Risky Business Cycles*

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Abstract

We identify a shock that explains the bulk of fluctuations in equity risk premia, and show that the shock also explains a large fraction of the business-cycle comovements of output, consumption, employment, and investment. Recessions induced by the shock are associated with reallocation away from full-time permanent labor positions, towards part-time and flexible contract workers. A flexible-price model with labor market frictions and fluctuations in risk appetite can explain all of these facts, both qualitatively and quantitatively. The size of risk-driven fluctuations depends on the relationship between the riskiness and the marginal product of different stores of value: if safe savings vehicles have relatively low marginal products, then a flight to safety will drive a larger aggregate contraction.

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1 Introduction

The time-varying and volatile nature of risk premia are among the most salient facts in financial economics (Cochrane, 2011). Recent macroeconomic research has revived interest in the classic idea, shared by both academics and outside analysts, that these volatile risk premia could be an important source of business cycle fluctuations (Cochrane, 2017). Yet risk-driven models face a crucial challenge, in that they generally have difficulty generating the hallmark of business cycles – comovement between output, consumption, investment and employment (Gourio, 2012; Ilut and Schneider, 2014; Basu and Bundick, 2017).

This paper makes two main contributions to this research agenda. First, we perform a model-free empirical analysis, which isolates the shock that drives the bulk of variation in expected excess stock returns. We find that the same shock accounts for most of the variation in macroeconomic quantities and an even larger share of their comovement – thus risk premia and business cycles are indeed very closely linked in the data. Second, we propose a novel real model where risk premia fluctuations propagate through the broader economy in a way that generates business cycle comovement and, hence, provide a new mechanism for overcoming the classic comovement challenge. We estimate our model and show it closely replicates all of the patterns we identify in the data.

Generating comovement via risk premia fluctuations is challenging in models without nominal rigidities, because increases in risk or risk premia create precautionary motives that push consumption and investment in opposite directions, ceteris paribus.[1] Our key theoretical insight is that, in addition to affecting the overall desire to save and invest, an increase in risk also makes it optimal to reallocate savings towards *safer* investments. However, safer assets naturally have lower equilibrium returns and, in the case of real saving technologies, this means lower marginal products. We show that through this reallocation channel a flight to safety can have significant real effects, and result in a recession in which output, consumption and investment all fall. In this way, our model provides a novel, quantitatively successful mechanism for demand-driven macroeconomic comovement without relying on either nominal rigidities or changes in production technology, both of which Angeletos et al. (2020) argue are not central to business cycles in the data.

We begin the paper with a model-free empirical exercise that aims to isolate the connection between risk premia fluctuations and business cycles. Specifically, we use a vector autoregression (VAR) and a maximum-share identification procedure in the tradition of Uhlig (2003) to extract the shock that, by itself, explains the largest portion of the five-

[1] For additional intuition, we observe that an increase in risk premia affects allocations today in a somewhat similar way as bad news about future productivity (e.g. Beaudry and Portier, 2006).

year-ahead variation in expected equity excess returns, our benchmark measure of the equity risk premium.[2] The resulting shock indeed explains the vast majority (around 90%) of the overall equity risk premium variation. While our analysis cannot uniquely label the structural origin of this "main risk premium" shock, the fact that a single shock can explain up to 90% of fluctuations effectively shows that surprise innovations to risk premia predominantly follow a common dynamic pattern.

To explore the relationship between risk premia and the broader economy, we examine the response of macroeconomic aggregates to our shock. We find that an increase in the equity premium driven by our shock is associated with concurrent, substantial falls in output, consumption, investment, employment, and stock prices, and only a small change in safe real interest rates.[3] Thus, our shock generates the type of comovement across macro quantities (and a "smooth" risk-free rate) consistent with the main stylized facts about business cycles. This shock also explains a substantial proportion of the overall variation in macro aggregates, accounting for over half of the unconditional variance of output, consumption, investment and employment and an even greater portion of their *covariances*. Thus, our analysis suggests that the bulk of the fluctuations in macro aggregates, and their hallmark comovement, share the same origins as risk premia fluctuations.

As a result, even though we isolate a shock that drives *risk premia* without imposing any restrictions on its effect on business cycles, it turns out that our shock is closely related to the "main business cycle" shock of Angeletos et al. (2020), which is recovered by a similar max-share procedure, but instead targeting macro quantities directly.[4] Hence, our results show that the central features of asset prices and business cycles are indeed closely related, especially in a conditional, dynamic sense.[5]

We go on to explore the effects of our shock on a set of additional variables that could help inform a theory of these fluctuations. We find that the risk premium shock generates small to insignificant changes in aggregate profits, the real interest rate and inflation. This suggests that the likely structural origins are unrelated to productivity, mechanisms that primarily operate through intertemporal substitution or rely heavily on textbook inflationary demand shocks. At the same time, even though our shock generates a pronounced fall in aggregate hours and in total employment, it is associated with a significant *rise* in *part-time* employment, both in absolute terms and as a share of total

[2]The 5-year horizon corresponds to the benchmark return forecastability results in Cochrane (2011).

[3]In robustness checks, we have found aggregate hours to behave similarly to employment.

[4]Another difference is that Angeletos et al. (2020) target business cycle frequencies while we target the unconditional variance. Our results are robust to this change in the targeted frequencies.

[5]Our conditional analysis thus contrasts with the evidence that, on average, traditional stock market predictors lack predictive power for real activity (e.g. López-Salido et al., 2017).

employment. This fact poses a particular challenge for many standard macroeconomic models which, whether driven by aggregate demand or aggregate supply shocks, generally imply that different types of labor should move in the same direction.

To rationalize our empirical results, we propose a novel real model where risk premium fluctuations propagate to, and generate, business cycles and macroeconomic comovement without a strict reliance on intertemporal substitution forces or nominal rigidities. To illustrate our mechanism cleanly, we use direct shocks to risk aversion as the cause of risk premia fluctuations (with stochastic productivity as the underlying source of uncertainty). However, we stress that our theory offers a *general* propagation mechanism that would transmit fluctuations in risk premia to the macroeconomy regardless of their source. The deeper cause of risk premia fluctuations does not matter for our basic mechanism.[6]

A key feature of our framework is that we allow for search frictions in labor markets, and two types of labor: the first, which we call "full-time," involves longer-term relationships and sticky real wages, while the second, which we call "part-time," involves shorter employment spells and flexible wages (as in the data, e.g. Lariau, 2017). Like in Hall (2017), frictions in forming or severing labor relationships imply that labor, like capital, is a long-lived investment good. Long duration also implies labor relationships are risky. Moreover, the structural differences in full-time and part-time labor result in full-time positions carrying a higher risk premium, as the sticky wages and longer duration of these contracts make the surplus accruing to the firm more volatile and more procyclical.[7]

Due to these differences in riskiness, a risk premium shock leads to a reallocation of vacancy postings (i.e. investment in labor relationships) from the riskier full-time, to the safer, part-time labor positions. Full-time labor, according to our estimated model, has a higher marginal product. Thus, the shift away from full-time vacancies ends up lowering aggregate composite labor and, therefore, output. This fall in the effective labor units also lowers the marginal product of capital (MPK). Putting everything together, the fall in output, and thus available resources for consumption and investment, together with the fall in MPK, leads to a recession where all four macro aggregates fall together. Importantly, all these effects operate via reallocation of inputs with heterogeneous marginal products, not via changes in production technology and measured TFP.

We quantify this channel of reallocation across different type of investment goods by

[6] The source of risk premia fluctuations is still debated by the literature, but recent empirical work finds that 90% of the equity premium variation is due to "risk-appetite" shocks, which are orthogonal to innovations in macro fundamentals, and thus similar to direct risk-aversion shocks (Bekaert et al., 2019).

[7] Recent empirical work by Faia and Pezone (2018) confirms that wage rigidity is indeed an important source of priced risk in the cross-section of firm valuations, consistent with our model.

matching the consequences of a rise in risk aversion in our model to the VAR impulse responses generated by the risk premium shock we extracted from the data. We find that the model does an excellent job of matching the empirical evidence, generating quantitatively realistic business cycle fluctuations in response to such shocks, including the hallmark comovement discussed earlier. Moreover, the model matches these salient facts without implying a strong cyclicality of measured final goods markups, avoiding a contentious debate (e.g. Rotemberg and Woodford, 1999 vs Nekarda and Ramey, 2013).

The introduction of two types of labor improves the empirical realism of the model in several other respects. First, the reallocation of employment from full-time to part-time labor conditional on a risk premium shock is indeed a pronounced feature of the data, as we show in our empirical analysis.[8] Second, having part-time workers with flexible wages allows the model to match the evidence that aggregate wages are cyclical, despite the fact that wages in our full-time sector are partially rigid. Third, the short duration of part-time jobs ensures that the model does not feature counter-factually long average job duration, helping it avoid Borovicka and Borovicková (2018)'s critique of Hall (2017).

Lastly, we note that the role of wage rigidities in our model is distinct from the one at play in Hall (2005). There, sticky wages amplify the volatility of the expected present discounted value of cash flows associated with new labor relationships. In contrast, the risk premium shocks we estimate in our model have a muted impact on future labor productivity (only indirectly, through the equilibrium fall in the other inputs to production), and thus do not lead to meaningful variations in the *expected* cash flows of matches. Instead, our shocks primarily affect the economy through their substantial impact on the risk premium associated with these cash flows. We make this point clear in a counterfactual exercise which shows that once we shut down the effects of risk premium fluctuations on the demand for full-time labor, keeping everything else the same, the model fails to produce meaningful real fluctuations and loses its ability to generate macro comovement.

We thus uncover a new way in which wage stickiness can help deliver large changes in the value of workers and resolve the Shimer (2005) puzzle, by relying on the differential riskiness of two types of labor. Remarkably, this mechanism does not lead to counterfactual predictions for the aggregate wage. Indeed, the aggregate wages in our estimated model are significantly less rigid than in Hall (2005).

[8] Lariau (2017), Mukoyama et al. (2018) and Borowczyk-Martins and Lalé (2019a) all emphasize that reallocation from full-time to part-time labor is crucial for understanding the over-all counter-cyclicality of part-time labor in the data. Reallocation from new to old capital could provide a similar amplification mechanism (see the empirical evidence of Eisfeldt and Rampini, 2006), though we abstract from it here.

Related Literature

Recent work has rekindled interest in the idea of uncertainty- or risk-driven macroeconomic fluctuations (Gilchrist et al., 2014), but this otherwise intuitive research agenda faces difficulty generating full macro comovement. For example, Bloom (2009) proposes a model of the firm where non-convex adjustment costs generate real-option-value effects so that an increase in uncertainty triggers a wait-and-see reaction in firm plans, generating a drop in investment, employment, and output, but not consumption. Some papers, such as Gourio (2012) and Bloom et al. (2018) for example, have therefore complemented risk mechanisms with first-moment shocks to also generate a drop in consumption. In related work, Arellano et al. (2019) exploit financial frictions to obtain drops in output and labor in response to an increase in idiosyncratic risk, but abstract from investment and capital, while Segal and Shaliastovich (2021) rely on persistent depreciation to obtain drops in consumption and investment, but abstract from labor implications.

One solution to comovement challenges is to use models with nominal rigidities, so that output is primarily determined by final goods demand (e.g. Ilut and Schneider (2014), Fernández-Villaverde et al. (2015), Basu and Bundick (2017), Bayer et al. (2019), Caballero and Simsek (2020)). Christiano et al. (2014) further exploits the interaction of nominal rigidities and financial frictions to obtain deep risk-driven recessions. Moreover, New-Keynesian frictions also help deliver large movements in unemployment following uncertainty shocks in models with labor search frictions (Leduc and Liu, 2016; Challe et al., 2017).[9] All of the above mechanisms rely on endogenous variations in markups driven by sticky prices to deliver simultaneous falls in consumption and investment in response to a risk or uncertainty shock. By contrast, our model does not rely on sticky nominal prices or suboptimal monetary policy to generate business cycle comovement.

