_t}{C^U_{t+1}/C^U_t}\right)^{-\gamma}\left(\frac{1+\rho_{t+1}\left(\chi^{-\gamma}_{U,t+1}-1\right)}{1+\eta_{t+1}\left(\chi^{\gamma}_{U,t+1}-1\right)}\right) > 1 \qquad a.s.$$

Since the consumption of the employed is higher than the consumption of the unemployed each period (because of the assumption that the unemployment benefit lies strictly below the equilibrium real wage), the first term exceeds one. The second term also exceeds one if $\chi_{U,t+1} < 1$ and $\rho_{t+1} > 0$, which both hold by assumption.

□

B Approximate Analytical Solution to the Model

Proposition 2: Under a Campbell-Shiller approximation of (27) around the deterministic steady state:

$$\widehat{\eta}_t = \frac{1-\alpha}{\alpha}\, c_A\, \widehat{A}_t,$$

where:

$$c_A = \frac{\psi\,(\kappa_2-1)+\gamma\rho_W\,(1-\rho_A)}{\kappa_2-\rho_A+\lambda_\rho\varphi_\rho\rho_A},$$

$$\psi = \frac{1-\rho_W\overline{W}}{1-\overline{W}}, \quad \phi = \frac{1}{1-(1-\omega)\overline{M}^E}, \quad \kappa_2 = \frac{\phi}{\phi-1} > 1\,,$$

$$\lambda_\rho = \overline{\rho}\,\frac{\chi_U^{-\gamma}-1}{1+\overline{\rho}\big(\chi_U^{-\gamma}-1\big)}, \qquad \varphi_\rho = \frac{\overline{\eta}}{1-\overline{\eta}}\frac{1-\alpha}{\alpha}.$$

Proof. The free-entry condition for vacancy posting is $J_t = \kappa/f_t$, where J_t is the value of a filled job. This value is determined by the Bellman equation, which equates the value to the current period dividend, $D_t = A_t - W_t$, plus the expected discounted continuation value:

$$J_t = D_t + \mathbb{E}_t \left[M^E_{t,t+1}(1-\omega)J_{t+1}\right] \tag{45}$$

where $M^E_{t,t+1}$ is the stochastic discount factor of employed households. Rearranging defines the hiring return $R^H_{t+1} = \frac{(1-\omega)J_{t+1}}{J_t - D_t}$ that must satisfy the Euler equation $1 = \mathbb{E}_t[M^E_{t,t+1}R^H_{t+1}]$.

I log-linearise the return $r^H_{t+1} = \log R^H_{t+1}$. Let $p_t = \log J_t$, $d_t = \log D_t$, and $pd_t = p_t - d_t$ be the log price-dividend ratio. The return is $r^H_{t+1} = \log(1-\omega) + p_{t+1} - \log(J_t(1 - D_t/J_t))$. A first-order Taylor expansion of $\log(1 - e^{-pd_t})$ around the steady-state ratio $\phi = \overline{J}/\overline{D}$ yields the standard Campbell-Shiller approximation:

$$r^H_{t+1} \;\approx\; \kappa_0 + pd_{t+1} - \kappa_2\, pd_t + \Delta d_{t+1}, \quad \text{where} \quad \kappa_2 = \frac{\phi}{\phi - 1} > 1. \tag{46}$$

κ_0 is a constant that depends on steady-state values and does not affect the dynamics.

I posit an affine solution for the price-dividend ratio: $pd_t = a_0 + a_A\, \widehat{A}_t$. The log-deviations of the model's key components are:

- **Job-filling rate:** From $J_t = \kappa/f_t$, we have $\widehat{p}_t = -\widehat{f}_t$.
- **Dividend:** With $\widehat{W}_t = \rho_W \widehat{A}_t$, we have $\widehat{d}_t = \psi \widehat{A}_t$.
- **Price-dividend ratio:** The identity $\widehat{pd}_t = \widehat{p}_t - \widehat{d}_t$ implies $a_A \widehat{A}_t = -\widehat{f}_t - \psi \widehat{A}_t$, which gives the link $\widehat{f}_t = -(a_A + \psi)\widehat{A}_t$. We need to find $c_A = a_A + \psi$.
- **SDF:** The log-linearised SDF is $m^E_{t+1} \approx \overline{m}^E - \gamma\rho_W(\widehat{A}_{t+1} - \widehat{A}_t) + \lambda_\rho \widehat{\rho}_{t+1}$.
- **Job loss rate:** The matching function implies $\widehat{\rho}_{t+1} = \varphi_\rho \widehat{f}_{t+1}$.