Two recent papers, Di Tella and Hall (2020) and Ilut and Saijo (2021), also provide mechanisms that deliver business-cycle comovements via a risk channel without nominal rigidities. They propose models where the marginal product of both capital and labor is uncertain – due to a labor-in-advance choice in the former, and imperfect information about productivity in the latter. In both cases, a rise in uncertainty can generate macro comovement, as long as the risk-driven fall in firms' investment demand is strong enough to offset the households' increased desire to save, operating on the usual intertemporal margin that trades off lower risk-adjusted capital returns with precautionary savings.

We differ from this work along two dimensions. First, we propose a new channel

[9] Occasionally binding downward wage rigidity also amplifies the impact of uncertainty shocks on labor market variables, with or without nominal rigidities (Cacciatore and Ravenna, 2020).

for propagating risk and uncertainty fluctuations into macro comovement, which is the reallocation of savings from investments with higher risk premia and higher marginal product to investments that are safer, but have a lower marginal product. We are the first to formally model this channel as the source of business cycle comovement, and argue that it is consistent with the reallocation from full-time to part-time labor we document in the data. Second, in the case of Di Tella and Hall (2020), the mechanism relies on variation in *idiosyncratic risk*, and does not generate time variation in the aggregate equity premium, while we document a close empirical link between the counter-cyclicality of the equity premium and macroeconomic comovement.

Previous research has also sometimes modeled direct shocks to risk appetite as we do in our model, but with the goal of capturing different aggregate phenomena. Dew-Becker (2014) for example, shows that such fluctuations can be useful in new-Keynesian contexts to explain the dynamics of the term structure of interest rates. More recently, Bansal et al. (2021) use fluctuations in risk appetite to explain longer run reallocations of investment between R&D intensive and non-intensive industries. The latter authors also propose a very different solution to comovement puzzles by assuming that the government sector absorbs demand for lower-risk investments in periods of high risk aversion.

Hall (2017) argues that the time variation in discount rates that is needed to explain stock market volatility can also rationalize the fluctuations in unemployment. Subsequent papers have built on this general idea to provide a risk-driven explanation of the Shimer (2005) puzzle and other labor market phenomena – see for example Kilic and Wachter (2018), Kehoe et al. (2019), Mitra and Xu (2019), and Freund and Rendahl (2020) among others. These and other models that focus on risk-driven unemployment fluctuations largely abstract from capital accumulation or, when capital is considered, do not focus on the comovement across macro aggregates. In addition, despite their labor market focus, they do not account for the disparate movements in part-time and full-time labor.

2 Risk Premium Shocks

This section summarizes our approach to estimating equity risk premium shocks in the data. Our baseline empirical specification consists of a vector-autoregression of the form

$$Y_t = B(L)Y_{t-1} + A\epsilon_t. \tag{1}$$

In the above, Y_t is a vector of observed variables, $B(L)$ contains the weights on past realizations of Y_t, ϵ_t is a vector of structural economic shocks, and A is the structural matrix that our procedure seeks to identify from the reduced-form residuals, $\mu_t \equiv A\epsilon_t$.

We estimate equation (1) on US data using the observable set

$$Y_t \equiv \left[gdp_t, c_t, inv_t, n_t, r_t^s, r_t^b, dp_t\right]', \tag{2}$$

which consists of the logs of real per-capita output, consumption, investment, employment, real stock log-returns (inclusive of dividends), log real ex-post three-month treasury bill rate, and the dividend-price ratio.[10] Our sample is 1954Q1-2018Q4.[11] The VAR is estimated in levels using OLS, including three lags in the polynomial $B(L)$.

2.1 Identification Approach

As with most VAR identification schemes, we seek to select a particular rotation of the matrix A that maps orthogonalized innovations ϵ_t to the reduced form residuals μ_t. We follow Uhlig (2003), and use a "max-share" approach to find the rotation matrix A such that the first element of the resulting shock vector ϵ_t is the orthogonal innovation that explains the largest portion of the variation in the *expected* equity excess return. This ex-ante expected risk premium is computed based on the VAR estimates.

Specifically, the *realized* j-period cumulative excess return is defined as usual

$$rp_{t,t+j} \equiv [r_{t+1}^s + r_{t+2}^s + ... + r_{t+j}^s] - [r_{t+1}^b + r_{t+2}^b + ... + r_{t+j}^b]. \tag{3}$$

We then compute the expectation of this excess return as implied by our VAR. Let $\tilde{Y}_t = \tilde{B}\tilde{Y}_{t-1} + \tilde{A}\tilde{\epsilon}_t$ be the companion form of the VAR in equation (1) – that is $\tilde{Y}_t$ is a stacked vector of Y_t and its three lags, $\tilde{\epsilon}_t$ pads ϵ_t with zeros at the bottom to be conformable. Taking expectations over (3) and iterating backwards through the VAR system, we can express the expected excess return as a linear function of innovations $\tilde{\epsilon}_t$

$$\mathbb{E}_t[rp_{t+j}] = (e_5 - e_6)(\tilde{B} + \tilde{B}^2 + ... + \tilde{B}^j)(I - \tilde{B}L)^{-1}\tilde{A}\tilde{\epsilon}_t. \tag{4}$$

where e_5 and e_6 are vectors that select the stock and bond returns from $\tilde{Y}_t$, respectively.

[10]The Appendix contains more details on data definitions.

[11]A previous version of the paper used data starting in 1985Q1 to avoid a potential structural break at the start of the "Great Moderation". The results are very similar, hence we use the longer sample in our benchmark analysis. The shorter sample results are reported in the Appendix.

Let $\phi(z) \equiv (e_5 - e_6)(\tilde{B} + \tilde{B}^2 + ... + \tilde{B}^j)(I - \tilde{B}z)^{-1}\tilde{A}$ be the z transfer-function associated with the MA(∞) representation in (4). Then, the variance of $\mathbb{E}_t[rp_{t,t+j}]$ associated with spectra of periodicity $p \equiv [p_1, p_2]$ is given by

$$\sigma_p^{rp} = \frac{1}{2\pi} \int_{2\pi/p_2}^{2\pi/p_1} \phi(e^{-i\lambda})\phi(e^{-i\lambda})' d\lambda. \tag{5}$$

Conversely, the contribution of each to the variance in the same range is given by

$$\Omega_p^{rp} = \frac{1}{2\pi} \int_{2\pi/p_2}^{2\pi/p_1} \phi(e^{-i\lambda})'\phi(e^{-i\lambda}) d\lambda. \tag{6}$$

We find the shock that explains the most of σ_p^{rp} by computing the eigenvector associated with the largest eigenvalue of Ω_p^{rp}, call it q_1, and setting

$$A = \hat{A}q_1, \tag{7}$$

where $\hat{A}$ is the Cholesky decomposition of the variance-covariance matrix of the reduced form residuals, $\Sigma_\mu \equiv cov(\mu_t)$. Thus, the first element of the resulting vector ϵ_t is the orthogonal innovation that has the highest contribution to the overall variance of the expected excess equity return – i.e. it is the main driver of the expected equity returns in the data. While this procedure cannot label the deep origins of this shock uniquely – it could be a linear combination of different structural shocks for example – this is nevertheless a powerful statistical tool for capturing and analyzing the impact of orthogonalized surprise changes in the equity risk premium. As such we will simply call the shock we recover a "risk premium" shock, and will dig into its potential deep sources in our further analysis.

To implement the procedure, we need to specify the horizon at which excess returns are computed (j) and the frequency band of variation we want our procedure to target ($[p_1, p_2]$). As a baseline case we choose $j = 20$, consistent with the common practice in the finance literature of emphasizing the predictability in the 5-year excess equity return. Second we choose $p = [2, 500]$, corresponding to fluctuations of periodicity anywhere between 2 and 500 quarters. Practically, this corresponds to targeting unconditional variances, but allows us to perform robustness checks in which the VAR is estimated in VECM form and the lag polynomial $B(L)$ has a unit root. In such robustness checks, we find our findings are robust to estimating the VAR in VECM form so long as we allow for more than two independent trends in the data. Similarly, our results are robust to increasing the lags in our VAR, but for the benchmark results we stick to three lags for degrees of freedom considerations.

2.2 Excess Returns Predictability

Before turning to the main empirical results, first we verify that our VAR is indeed able to forecast equity returns well, and hence the VAR expected returns capture the true ex-ante risk effectively.

In Figure 1 we plot the expected excess stock return as estimated by our VAR, $\mathbb{E}_t(rp_{t,t+20})$ against the realized excess return over that same forecasting horizon, $rp_{t,t+20}$. The Figure shows that both series exhibit substantial variation, and while the ex-post series is not surprisingly more volatile, the VAR-implied expected excess return tracks it reasonably well. The R^2 of regressing ex-post returns on our VAR forecast is 0.49, which is both significant and at the same time in line with the previous literature, which has found very similar moderate to high predictability in 5-year returns (e.g., Cochrane, 2011).

To understand which specific variables in our VAR are most important in driving the predictability of excess returns, we now present the expected excess stock returns $\mathbb{E}_t(rp_{t,t+j})$ as implied by a sequence of smaller VARs that use only a subset of the 7 variables contained in our main specification.

We start with a the smallest VAR that allows us to compute expected excess stock return: the VAR that contains only stock and bond returns, that is $Y_t = [r_t^s, r_t^b]$. In Figure 2, we plot the implied expected excess return of this VAR with the light blue line. The Figure shows that stock and bond returns alone are very poor predictors of future excess stock returns, delivering an essentially flat line throughout our sample and an R^2 of expected on realized excess return of only 0.01.

We then sequentially expand the number of variables we include in the VAR to include more variables from our original set. In doing this exercise in different permutations, we have found that consumption and GDP are particularly important. While including GDP or consumption alone only marginally improves the prediction (not shown), the dark blue line in the figure shows that adding them jointly delivers a substantial improvement and raises the R^2 to 0.43. Notice that the VAR-implied expected return now exhibits large fluctuations as in the data and is characterized by significant spikes in all recessions in our sample, all followed by a steady decline. In most occasions, including during the Great Recession, these patterns align well with the data. Moreover, no other alternative combination of four variables from our full VAR can deliver similarly large forecastability.

Finally, we have also found that the third most important variable is the dividend-

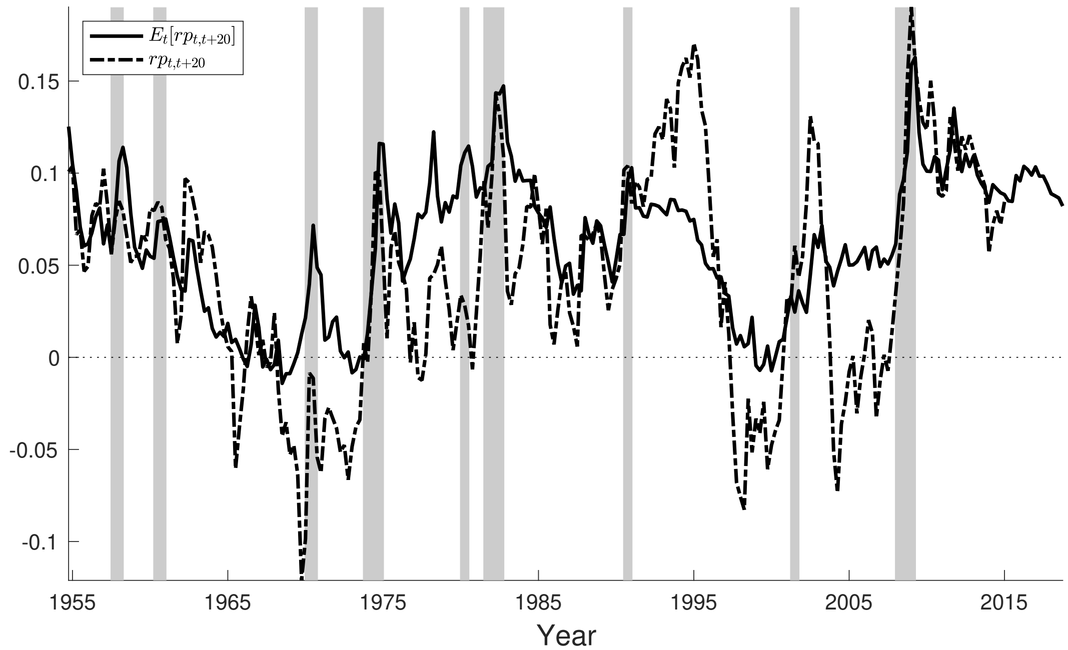

Figure 1: Ex-ante and ex-post excess stock returns.

price ratio. Adding dp_t to the previous 4-variable VAR further improves predictability and brings the R^2 to 0.46. Moreover, the figure also shows that the VAR-implied excess return in this case (purple line) is essentially identical to that of out baseline 7-variable VAR.

We thus conclude that the joint information in GDP and consumption, and in the dividend-price ratio to a lesser extent, play the most important role in our VAR's ability to predict excess equity returns. As such, our VAR is essentially relying on the information underlying two of the most robust return predictors found by the previous literature – the cay_t variable of Lettau and Ludvigson (2001) which captures deviations from the long-run mean in the consumption-to-income ratio, and the dividend price ratio (Cochrane (2011)). While we do not include cay_t directly in Y_t, our VAR nevertheless flexibly captures the same information by estimating the cointegration relationship between consumption and GDP, rather than fixing it as Lettau and Ludvigson (2001) do when computing the specific formulation of cay_t. Overall the predictability in our VAR is both substantial, and also based on well-understood, and robust predictors that have a long tradition in the literature.

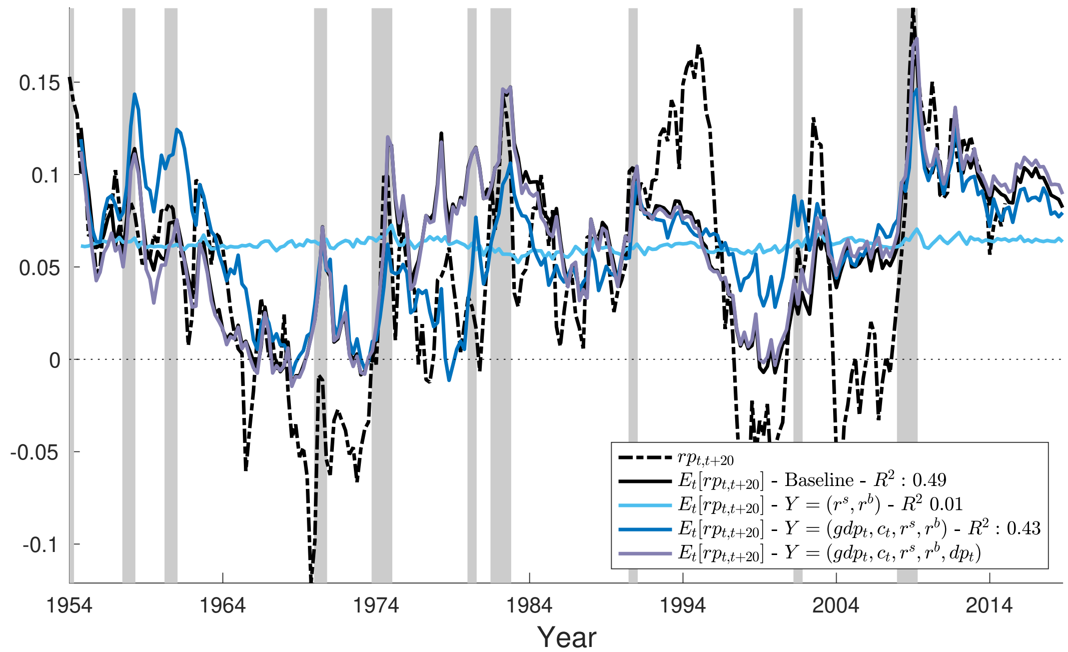

Figure 2: Ex-post and Ex-ante excess stock returns from alternative VARs.

2.3 Empirical Results

Having established the bona fides of our VAR-based expected equity returns, we apply the identification procedure detailed in Section 2.1, extract the shock that accounts for the bulk of the fluctuations in this expected return, and study its impact.

Figure 3 plots the impulse responses of the major business cycle variables in response to the shock identified by our VAR procedure. The numbers in the panel titles represent the percent of variance of the given variable explained by our shock at the business cycle frequencies (first number) and [2,500]-periodicity frequencies (second number).

The first panel plots the response of the equity risk premium itself ($\mathbb{E}_t rp_{t,t+j}$), the target of our max-share procedure. We see that the recovered "risk premium" shock causes a substantial and persistent increase in the 5-year equity risk premium. It jumps up by about 1.25% (annualized) on impact (compared to an average risk premium of 5.4% in our sample), and the impulse response is largely monotonic but decays slowly, with a half-life of 9 quarters. Overall, this shock explains 95% of the variation in the risk premium at business cycle frequencies, and 87% of what is effectively its unconditional variance. These very high numbers mean that the impulse responses associated with this single shock can give us a very good approximation of the impact of a surprise change in the risk premium.

Naturally, we find that this persistent rise in the risk premium is associated with a

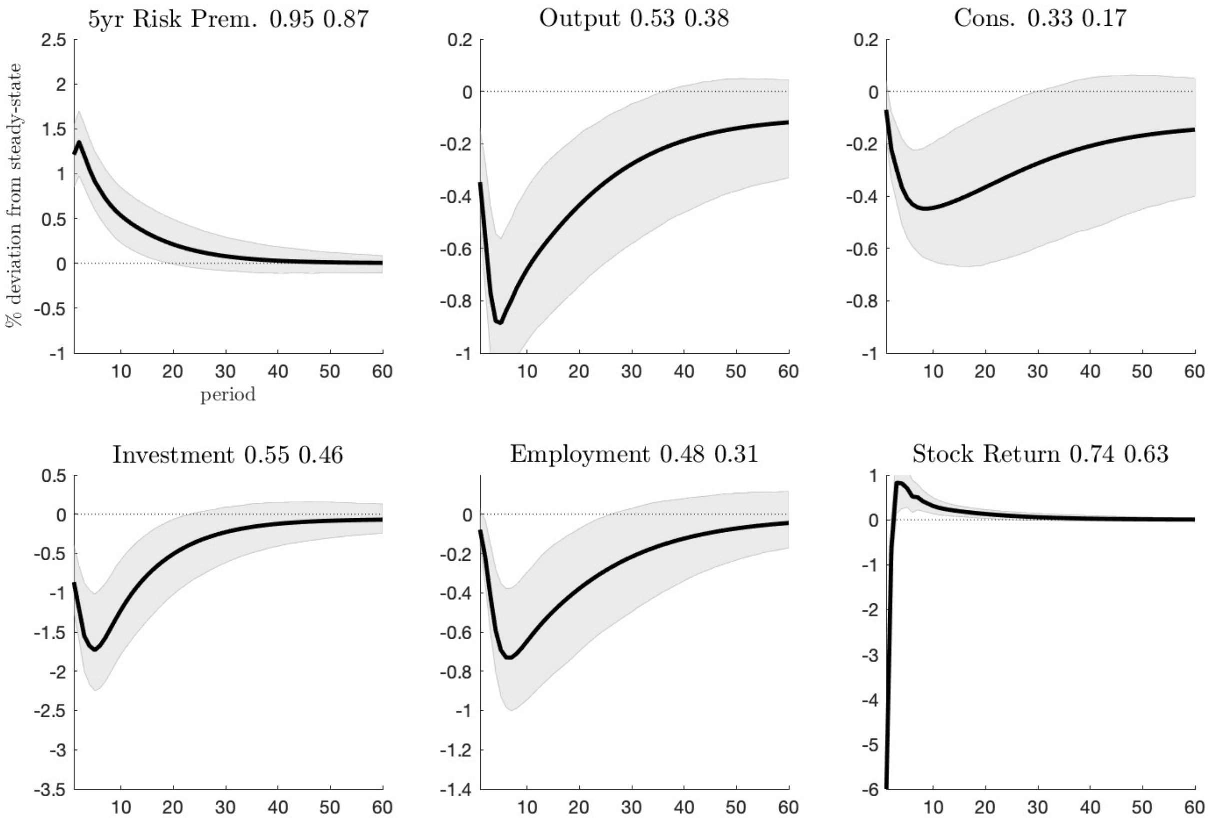

Figure 3: Impulse responses to VAR-identified risk premium shock. Shaded lines are the 10th- and 90th-percentile bootstrapped responses. Numbers in subplot titles correspond to the percent of variance explained at the business cycle (6-32 quarters) and unconditional frequencies (defined as variance over frequencies of 2-500 quarters since many variables are non-stationary), respectively.

sharp drop in stock prices on impact (fall in ex-post return) – see panel six. This is followed by a prolonged period of higher than average returns, which essentially underlie the elevated expected excess returns $\mathbb{E}_t(rp_{t,t+j})$.

Most interesting, are the responses of the four main macro aggregates output, consumption, investment and employment, which are plotted in panels 2 through 5. We find that all of these variables exhibit a substantial and persistent contraction following a risk premium shock, with hump-shaped dynamics. These significant dynamic responses underpin the shock's importance in terms of variance decomposition. For output, investment and employment we find that the shock explains roughly half of their variance at business cycle frequencies, and it explains a third of the business cycle variance of consumption. In terms of unconditional variance (again, periodicities between 2 and 500 quarters), the

Table 1: Business-cyle Covariance Explained - Baseline Procedure

	Output	**Cons.**	**Investment**	**Employment**	**Stock Return**
Output	0.53				
Cons.	0.49	0.33			
Investment	0.61	0.66	0.55		
Employment	0.55	0.54	0.56	0.48	
Stock Return	0.67	0.87	0.66	0.79	0.74

numbers are still substantial, but a bit lower, as could be expected from the fact that the risk premium shock is persistent but clearly stationary (see the first panel).

Moreover, the conditional responses exhibit a strong positive comovement. Thus, macro comovement, a quintessential feature of business cycles the macro literature often stresses, is not just an unconditional phenomenon, but is also present specifically conditional on risk premium shocks.

Table 1 quantifies how important our risk premium shock is for explaining the overall comovement we see in the data. Each entry in the table reports the covariance (at business cycle frequencies) between the variables listed in the row/column, conditional on *only the risk premium shock* being active, relative to the covariance implied by the full estimated system in (1). Thus, the diagonal elements of the table correspond to the standard variance share decomposition, as also reported in the panel titles of Figure 3. By contrast, the off-diagonal elements are a form of "covariance decomposition", and are not bounded between zero and one: They will take negative values if the covariance implied by our shock has the opposite sign as the corresponding unconditional covariance, and they will be larger than unity when the covariance conditional on our shock is larger than the unconditional covariance.

The Table shows that, as important as our shock is in terms of variance decomposition, it is an even more important driver of the *covariance* among the variables. For example, the "share" of 0.87 for the covariance between consumption and stock returns implies that our shock alone generates almost all of the positive consumption-stock return covariance that we see in the data as a whole. Thus, all other shocks that otherwise drive the remaining two-thirds of consumption volatility in the data cause only mild positive relationship between consumption and stock returns. More generally, the off-diagonal entries are bigger than the diagonal elements,and are almost all bigger than 0.5, signifying that our risk-premium shock is more important in causing the positive comovement across macro aggregates than all other shocks combined.

Thus, overall, our findings show that the "risk premium" shock appears to be a potentially important driver of business cycles, both in generating macro fluctuations and in driving the classic observation of macroeconomic comovement. It is interesting, then, to compare our findings with the "main business cycle shock" of Angeletos et al. (2020), who follow a max-share procedure that isolates the main driver of the (business cycle) variance of one of output (or employment, depending on the specification).

Unsurprisingly, the Angeletos et al. (2020) shock captures a bigger portion of the (business cycle variance) of macro aggregates (e.g. in our data it explains 93% of the variation in output), as it is specifically designed to do so. Nevertheless, the two shocks are fairly highly correlated, with a correlation coefficient of 0.75, and the impulse responses (unreported) are qualitatively similar. Hence, we conclude that though we target very different portions of the data (equity risk premium vs output), the Angeletos et al. (2020) shock appears to be a combination of the risk premium shock and something else, but with the risk premium shock playing a key role.

From this perspective, our empirical exercise showcases that the central features of business cycles and risk-premia are indeed intimately related.