The term $x_{t+1} = m^E_{t+1} + r^H_{t+1}$ is conditionally normally distributed, and the Euler equation $1 = \mathbb{E}_t e^{x_{t+1}}$ is equivalent to $0 = \mathbb{E}_t x_{t+1} + \frac{1}{2}\operatorname{Var}_t(x_{t+1})$. The variance term, $\operatorname{Var}_t(x_{t+1})$, depends only on the volatility of the TFP shock σ^2_A and is constant, so it does not affect the dynamic coefficient a_A. We solve for a_A by setting the coefficient on $\widehat{A}_t$ in the conditional mean $\mathbb{E}_t x_{t+1}$ to zero.

$$\mathbb{E}_t[r^H_{t+1}] = [a_A(\rho_A - \kappa_2) + \psi(\rho_A - 1)]\, \widehat{A}_t$$
$$\mathbb{E}_t[m^E_{t+1}] = [-\gamma\rho_W(\rho_A - 1) - \lambda_\rho\varphi_\rho c_A \rho_A]\, \widehat{A}_t$$

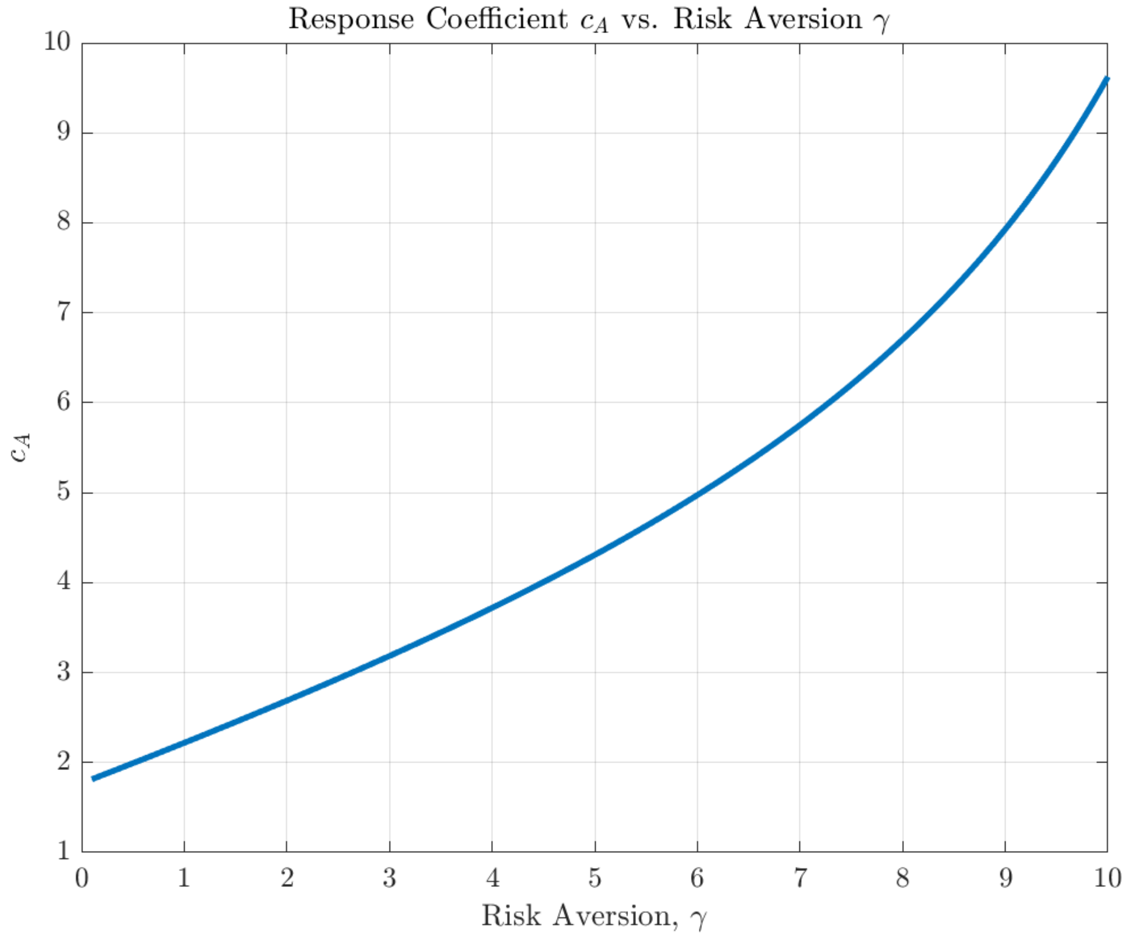
Summing the coefficients on $\widehat{A}_t$ and setting to zero yields:

$$a_A(\rho_A - \kappa_2) + \psi(\rho_A - 1) - \gamma\rho_W(\rho_A - 1) - \lambda_\rho\varphi_\rho(a_A + \psi)\rho_A = 0. \tag{47}$$

I then solve the linear equation for a_A. Grouping terms with a_A:

$$a_A(\rho_A - \kappa_2 - \lambda_\rho\varphi_\rho\rho_A) = -\left[(\psi - \gamma\rho_W)(\rho_A - 1) - \lambda_\rho\varphi_\rho\psi\rho_A\right].$$

Figure A1: Elasticity of job finding rate to TFP.



$$a_A = \frac{(\psi - \gamma\rho_W)(1-\rho_A) + \lambda_\rho\varphi_\rho\psi\rho_A}{\rho_A - \kappa_2 - \lambda_\rho\varphi_\rho\rho_A}.$$

Using the relation $c_A = a_A + \psi$, we find the final coefficient:

$$\begin{aligned} c_A &= \psi + \frac{(\psi - \gamma\rho_W)(1-\rho_A) + \lambda_\rho\varphi_\rho\psi\rho_A}{\rho_A - \kappa_2 - \lambda_\rho\varphi_\rho\rho_A} \\ &= \psi - \frac{(\psi - \gamma\rho_W)(1-\rho_A) + \lambda_\rho\varphi_\rho\psi\rho_A}{\kappa_2 - \rho_A + \lambda_\rho\varphi_\rho\rho_A}. \end{aligned}$$

This rearranges to the condition in Proposition 2. □

The graph below plots c_A as a function of γ, with all parameter values as in Table 1. This highlights that strengthening the risk premium channel increases the elasticity of the job finding rate to TFP, which is fundamental in resolving the Shimer puzzle.

C Numerical Solution Method

In this Appendix I describe the two-step projection method used to solve the model numerically. TFP follows

$$\log A_{t+1} \;=\; \rho_A \log A_t \;+\; \sigma_A \varepsilon_{t+1}\,.$$

Step 1: Vacancy Policy Function

I approximate the vacancy posting policy in *log*-space:

$$\ell_t \;=\; \log v_t \;\approx\; \sum_{i=0}^{n_A-1} \sum_{j=0}^{n_N-1} c_{ij}\, T_i(z_{A,t})\, T_j(z_{N,t-1})\,,$$

where

$$z_{A,t} = \frac{2\,(A_t - A_{\min})}{A_{\max} - A_{\min}} - 1, \quad z_{N,t-1} = \frac{2\,(N_{t-1} - N_{\min})}{N_{\max} - N_{\min}} - 1,$$

and $T_k(\cdot)$ is the kth Chebyshev polynomial on $[-1, 1]$. I choose

$$A_{\min} = \overline{A} - 2\sigma(A_t), \quad A_{\max} = \overline{A} + 2\sigma(A_t),$$

and

$$N_{\min} = \overline{N} - 0.05, \quad N_{\max} = \overline{N} + 0.05,$$

I take $n_A = n_N = 6$ Chebyshev nodes in each dimension.

The coefficients $\{c_{ij}\}$ are chosen to drive to zero the equilibrium residual

$$1 \;-\; \Omega \;+\; \frac{\Omega}{A_t}\Big[W_t + \tfrac{\kappa}{f_t} \;-\; \mathbb{E}_t\{M^E_{t,t+1}\,(1-\omega)\tfrac{\kappa}{f_{t+1}}\}\Big]\,,$$

evaluated at each collocation node. Expectations over the technology shock are computed by a 21-point Gauss–Hermite quadrature:

$$\int_{-\infty}^{\infty} g(\varepsilon)\,\tfrac{e^{-\varepsilon^2/2}}{\sqrt{2\pi}}\,d\varepsilon \;\approx\; \sum_{k=1}^{21} w_k\, g(\sqrt{2}\,\xi_k)\,/\,\sqrt{\pi}\,.$$

I solve the resulting nonlinear system for the vector of c_{ij} using MATLAB's `lsqnonlin`.