2.4 Additional Results

To help unpack our results, and dig deeper in the nature of the risk premium shock we have identified, we augment our baseline VAR with a set of auxiliary variables, S_t, that includes additional labor market and business cycle indicators, and study their impulse responses as well. To save on degrees of freedom (and because not all of the additional variables are available starting in 1954:Q1), we estimate these auxiliary impulse responses by projecting the vector of variables S_t on current and past observations of our VAR Y_t:

$$S_t = \Gamma(L)Y_t + v_t, \tag{8}$$

The coefficient matrix $\Gamma(L)$, estimated via OLS, contains the same number of lags as the VAR in (1). Using the estimated values of $\Gamma(L)$, we can then compute the impulse responses for any auxiliary variable using the responses for Y_t implied by our VAR in (1). It includes real profits of non-financial corporations, inflation, the yield on 5-year bonds, and also the number of part-time workers in the economy.

First, we want to know whether our risk premium shock is also associated with significant movements in profitability, and thus cashflows, or if it is more of a "pure" risk

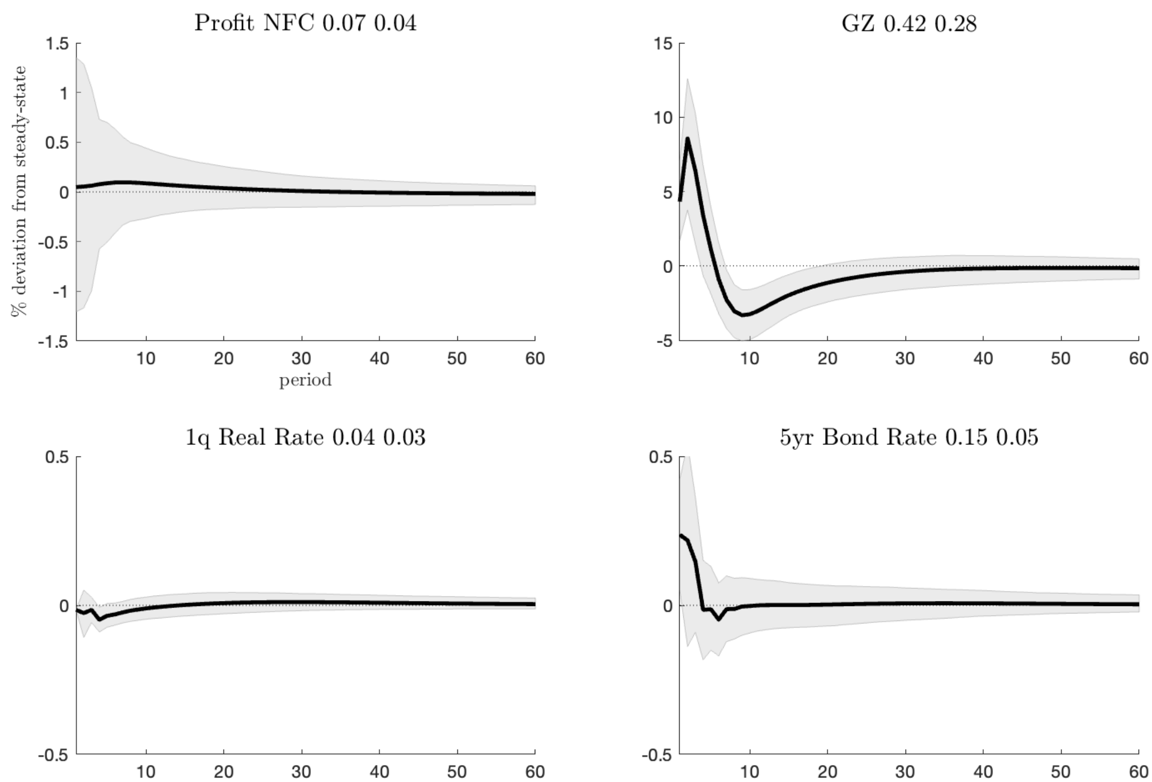

Figure 4: Impulse responses to VAR-identified risk premium shock for additional variables. Shaded lines are the 10th- and 90th-percentile bootstrapped responses. Numbers in subplot titles correspond to the percent of variance explained at the business cycle (6-32 quarters) and unconditional frequencies (defined as variance over frequencies of 2-500 quarters since many variables are non-stationary), respectively.

premium shock, such that it affects stock prices, but does not affect cash flows and profitability directly. To answer this in the top left panel of Figure 4, we plot the impulse response of the present discounted value of expected real non-financial corporate profits. The time discount we use is the average real interest rate over our sample, and the present value of future expected profits is computed by iterating on equation (8).

The main result here is that the present discounted value of profits shows no significant movement, either on impact or eventually. Thus, if we think about the typical (non-orthogonal) decomposition of stock prices into the sum of present discounted value of cash flows and risk premia, this result suggests that our shock is indeed a pure shock to risk-premia, and not a shock that affects profitability first, and then also indirectly changes the price of risk. This is in line with other results in asset pricing (e.g. Bekaert et al. (2019)), which typically attribute risk-premium fluctuations to factors that are orthogonal to cash-flow fundamentals.

Moreover, while for simplicity we computed the present discounted value of profits using a constant time discount rate, we also find that our risk premium shock has virtually no effect on real rates, both short and long-term rates. The impulse response of the real 3-month and 5-year Treasury rates are plotted in the bottom two panels of Figure 4.

Moreover, not only are safe rates flat, but credit spreads do not rise significantly. We showcase that with the impulse response of the GZ spread of Gilchrist and Zakrajšek (2012), which is plotted in the top right panel of Figure 4. While the GZ spread indeed rises on impact, this increase is temporary, and offset by the fact that the GZ spread falls significantly below its average 6 quarters after the shock, and remains depressed for an extended period of time. Thus, our shock is not having a major impact on bond markets, either in the level of safe rates, or in terms of an unambiguous increase in the credit spread, while at the same time our shock causes a very persistent and pronounced increase in the equity risk premium.

This behavior is very different from the GZ *shock* that Gilchrist and Zakrajšek (2012) identify, in which case the GZ spread rises persistently. Moreover, the GZ shock of Gilchrist and Zakrajšek (2012) causes deflation, not inflation as our shock does, and also its real impacts are much more temporary that what we find. In addition, from Figure 4 we can also see that our shock is also not related to the Kurmann and Otrok (2013) yield curve slope shock either, as both short and long term rates remain unchanged (and also the impacts on real variables are quite different, with investment rising after a positive shock to the yield slope in Kurmann and Otrok (2013)).

Thus, overall we conclude that our shock has no appreciable impact on cash flows and safe rates, and does not look like a typical credit spread or yield curve shock, and rather appears to be a shock that is specific to the equity risk premium.[12]

2.5 Potential propagation mechanisms

As mentioned in the introduction, risk-premium (or more broadly uncertainty) shocks face significant hurdles in generating macroeconomic comovement in standard models, as shocks to the risk premium would typically raise pre-cautionary savings demand and thus increase investment rather than decrease it. The typical way of overcoming this is Neo Keynesian frictions, in which case the fall in consumption demand can have a sufficiently

[12]Our shock is indeed related to the equity-based "perceived-risk" measure of Pflueger et al. (2020), with the PVS spread variable falling significantly (which signifies an increase in perceived risk) following our risk-premium shock.

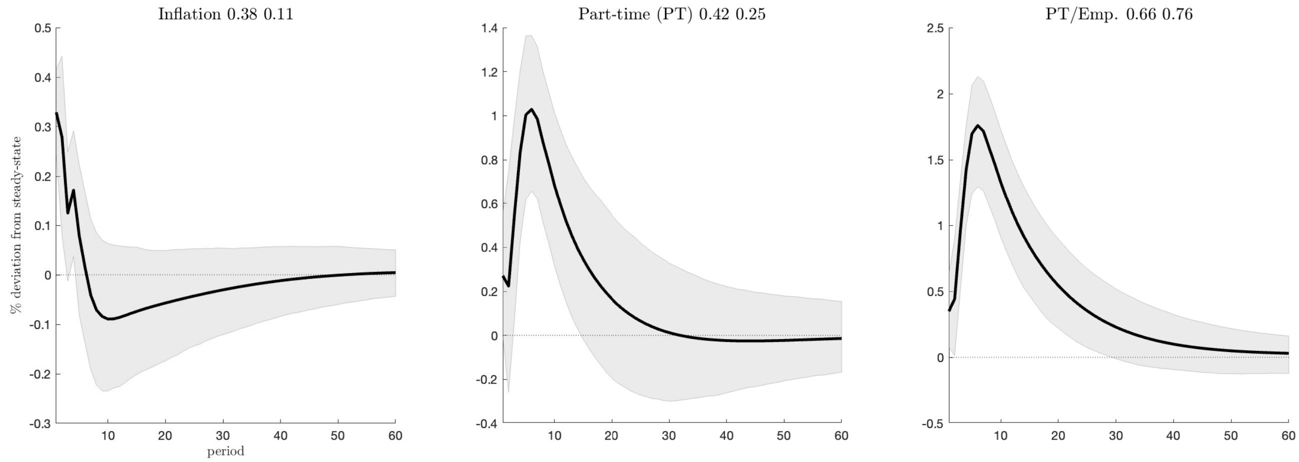

Figure 5: Impulse responses to VAR-identified risk premium shock for additional variables. Shaded lines are the 10th- and 90th-percentile bootstrapped responses. Numbers in subplot titles correspond to the percent of variance explained at the business cycle (6-32 quarters) and unconditional frequencies (defined as variance over frequencies of 2-500 quarters since many variables are non-stationary), respectively.

strong depressing effect on aggregate demand and cause a broad recession across all four macro aggregates.

Thus, a natural hypothesis is that the seemingly pure risk premium shock we are uncovering is propagated to the real side of the economy via Neo Keynesian frictions and slack aggregate demand. As such, we would expect that the shock would have a negative impact on inflation. Contrary to this, we actually find that our risk premium shock is associated with an *increase* in inflation, as we can see from the left panel in Figure 5. And moreover, textbook Neo-Keynesian mechanisms also imply that the real risk-free rate should fall significantly, as the recession will be both deflationary and the Central Bank will try to stimulate with lower nominal rates. But as we saw in Figure 4, that is not the case conditional on our shock. Hence, overall our data speaks against the possibility of a Neo Keynesian propagation mechanism.

Instead, we want to propose a novel hypothesis that would operate in a flexible price model, and hence would not necessitate a counterfactual fall in inflation. Specifically, we observe that an increase in the risk sensitivity of agents should cause not only an overall increase in precautionary savings, but also a desire to reallocate investment from riskier to safer activities – a "flight to safety" so to say. Naturally, in equilibrium the safer activities must be less productive on the margin to reflect their "safety premium", or otherwise they will be strictly preferred over the risky investments, and markets would not clear. Following this intuition, a flight to safety can indeed cause a recession through lowering marginal productivity and thus output. This could potentially lead to a fall in all four macro aggregates, if the fall in output is sufficiently strong.

Before we flesh out and quantify this argument in a model, let us first turn to the data. Our hypothesis suggests that there should be a change in the structure of firms, where managers respond to incentives from their investors and restructure activities (on the margin) to become safer. The previous literature has found that capital reallocation is highly procyclical (Eisfeldt and Rampini (2006)), hence we are motivated to look for changes on the labor side.[13]

One component of employment that is known to be counter-cyclical is part-time employment – see for example Figure 6. At the same time, part-time work arrangements have an eight times lower duration than full-time work positions and carry more flexible wages (e.g. Lariau (2017)). From that point of view, part-time workers provide the firm the ability to make its operations more flexible, and thus, in the language of Donangelo et al. (2019), imply a lower "labor leverage" for their firms, and decrease the company's risk profile. With that in mind, we conjecture that there is an increase in part-time labor demand following our risk premium shock. Thankfully, micro level studies of part-time workers suggest that the labor supply in those markets is relatively rigid, with most cyclical fluctuations driven by changing labor demand shifting workers from full-time to part-time status within the same firm (Borowczyk-Martins and Lalé (2019b))).

Thus, we can formally test our hypothesis by estimating the impulse response of the aggregate part-time employment to our equity risk premium shock. We plot the IRFs of both log part-time employment level and the log share of part-timers in employment in the middle and right panels of Figure 5. And indeed, we find that the employment of part-time workers actually *increases* in response to our shock. This response is significant and persistent, peaking at an increase of 1% in the number of part-timer works. This is striking given that, at the same time, the economy is experiencing a deep recession and employment overall *falls* by 0.7% at its trough. Naturally, given the fall in total employment, the share of part-timer workers in total employment rises by even more, peaking at an increase of 1.75%.

Moreover, our shock also explains a very significant fraction of the business cycle fluctuations in part-time workers. It explains 42% of the fluctuations in raw numbers,

[13]Note that labor is indeed a risky component of firms. For example, Belo et al. (2022) finds that "installed labor" accounts for 20% of firm value, compared to physical capital which accounts for 40% (and the rest is intangible capital). Similarly, Favilukis and Lin (2016) and Donangelo et al. (2019) find that wage rigidity and labor leverage more generally carry significant price of risk in the cross-section of firms.

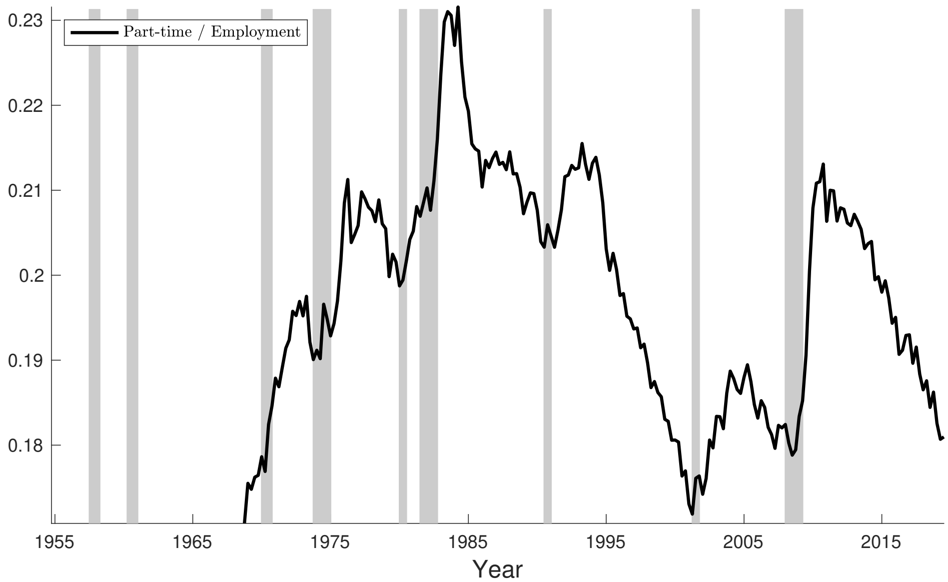

Figure 6: Part time workers as share of total employment

and 66% of fluctuations in the ratio of part-time workers to employment. Thus, we conclude that our risk premium shock is indeed causing a significant shift in the labor structure of firms from full-time to part-time employment.

In order to understand whether such a reallocation can indeed generate the deep recession with full comovement across Y, C, I and N that we estimate, we turn to a model which formalizes and quantifies the flight to safety argument above.

3 Model

Our model is an otherwise standard real economy, with frictional labor markets, and capital adjustment costs. In our one sector real economy, the capital adjustment costs and the frictional labor markets are what make capital and labor essentially risky components of firm values. The model consists of a representative household and a representative firm. The household consumes, supplies labor inelastically, and invests in firm shares along with firm and government debt instruments. The firm produces final goods and accumulates two types of labor positions (via labor search markets) and capital in order to maximize shareholder value. We present the key elements of the model below and relegate full derivations to the Appendix.

We model the risk premium shock we identified in the data as a shock to the risk aversion of the household. In that sense, it is a "pure" risk premium shock and does not have a direct impacts on either first or higher order moments of firms' productivity. This makes our exercise conservative, as we would need to generate the estimated recessionary effects purely through propagation mechanisms, as the shock itself has no direct impact on fundamentals.

The central modeling challenge in generating comovement via risk aversion fluctuations is that an increase in risk sensitivity leads to precautionary motives, which move consumption and investment in opposite directions ceteris paribus. However, since our model features frictions in forming or severing labor relationships, this means that a firm can adjust its risk profile by adjusting all three inputs to production – physical capital, and part-time and full-time labor. As a result, an increase in risk aversion would lead to not only an increased desire to save on the part of the household, but also a restructuring of firm operations, as managers respond to the desire for safety of investors. Intuitively, in the aggregate, there will be a rebalancing on investment from riskier to safer activities.

Households

The economy is populated by a representative household with a continuum of members of unit measure. In period t, the household chooses aggregate consumption (C_t), government bond holdings (B_{t+1}), corporate bond holdings (B^c_{t+1}), and holdings of equity shares in the firms (X_{t+1}), to maximize lifetime utility

$$V_t = \max \left[(1-\beta) C_t^{1-1/\psi} + \beta (\mathbb{E}_t V_{t+1}^{1-\gamma_t})^{\frac{1-1/\psi}{1-\gamma_t}} \right]^{\frac{1}{1-1/\psi}}, \tag{9}$$

subject to the period budget constraint, denoted in terms of the consumption numeraire,

$$C_t + P^e_t X_{t+1} + Q^c_t (B^c_{t+1} - dB^c_t) + \frac{1}{R^r_t} B_{t+1} \leq (D^e_t + P^e_t) X_t + B^c_t + B_t + E^l_t + T_t. \tag{10}$$

In the above, Q^c_t is price of a multi-period corporate bond where a fraction $(1-d)$ of the principal is repaid each period, R^r_t is the one-period safe real interest rate, P^e_t is the price of a share of the representative firms that pays a real dividend D^e_t, and E^l_t is the household's total labor earnings (detailed below). T_t denotes lump-sum transfers. The corporate bonds are only needed to create empirically relevant amount of financial leverage in firms, since we would eventually match the average equity risk premium. The government bonds are in zero net supply, and only serve to define the safe real rate.

The inter-temporal elasticity of substitution is denoted by ψ, and risk-aversion by γ_t. In order to transparently illustrate the basic mechanism through which risk-premia propagate to the broader economy in our setup, we will consider direct shocks to risk-aversion, hence γ_t can vary over time. However, our intuition suggests that the same mechanism would similarly propagate risk fluctuations that come from any other source (e.g. changes in volatility).

The Epstein-Zin preferences in equation (9) imply the following stochastic discount factor between t and $t+1$:

$$M_{t,t+1} \equiv \left(\frac{\partial V_t/\partial C_{t+1}}{\partial V_t/\partial C_t}\right) = \beta \left(\frac{C_{t+1}}{C_t}\right)^{1-1/\psi} \left(\frac{C_t}{C_{t+1}}\right) \left(\frac{V_{t+1}}{(\mathbb{E}_t V_{t+1}^{1-\gamma_t})^{\frac{1}{1-\gamma_t}}}\right)^{1/\psi-\gamma_t}. \tag{11}$$

Households supply labor inelastically, but labor markets are subject to search and matching frictions in the spirit of Mortensen and Pissarides (1994). We fix labor supply in order to focus on the labor demand mechanism that is at the heart of our mechanism.

There are two types of labor contracts: the first, which we call "full-time", involves longer-term relationships and sticky wages, labeled $W_{1,t}$, while the second, which we call "part-time", involves shorter employment spells and flexible wages, $W_{2,t}$. We normalize the the total mass of workers to 1 and denote with $N_{1,t}$ and $N_{2,t}$ the masses of labor currently working under the full-time and part-time contracts, respectively. The mass of unemployed workers in period t is therefore $U_t = 1 - N_{1,t} - N_{2,t}$. While employment status may vary across workers, their consumption is equalized because the household provides perfect consumption insurance for its members.

Workers search sequentially. Specifically, every worker seeking a job in period t first tries to find a full-time job. If the search is unsuccessful, the worker searches for a part-time job within the same period.[14] A job-seeker that is unsuccessful in both searches will be unemployed in period t. In addition, at the end of a period, workers experience exogenous separation from full-time and part-time positions with probabilities ρ_1 and ρ_2, respectively. The mass of searchers for the two types of contracts are then given by:

$$S_{1,t} = U_{t-1} + \rho_1 N_{1,t-1} + \rho_2 N_{2,t-1} \tag{12}$$

$$S_{2,t} = S_{1,t} - N_{1,t} + (1-\rho_1) N_{1,t-1}. \tag{13}$$

Equation (12) states that the mass of searchers for full-time jobs in period t, $S_{1,t}$, is given by the workers who were unemployed in period $t-1$, $U_{t-1} = 1 - N_{1,t-1} - N_{2,t-1}$, plus the full-time and part-time workers that separated from firms at the end of period

[14] This behavior is optimal if the expected value of searching sequentially in the full-time and part-time sector exceeds the value of searching only in the part-time sector. We verify that this is the case in all our simulations. See the Appendix for the formal details.

$t-1$, $\rho_1 N_{1,t-1} + \rho_2 N_{2,t-1}$. The mass of searchers for part-time jobs in period t, $S_{2,t}$, is simply $S_{1,t}$ minus the job-seekers that find full-time job in period t, $N_{1,t} - (1-\rho_1)N_{1,t-1}$.

The introduction of distinct full-time and part-time sectors creates some subtle issues regarding how workers are compensated in case they are unemployed or "under-employed". We assume that a worker who finds no employment in either sector in period t is unemployed in that period. Such a worker receives a benefit $b_{2,t}$ that corresponds to monetary unemployment benefits as well any other time-use benefits they might accrue from not working. In addition, a worker employed in the part-time sector receives not just a wage, but also a flow κ_t that corresponds to the benefits (e.g., of home production) from the additional time made available by part-time work. Both of these values are time-varying because they are cointegrated with the stochastic trend in our economy, but they are not subject to any shocks themselves.

Because the representative household self-insures from heterogeneous employment income, we only need to track aggregate household earnings each period:

$$E_t^l = W_{1,t}N_{1,t} + (W_{2,t} + \kappa_t)N_{2,t} + b_{2,t}(1 - N_{1,t} - N_{2,t}). \tag{14}$$

The implicit ranking of labor-market outcomes implied by the sequence of search imposes restrictions on κ_t and $b_{2,t}$. To ensure that full-time work is preferred to part-time, κ_t cannot be too large. Meanwhile, to ensure that part-time work is preferable to unemployment, $b_{2,t}$ must also not be too large; we verify both conditions in all of our simulations.

Firms

The representative firm seeks to maximize the present discounted value of its cash flows,

$$D_t = Y_t - W_{1,t}N_{1,t} - W_{2,t}N_{2,t} - I_t - \gamma_{1,t}^l v_{1,t} - \gamma_{2,t}^l v_{2,t} \tag{15}$$

by choosing employment for the two types of contracts, $N_{1,t}$ and $N_{2,t}$, vacancies, $v_{1,t}$ and $v_{2,t}$, capital, K_{t+1}, and investment, I_t. The variables $W_{i,t}$ and $\gamma_{i,t}^l$ denote the real wage and the vacancy posting cost for the labor contract of type $i \in \{1, 2\}$, all of which the firm takes as given.

The firm discounts cash flows using the stochastic discount factor consistent with the household problem above. Its objective is to maximize

$$\mathbb{E}_t \sum_{s=0}^{\infty} \left(\frac{\partial V_t / \partial C_{t+s}}{\partial V_t / \partial C_t} \right) D_{t+s}, \tag{16}$$

subject to the production function with labor-augmenting technology Z_t

$$Y_t \leq K_t^{\alpha}(Z_t N_t)^{1-\alpha}, \tag{17}$$

a CES labor aggregator that combines the inputs of the full-time and part-time workers of the firm,

$$N_t = \left((1-\Omega)N_{1,t}^{\frac{\theta-1}{\theta}} + \Omega N_{2,t}^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}}, \tag{18}$$

a capital accumulation equation with quadratic capital adjustment costs,

$$K_{t+1} = \left(1 - \delta - \frac{\phi_K}{2}\left(\frac{I_t}{K_t} - \delta\right)^2\right)K_t + I_t, \tag{19}$$

and the laws of motion for employment as perceived by the firm,

$$N_{1,t} = (1-\rho_1)N_{1,t-1} + \Theta_{1,t}v_{1,t}, \tag{20}$$

$$N_{2,t} = (1-\rho_2)N_{2,t-1} + \Theta_{2,t}v_{2,t}, \tag{21}$$

where $\Theta_{i,t}$ is the probability of filling a type-i vacancy.