Step 2: Equity-Price Policy Function

With the vacancy policy fixed, I next approximate the equity price as

$$P_t \;=\; F(A_t, N_{t-1}) \;\approx\; \sum_{i=0}^{n_A-1} \sum_{j=0}^{n_N-1} d_{ij}\, T_i(z_{A,t})\, T_j(z_{N,t-1})\,,$$

on the same grid and basis. The coefficients $\{d_{ij}\}$ are chosen to satisfy the asset-pricing Euler equation

$$P_t \;=\; \mathbb{E}_t\Big[M^E_{t,t+1}\,(P_{t+1} + d_{t+1})\Big],$$

where dividends are

$$d_t = Y_t - \kappa\, v_t - W_t N_t, \quad Y_t = A_t N_t, \quad W_t = \overline{W}\, A_t^{\rho_W}.$$

Again, expectations are evaluated by 21-point Gauss–Hermite quadrature, and the nonlinear system for $\{d_{ij}\}$ is solved via `lsqnonlin`.

Step 3: Simulation and Equity Premium

Once both policy functions are determined, I simulate the model for $T = 1{,}000$ periods, 100 different times, iterating

$$\begin{aligned}
&A_{t+1} = \exp\big(\rho_A \log A_t + \sigma_A \varepsilon_{t+1}\big),\\
&N_t = (1-\omega)N_{t-1} + e_t^{\alpha}\, v_t^{1-\alpha}\\
&e_t = 1 - (1-\omega)N_{t-1},\\
&v_t = \exp\big(F_\ell(A_t, N_{t-1})\big)\\
&P_t = F_P(A_t, N_{t-1}),\\
&Y_t = A_t N_t\\
&d_t = Y_t - \kappa v_t - W_t N_t
\end{aligned}$$

where F_ℓ and F_P denote the Chebyshev approximations for $\log v_t$ and P_t respectively. I then form one-period equity returns

$$R^S_{t+1} = \frac{P_{t+1} + d_{t+1}}{P_t},$$

and the risk-free rate

$$R^f_t = \frac{1}{\mathbb{E}_t[M^E_{t,t+1}]}\,,$$

using the same quadrature rule. The unconditonal equity premium is reported as $\mathbb{E}(R^S) - \mathbb{E}(R^f)$. I then report moments as those averaged over the 100 simulations.

D Data Sources and Variable Construction

1. **Real Risk-Free Rate**. The return on a 1-month Treasury bill taken from Kenneth French's website, adjusted by the rate of CPI inflation (FRED code: CPIAUCSL).

2. **Real Equity Return**. The return on the CRSP value-weighted market portfolio adjusted by the rate of CPI inflation. Taken from Amit Goyal's website. I create an unlevered return by adjusting by a leverage factor of 1.5. This is in line with the average debt-to-equity ratio of ≈ 0.5 nonfinancial corporate businesses in the US over the sample period.

3. **Real Excess Equity Return**. The real equity return minus the real risk-free rate, as defined above.

4. **Dividends**. The 12-month moving average of dividends paid on the S&P 500 price index. Taken from Amit Goyal's website. This is then detrended using the Hamilton (2018) filter.

5. **Log Price-Dividend Ratio**. The natural log of the ratio between the S&P 500 price index and the 12-month moving average of dividends paid on the S&P 500 price index. Taken from Amit Goyal's website.

6. **Unemployment Rate**. The number of unemployed as a percentage of the labour force, taken from the Current Population Survey (CPS). FRED code: UNRATE.

7. **Real Consumption Growth**. The growth rate of the sum of personal consumption expenditures: nondurable goods (FRED code: PCND) and personal consumption expenditures: services (FRED code: PCESV) from NIPA, deflated by the CPI. Available at the quarterly frequency.

8. **Job Loss Rate.** This is defined conceptually as the employment-unemloyment transition rate, in line with ρ_t in the model. It is constructed as the total number of unemployed less than 5 weeks (FRED code: UEMPLT5), multiplied by the fraction of the unemployed who are job losers (FRED code: LNS13023622), divdided by the previous period's employment level (FRED code: CE16OV). The availability of the series begins in 1967.