Equations (17),(18), and (20)-(21) imply that workers engage in production as soon as they are hired. Like in Christiano et al. (2016), we adopt this timing assumption because the time period in our model is one quarter and it would be implausible to assume such a whole quarter delay between a worker-firm match and the start of employment.

We assume that the representative firm can raise capital by issuing equity shares and debt. Specifically, we follow Jermann (1998) by assuming the representative firm finances a percentage of its physical capital stock each period through debt. Like in Gourio (2012), this financing occurs with multi-period riskless bonds. Firm debt evolves according to

$$B_{t+1}^c = dB_t^c + L_t, \tag{22}$$

where the parameter $d \in [0, 1)$ is the portion of outstanding debt that does not mature in the current period, and hence determines the effective duration of a bond as $\frac{1}{1-d}$. The net amount of new borrowing each period, $Q_t^c L_t = \xi K_{t+1}$, is proportional to the quantity of capital owned by the firm. Under these assumptions, the steady-state leverage ratio of the firm is given by $B^c/K \equiv \nu = \xi/(1-d)$. This is a parameter we will estimate.

The price of the multi-period bond (Q_t^c) is determined by the pricing equation

$$Q_t^c = \mathbb{E}_t \left[M_{t,t+1}(dQ_{t+1}^c + 1) \right]. \tag{23}$$

Total firm cash flows are divided between payments to bond holders and equity holders as follows:

$$D_t^E = D_t - B_t^c + \xi K_{t+1}. \tag{24}$$

Since in our model there are no distortionary taxes, agency costs, or asymmetric information, the Modigliani and Miller (1958) theorem holds: financial policies such as leverage decisions do not affect firm value or optimal firm decisions. Leverage does, however, affect the volatility of cash flows to shareholders and, therefore, the price of equity and its risk premium. The introduction of leverage allows us to map equity returns from the model to the data, where firms carry significant financial leverage.

The value of a type-i labor match for a firm, $J_{i,t}$, in equilibrium is given by:

$$J_{i,t} = MPL_{i,t} - W_{i,t} + (1-\rho_i)\mathbb{E}_t \left\{ M_{t,t+1} J_{i,t+1} \right\}. \tag{25}$$

Equation (25) states that the value a of match is equal to the current surplus the firm extracts from it, given by the marginal product of the worker ($MPL_{i,t}$) net of the wage payment, plus the discounted continuation value if the worker does not separate from the firm. Solving this condition forward, we can rewrite the value of a match as:

$$J_{i,t} = \underbrace{\sum_{j=0}^{\infty} \frac{(1-\rho_i)^j \mathbb{E}_t (MPL_{i,t+j} - W_{i,t+j})}{R_{t,t+j}^R}}_{\text{cash flows}} + \underbrace{\sum_{j=1}^{\infty} (1-\rho_i)^j Cov_t \left(M_{t,t+j}, MPL_{i,t+j} - W_{i,t+j} \right)}_{\text{risk premium}}, \tag{26}$$

where we have imposed the transversality condition that $\lim_{j\to\infty} \mathbb{E}_t[M_{t,t+j} J_{i,t+j}] = 0$.

Equation (26) expresses the value of a match as the sum of two terms. The first term is the present value of cash-flows, in this case the surplus from the match from the view point of the firm, discounted with the relevant risk-free rate $R_{t,t+j}^R = \mathbb{E}_t[M_{t,t+j}]^{-1}$. The second term is a risk adjustment factor. Assets whose cash flows covary negatively with the stochastic discount factor, and positively with consumption, have lower prices or higher risk premia, since holding those assets gives the investor a more volatile consumption stream. In this particular context, labor relationships whose future firm's surplus covary more negatively with the stochastic discount factor will carry a higher risk premium.

Wage-setting

We make a set of assumptions about wage determination that simplify our equilibrium computations and serve as a realistic baseline for examining the quantitative importance of our mechanism.

First, we assume that wages for the full-time sector are sticky, and equal each period to their previous value plus an adjustment for the change in the level of productivity (to be described momentarily). The initial value of the wage is the Nash bargained wage that would emerge in a non-stochastic steady-state with $Z = 1$:

$$W_1 = \eta_1 \left[(1-\Omega)(1-\alpha)\left(\frac{K}{N}\right)^{\alpha} \left(\frac{N}{N_1}\right)^{\frac{1}{\theta}} + \gamma_1^l \theta_1 \right] + (1-\eta_1) b_1, \tag{27}$$

where $\eta_1 \in [0,1]$ and $\theta_1 = \frac{v_1}{S_1}$ denote the workers' bargaining power and the steady-state labor market tightness in the full-time sector, while b_1 represents the value of the worker's outside option when negotiating for a wage.

Given the sequential nature of the search in the two sectors, the steady-state outside option for the full-time sector is

$$b_1 \equiv P_2^m (W_2 + \kappa) + (1 - P_2^m) b_2, \tag{28}$$

In case the worker declines a full-time job, they find a part-time job with probability P_2^m, earning a steady-state wage W_2 plus κ units of additional home production made possible by part-time work. With probability $(1 - P_2^m)$, the worker becomes unemployed, earning formal unemployment benefits plus home production with a total value of b_2.

Wages in the part-time sector are flexible, and equal to the Nash wage that would emerge in every period in this sector:

$$W_{2,t} = \eta_2 \left[\Omega(1-\alpha) Z_t \left(\frac{K_t}{Z_t N_t}\right)^{\alpha} \left(\frac{N_t}{N_{2,t}}\right)^{\frac{1}{\theta}} + \gamma_{2,t}^l \theta_{2,t} \right] + (1-\eta_2) b_{2,t}. \tag{29}$$

where $\eta_2 \in [0,1]$ and $\theta_{2,t}$ denote the workers' bargaining power and the labor market tightness in the part-time sector.

This wage setting setup is flexible and also conforms with the data, where the part-time positions indeed display more flexible wages than full-time positions, as documented by Lariau (2017). Moreover, the same paper as well as Borowczyk-Martins and Lalé (2021) also document that part-time position feature eight times higher separation rates than full time positions, hence we calibrate $\rho_2 > \rho_1$ accordingly.

As can be seen explicitly in equation (26), these empirically relevant differences in the duration of employment spells and in the wage flexibility result in different risk profiles of the two labor contracts. On the one hand, the recursive preferences place a higher risk-premium on longer duration assets (i.e. there is a higher covariance between the long-horizon SDFs and far off uncertain cash flows). On the other hand, the stickier wages effectively act as leverage (see also Donangelo et al. (2019)) and amplify the volatility of the full-time labor match surplus that accrues to the firm. Both of these features, make the risk-premium on full-time labor positions higher, than that on part-time positions.

Government

The government finances a stream of expenditures, which are exogenous but only gradually catch-up with the trend in the economy. The initial value of the government expenditure in a non-stochastic steady-state with $Z = 1$ is

$$G = \bar{g}Y. \tag{30}$$

Government expenditures and the pecuniary component of unemployment benefits are financed using a purely lump-sum tax instrument. As a result, government bonds remain in zero-net supply, $B_t = 0$, for all t.

Market clearing

At the aggregate level, the labor workforce at time t in the two sectors is:

$$N_{1,t} = (1 - \rho_1)N_{1,t-1} + \mathcal{M}_{1,t}, \tag{31}$$

$$N_{2,t} = (1 - \rho_2)N_{2,t-1} + \mathcal{M}_{2,t}, \tag{32}$$

where $\mathcal{M}_{1,t}$ and $\mathcal{M}_{2,t}$ represent the matches from the CES matching functions of the full-time and part-time sectors, respectively. These matching functions take the form:

$$\mathcal{M}_{i,t} = \chi_i v_i^{\epsilon_i} S_i^{1-\epsilon_i}, \tag{33}$$

for $i \in \{1, 2\}$. The corresponding job-finding and vacancy-filling probabilities as a function of the labor markets tightness $\theta_{i,t} = \frac{v_{i,t}}{S_{i,t}}$ are respectively: $P_{i,t}^m = \chi_i \theta_{i,t}^{\epsilon_i}$ and $\Theta_{i,t} = \chi_i \theta_{i,t}^{\epsilon_i - 1}$.

Finally, the aggregate resource constraint in the economy is given by

$$Y_t = C_t + I_t + \gamma^l_{1,t} v_{1,t} + \gamma^l_{2,t} v_{2,t} + G_t. \tag{34}$$

In order to ensure our model satisfies the usual accounting identity, we follow den Haan and Kaltenbrunner (2009) by including job posting costs in defining our model analogue to measured investment, i.e., $\tilde{I}_t \equiv I_t + \gamma^l_{1,t} v_{1,t} + \gamma^l_{2,t} v_{2,t}$.

Exogenous Processes

The economy is perturbed by two exogenous disturbances. The first is technology, Z_t, which we assume follows a random walk, as is the case for utilization-adjusted US TFP (Fernald (2014)):

$$\ln(Z_t) = \ln(Z_{t-1}) + \sigma_z \epsilon^z_t \tag{35}$$

The second is risk aversion, γ_t, with dynamics governed by an AR(1) process in logs:

$$\log(\gamma_t/\gamma_{ss}) = \rho_\gamma \log(\gamma_{t-1}/\gamma_{ss}) + \sigma_\gamma \epsilon^\gamma_t. \tag{36}$$

Because our economy has a unit root in productivity, we impose additional assumptions to ensure that the model has a balanced growth path. In particular, we assume that the cost of vacancy posting, the workers' outside options, the sticky full-time wage, and government expenditure are all cointegrated with technology, with a common error-correction rate of ω. Specifically, for each variable $X \in \{\gamma_{1,t}, \gamma_{2,t}, b_{1,t}, b_{2,t}, W_{1,t}, G_t\}$, we assume that $X_t = \Gamma_t \bar{X}$ where $\bar{X}$ is the deterministic steady-state value, and

$$\Gamma_{t+1} = \Gamma^\omega_t Z^{1-\omega}_t. \tag{37}$$

When the parameter $\omega \in [0, 1)$ is close to one, which turns out to be the case in our estimation, the variables "catch-up" with the (non-stationary) changes in productivity slowly, but are nevertheless cointegrated with productivity.

In particular, the process for the full-time wage is given by

$$W_{1,t} = \left(\frac{Z_{t-1}}{\Gamma_{t-1}}\right)^{1-\omega} W_{1,t-1}. \tag{38}$$

Thus, the full-time wage is sticky in the sense it only partially adjusts for the change in productivity, to the extent to which $\omega > 0$. If $\omega = 1$, then the wage is perfectly rigid at its steady state value, and if $\omega = 0$, it adjusts fully with changes in productivity.

Table 2: Calibrated Parameters

Name	Description	Value
β	Discount rate	0.994
ψ	Intertemporal elasticity of substitution	2.5
α	Capital share	0.300
δ	Capital depreciation rate	0.025
$\bar{g}$	Steady-state G/Y	0.200
d	Corporate bond duration	0.975
	Labor Markets	
ρ_1	Separation Rate - FT	0.044
ρ_2	Separation Rate - PT	0.354
η_1	HH's bargaining power - FT	0.500
η_2	HH's bargaining power - PT	0.200
	Exogenous Processes	
σ_z	Std. dev. of tech shock	0.008

4 Quantifying the Mechanism

We quantify the potential of the model to match our empirical evidence via an impulse-response matching exercise, where we match the model-implied IRF to a risk-aversion shock, γ_t, to the empirical impulse responses to the "risk premium" shock we identified in Section 2. In addition, we also further discipline the model by matching a number of unconditional moments in the data. Thus, the estimation exercise is restricted with numerous and different kinds of data moments, leading to a highly over-identified system and tight parameter estimates as we report below.

We solve the model using a third-order perturbation, and compute impulse responses by comparing the path of the economy over an extended period in which the realizations of all shocks are identically zero to the counter-factual path in which a single one-standard deviation shock to γ_t is realized.

4.1 Calibrated Parameters and Steady-State Targets

To begin, we calibrate a set of standard parameters to values that are consistent with the literature, as summarized in Table 2. Namely, we set $\beta = 0.994$ to be consistent with a non-stochastic steady-state annual real interest rate around 2.4%. The capital share is set to a standard value of 0.3 in the production function. Because the estimated model includes risk, this will imply an unconditional capital income share that is slightly less than 0.3. We use a standard long-run depreciation rate of $\delta = 0.025$. Finally, we assume that on average government expenditures are 20% of GDP and fix the bond duration parameter $d = 0.975$, so as to imply corporate debt has a 10-year maturity, as in Gourio (2012).

The elasticity of intertemporal substitution plays an important role in models that target asset pricing facts, and we set this parameter to $\psi = 2.5$. This value is relatively high compared to the standard macro literature that focuses on quantities only, but is in-line with values used by macro-finance papers that target asset pricing moments (Schorfheide et al., 2018). Nevertheless, the overall qualitative patterns we estimate do not rely on any restriction on ψ and can still emerge, for example, even when $\psi < 1$ (See Appendix Figure C.2 for model implications with $\psi = 0.5$). Our primary motivation for choosing a high elasticity is that this choice allows our model to match fairly large responses of consumption to our shock without generating counterfactually-large changes in safe interest rates. But the overall difference in fit is not huge.

In terms of labor markets, the key calibrated parameters are the separation rates, ρ_1 and ρ_2. We pick these values to satisfy two features of the data. First, we fix $\rho_2/\rho_1 = 8$, matching recent estimates of the relative difference in separation rates of part-timers to full-timers from the longitudinal dimension of the U.S. Current Population Survey (Lariau, 2017; Borowczyk-Martins and Lalé, 2021). Second, we then fix the level of separations in the full-time sector (ρ_1) to match the aggregate quarterly separation rate in the US economy of 10% (Yashiv, 2008). We also choose standard values for the Nash bargaining parameters, picking $\eta_1 = 0.5$ and a lower bargaining power for part-timers $\eta_2 = 0.2$. However, we have found that alternative choices for these parameters make a very little difference.

Finally, we use the Basu et al. (2006); Fernald (2014) data on utilization-adjusted U.S. TFP to calibrate the process for productivity. Over our sample period, we find that productivity is an almost perfect random walk and it has standard deviation in growth rates of 0.8%, $\sigma_z = 0.008$.

The remaining parameters are estimated by matching the impulse-responses to a risk-aversion shock, and also eight additional unconditional moments, which we report in Table 3. Our approach is to place extremely high weight on the unconditional moment targets in the estimation procedure (described below), with the goal of forcing the model to match the unconditional moments perfectly, and then see how the model does in terms of conditional dynamics. As we can see from the third column in Table 3, the model can indeed match the unconditional targets virtually perfectly.

Table 3: Unconditional Target Moments

Description	Value
Equity risk premium	0.054
Share of part-time	0.180
LR unemployment	0.060
Vancancy Rate	0.035
Hiring cost/GDP	0.020
PT earn./FT earn.	0.500
Std. HP log(Emp/Pop)	0.013
Std. HP log(vacan.)	0.138

The first three unconditional moments we target, the average equity premium, the share of part-time workers, and the average unemployment rate are directly observed in the data, and we match their average values over our sample period. The average vacancy rate of 3.5% is fixed to be consistent with the full-sample average of the JOLTS dataset (which starts in 2000). In turn, we assume that the ratio of hiring costs to GDP is 1%, in-line with Blanchard and Galí (2010).

We also target the standard-deviations of (HP-filtered) employment and vacancies (using the series created by Barnichon, 2010), in order to ensure that the model delivers a Beveridge curve in line with the data. We also note that since the model is indeed successful at matching both of these moments, this implies it also does not suffer from the Shimer puzzle. As we explain below, this is due to a novel channel – the fluctuating risk aversion generates movements in employment that are not driven by productivity shocks, as we explain below.

Finally, we target a ratio of full-time to part-time earnings of 0.5. This ratio should account not just for any hourly wage differential, but should also include the lower number of hours worked by people in part-time positions. The wage and hourly data is not sufficiently disaggregated to directly speak to this moment, but we have found that our results change very little if we make a different choice here.

4.2 Estimation Procedure

Aside from the additional long-run target moments in Table 3, our impulse response matching exercise is standard. The estimation targets are the impulse responses of output, consumption, investment, total employment, part-time employment, equity returns, and the real interest rate. We denote the set of parameters we estimate with Π, and those includes the steady-state risk aversion parameter γ, the capital adjustment cost parameter, ϕ_K, the aggregate leverage ratio ν, the vacancy posting costs, γ_1^l and γ_2^l, the value of outside options b_1 and b_2, the production share of part-time labor Ω, the four parameters governing the aggregate matching technologies, the cointegration parameter ω, and the parameters of the risk aversion shock, $\rho_{1,\gamma}, \rho_{2,\gamma}$ and σ_γ.

Let $\hat{\psi}$ denote the column vector stacking the point estimates of each impulse response variable across all horizons along with our unconditional target moments. The objective function of our estimation is then given by

$$\mathcal{L}(\Pi) \equiv (\hat{\psi} - \psi(\Pi))' W (\hat{\psi} - \psi(\Pi)). \tag{39}$$

The matrix W is a diagonal weighting matrix consisting of the inverse of the bootstrapped variances of each impulse response in $\hat{\psi}$, plus very large weights for our unconditional target moments. Given the extreme weights on our eight unconditional targets, we are essentially targeting $7 \times 30 = 210$ impulse response moments with just nine degrees of freedom.

4.3 Estimation Results

The estimation procedure finds a global interior optimum, and Table 4 reports the estimated parameters $\widehat{\Pi}$ along with their corresponding standard errors.

To comment on one important parameter, note that while the estimated value for the average level of risk aversion, $\gamma = 63$, might appear high, it still remains similar to or lower than the values used by other quantitative papers focused on matching risk premia facts in business cycle models (e.g., Piazzesi and Schneider, 2006; Rudebusch and Swanson, 2012; Basu and Bundick, 2017; Caggiano et al., 2021). This is essentially a manifestation of the well known "equity premium" puzzle, in that models with standard preferences (like ours) have a hard time matching the high average equity risk premium (5.4% in our sample), unless they have a high risk aversion coefficient (typically 50 or more). One can increase the effective quantity of risk in the model by modifying the preferences by introducing habit formation Campbell and Cochrane (1999)), augmenting the shock process with either long-run risk (Bansal and Yaron (2004)) or rare disasters (Barro (2006)), or introduce parameter uncertainty (Weitzman (2007)) or model uncertainty (Barillas et al. (2009)). At this stage, the macro finance literature has not converged on a consensus explanation of the equity risk premium, and most papers that do not

Table 4: Estimated Parameters

Name	Description	Point Est.	Std Err.
γ_{ss}	Steady-state risk aversion	63.17	0.73
ϕ_k	Capital Adj. Cost	2.75	0.21
ν	Leverage Ratio	0.73	0.006
	Labor Markets		
γ_1^l	Vacancy posting cost - FT	2.91	0.05
γ_2^l	Vacancy posting cost - PT	0.06	0.004
b_1	Value if no perm posit.	0.95	0.004
b_2	Value if unemployed	0.62	0.002
Ω	Labor contrib. of PT	0.24	0.0008
θ	Elas. between FT & PT	3.41	0.03
ϵ_1	Matching elasticity - FT	0.37	0.0008
ϵ_2	Matching elasticity - PT	0.63	0.008
χ_1	Matching technology - FT	0.71	0.005
χ_2	Matching technology - PT	1.17	0.02
ω	Gradual wage adj.	0.976	0.004
	Risk Aversion Process		
ρ_γ	AR(1) risk av. shock	0.94	0.002
σ_γ	Std. dev. of risk av. shock	0.44	0.013

Note: Standard errors computed via bootstrap, by restimating model parameters targeting N=100 different (bias-corrected) impulse responses drawn from the VAR bootstrap procedure.

focus on explaining the deep reasons for the large risk premium, but want to match it quantitatively, simply rely on a high risk aversion coefficient. We follow a similar strategy, although in (unreported) robustness checks we have verified that our model can work similarly well with $\gamma = 10$ and a long-run risk formulation for Z_t.

Moving onto the main results, Figure 7 shows that the impulse responses implied by the estimated model (blue-dot lines) match the data quite well, and in particular generate the key aggregate comovement pattern that traditionally defines the standard business cycle. On the macroeconomic side, the changes in output, consumption and employment track the data quite closely. Output and investment perhaps undershoot modestly, but the model implied responses are still quite significant and remain within the standard error bands of the data.

In addition to the macro variables, the model does an excellent job at capturing two central features of asset prices. First, the model closely matches the persistent increase in the 5-year equity risk premium. This variable was central for the identification of the empirical shock, however is *untargeted* by the model estimation. Hence, the fact that

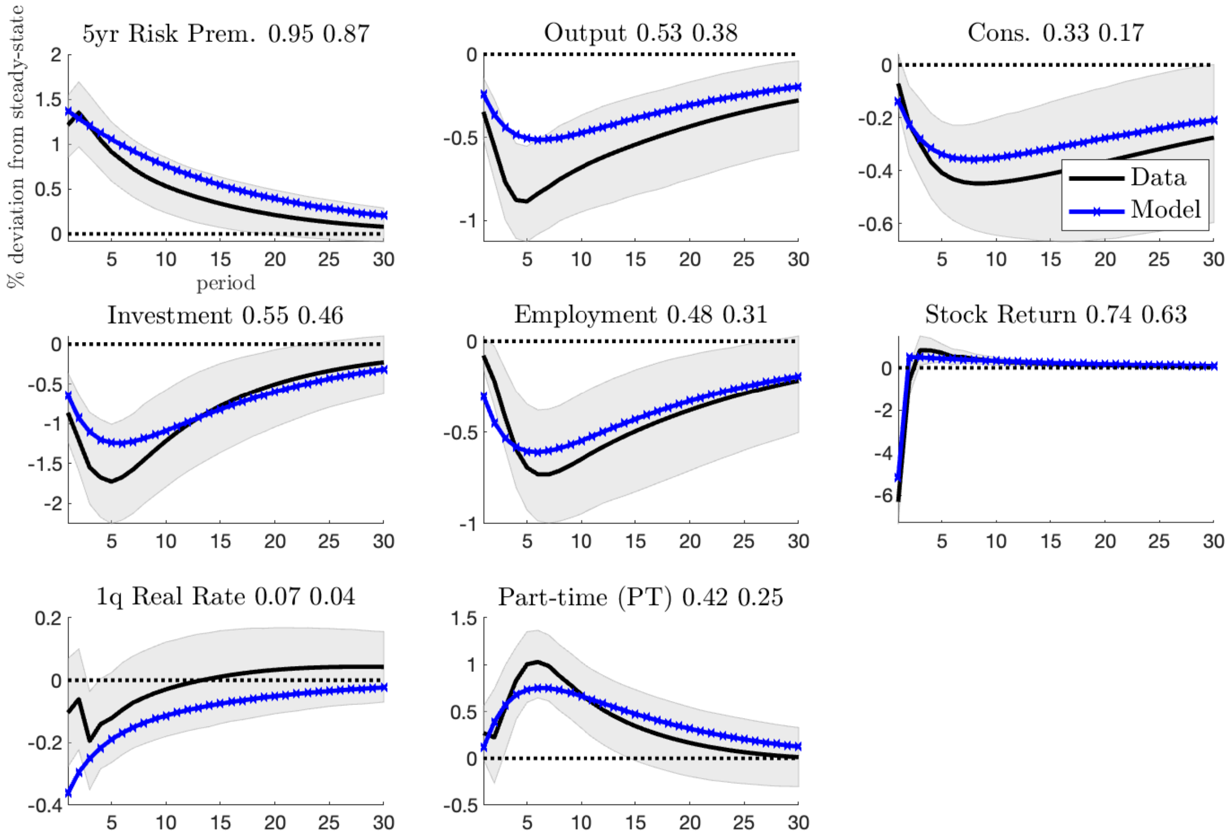

Figure 7: Impulse responses to VAR-identified risk premium shock along with model-implied responses.

our model is able ot match the 5-year risk premium so well one piece of evidence of its external validity. Second, the model also matches the pattern of realized equity returns very well, with a steep fall in stock returns on impact, followed by a long period of above-average returns. Thus, the model indeed generates variation in asset prices primarily due to changes in expected excess returns, and not changes in cash-flows, as is also true in the data. Overall, the model is successful at capturing both the business cycle comovements and the counter-cyclical risk premium that we found in the data.

Perhaps the most surprising result is that our model predicts a substantial and long-lived decline in total investment.[15] Indeed, investment falls despite the fact that, ceteris paribus, an increase in risk aversion increases people's desire to save. How can this happen?

[15]Recall from eq. (34) that investment in our model includes both investment in capital and in vacancy posting. Each contributes roughly half of the fall in measured investment, with the fall in vacancies contributing more early on and the fall in capital investment contributing more after the first year.

The answer is that, in our model, the increase in risk aversion also generates a "flight-to-safety" effect. The main action in our model is on the side of the firm, which in accordance with the SDF of households chooses to reallocate resources towards safer factors of production. As we will detail below, such safer factors of production have lower marginal products, and thus the reallocation lowers overall output and kicks off a recession.

There are two types of reallocations that happen in our model: one between labor as a whole and capital, and another across the two labor types. Consider first how an increase in risk aversion affects the firms' choice of posting full-time vs part-time vacancies. Since our calibration choices imply that short-term labor relationships are less risky, due to both a flexible wage and shorter duration, an increase in risk aversion induces firms to shift their vacancy postings towards the safer, part-time sector. At the same time, in line with our intuition above, at our estimated parameters part-time labor has a lower marginal product. This is not because of a difference in the fundamental productivity of the two types of labor, as both have the same labor-augmenting technology level Z_t. Instead, the reason is that in general firms value safety according to the SDF of the household, and hence at the stochastic steady state of the model they invest more in part-time labor positions, ceteris paribus. Due to the concavity in the production function, this pushes down the marginal product of part-time labor at the stochastic steady state.

Because of this difference in marginal products, the firms' shift in allocating hiring resources (i.e. vacancies) from full-time to part-time labor positions manifests in a fall in the composite labor aggregate N_t. In addition, the shift towards posting part-time labor vacancies coupled with search frictions generates congestion externalities which effectively act as a real adjustment cost, further decreasing N_t. This fall in aggregate labor lowers output, without affecting (properly measured) TFP.

The second kind of reallocation that operates in our model is between capital and labor markets. Specifically, as we discuss in Section 4.5 below, our estimation also implies that capital is relatively safe compared to either full- or part-time labor. Hence, the rise in risk aversion also leads firms to substitute away from labor of both types towards investment in physical capital. This reallocation also lowers aggregate labor N_t, causing an even larger fall in output on impact.

The result of these reallocations is a significant drop of output on impact, due to the fall in N_t. In addition, the drop in N_t also lowers the marginal product of capital. Thus, while ceteris paribus, there is an increased desire to invest in physical capital, in equilibrium I_t falls, as a result of the combination of low output (and thus not enough resources to increase I_t) and also a lower MPK, which lowers the desire to invest in the first place.

Overall, we have a modified version of the Paradox of Thrift – or perhaps a Paradox of Flight-to-Safety – where the increased desire to save in safer assets, leads firms to respond by restructuring their operations accordingly, causing a drop in output and thus also a drop in investment. And more generally, thanks to this mechanism, the risk aversion shock is able to generate a deep recession with strong comovement across macro aggregates, and also a very little response in the real interest rate. The emerging narrative is thus consistent with the "central lesson" of the macro-finance literature summarized in Cochrane (2017), which emphasizes counter-cyclical stock prices and a smooth interest rate.

4.4 Risk Premia

Above, we discussed the basic intuition that underlies our model's ability to deliver realistic macroeconomic comovements based on differences in the relative risk profiles of the available real investment vehicles. Our argument essentially requires full-time labor, the dominant component of aggregate labor, to be sufficiently risky. Here we quantify the exact average risk premia that all three factors of production carry.

We begin by defining the excess return on physical capital as

$$KP_t = \mathbb{E}_t\left[\frac{\tilde{R}^K_{t+1}}{R^R_t}\right],$$

where

$$\tilde{R}^K_{t+1} \equiv \frac{\alpha\left(\frac{K_{t+1}}{Z_{t+1}N_{t+1}}\right)^{\alpha-1} + q_{t+1}\left(1-\delta-adj.costs\right)}{q_t}, \tag{40}$$

can be derived by rearranging the capital Euler equation. In (40) the return on capital reflects the net cash flow of a unit of capital, equal to its marginal product plus the change in the market price net of depreciation and adjustment costs.

Similarly, the vacancy posting condition of a firm can be re-cast in terms of a return on a dollar invested in a given type of vacancies:

$$R^L_{i,t+1} = \frac{(MPL_{i,t} - W_{i,t})R^R_t + (1-\rho_i)\frac{\gamma^l_{i,t+1}}{\Theta_{i,t+1}}}{\frac{\gamma^l_{i,t}}{\Theta_{i,t}}},$$

Table 5: Unconditional Risk Premia

Description	**Value (%)**
Capital premium	0.28
Full-time labor premium	18.8
Part-time labor premium	5.10

which then allows us to define the risk premium of this type of investment too:

$$LP_{i,t} = \mathbb{E}_t \left[\frac{R^L_{i,t+1}}{R^R_t} \right] = 1 - (1-\rho_i)\Theta_{i,t} Cov_t \left(M_{t,t+1}, \Theta^{-1}_{i,t+1} \right),$$

where $MPL_{i,t}$ denotes the marginal product of labor in sector i. The definition of the return reflects the net cash flow from a filled vacancy, equal to the marginal product of labor minus the wage plus the change in the value of a job. The latter equals the vacancy cost, γ^l_i, times the duration of the typical vacancy, $\frac{1}{Q^m_{i,t}}$. In contrast to capital, which becomes productive with a one-period delay, both labor types generate cash flow immediately, so for ease of comparison with the capital premium concept, the first term in the numerator of the labor returns is multiplied by R^R_t.

The two types of labor market premium are higher when the covariance between their respective tightness and the stochastic discount factor is more negative. Intuitively, a tighter labor market indicates that the vacancy filling probability is low or that the marginal value of the workers to the firm is high. Thus, if tightness increases when the the stochastic discount factor is high (i.e., in a recession), it means that workers of this type are a good hedge: they are most valuable when marginal utility is high. Conversely, if in a recession the tightness of a particular labor market is low, it means that the job filling probability is high or that the marginal value of these workers is low. These workers are poor hedges and, therefore, command a risk premium.

Table 5 reports the (annualized) stochastic steady state premia implied by our model. Our baseline estimation implies a part-time labor premium of 5.1%, and a full-time labor premium of 18.8%, which is several times higher. This reflects the characteristic differential features of the part-time sector as having (i) flexible wages and (ii) a shorter duration – both of which make the part-time labor relatively less risky, and thus makes it an attractive alternative to full-time positions during periods of heightened risk aversion. It turns out that that the average capital premium of the model is also fairly low, at just 0.28%, thus full-time labor vacancies are indeed the riskiest investment vehicle in our model.

Assessing the quantitative realism of the labor and capital premia is a daunting task, as empirical counterparts of these objects are not readily available.[16] Nevertheless, we can try to map them into a measurable object by recognizing that the overall value of firm equity in the model reflect the market value of installed capital plus the value of the established relationships with workers. In this way, the fact that our model perfectly matches the average equity premium in the data provides important discipline, and suggests that the estimated numbers for the underlying capital and labor premiums are not unreasonable. Moreover, the estimation also matches the impulse response of part-timers in the data, which provides additional discipline on the level of risky-to-safe reallocation in the model.

In addition to the unconditional levels of risk premia, it is also interesting to ask whether the model implies realistic variability of excess returns. To answer this question, we again rely on the observable equity premium, and compute the famous Sharpe (1994) ratio using quarterly returns:

$$SR = \frac{E[log(R^E_{t+1}/R^b_t)]}{std\left[log(R^E_{t+1}/R^b_t)\right]}. \tag{41}$$

where R^E_{t+1} is the return on equity. The annualized Sharpe ration implied by our model is 0.43, which is quite close to the empirical value of 0.33 in our sample. In terms of volatility, the model-implied standard deviation of the (annualized) 5-year risk premium is $100 \times std(rp_{t,t+20}) = 3.25\%$, which is of the same order of magnitude as the corresponding realized standard-deviation in our data sample of 6.01%. [17] These results provide additional confirmation that our model provides a quantitatively realistic match to the data, not only in terms of average premia, but also in terms of their volatility.

Lastly, we can also look at the impulse responses of the risk premia on capital and the two types of labor., which we report in Figure 8. The figure shows that the risk premia for the full-time labor is not only high on average, but also rises substantially more than the risk premia on part-time labor and capital, following an increase in risk aversion.

4.5 Inspecting the Mechanism: the role of sticky wages

Sticky wages play an important role in our model, but the way they operate is novel. Recall equation (26):

[16] A first attempt of decomposing firm value in the contribution of the inputs of production using firm-level data on U.S. publicly traded firms is Belo et al. (2019), who indeed find a significant contribution of "installed" labor to firm value, in-line with our theory.

[17] A previous version of the paper in which the model was estimated over the sample 1985Q1-2018Q4 delivered a standard deviation of 6.68%.

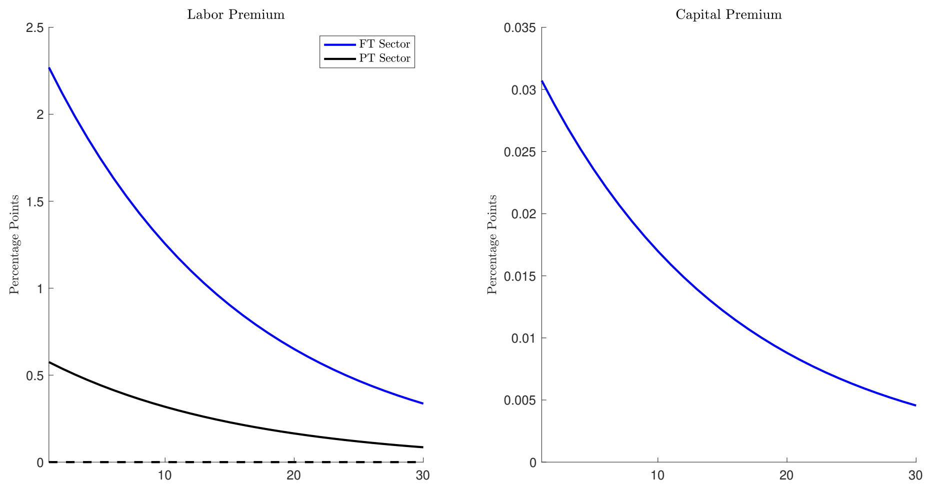

Figure 8: Impulse responses of risk premia in the model following a risk appetite shock.

$$J_{1,t} = \sum_{j=0}^{\infty} \frac{(1-\rho_1)^j \mathbb{E}_t(MPL_{1,t+j} - W_{1,t+j})}{R^R_{t,t+j}} + \sum_{j=1}^{\infty} (1-\rho_1)^j Cov_t\left(M_{t,t+j}, MPL_{1,t+j} - W_{1,t+j}\right)$$

The function of sticky wages in our model is not in generating a volatile *expected* discounted flow of surplus matches (the first term in the above equation), as in Hall (2005) where this is used as a way of solving the Shimer puzzle. In our model, instead, the key role of the sticky wages is to amplify the risk premium of full time labor (the second term in the equation above). The sticky wages effectively act as "leverage" from the view point of the firm, increasing the surplus *volatility*, and thus its *pro-cyclicality*. This makes the second, risk premium term, important and allows it to rise significantly upon a risk aversion shock.

To showcase this, we consider two counter-factual experiments. First, in Figure 9 we plot the impulse responses of our estimated model against those of a counterfactual economy where everything is the same, except that full-time labor has flexible, Nash wages. This model completely fails to replicate the empirical results, except for the fall in consumption.

Chiefly, in this model, the full-time labor relationships are much safer – the risk-premium now drops to 3%, equaling that of part-time labor in this formulation of the model. Hence, firms have little incentives to reallocate away from full time labor. Without a strong reallocation from full-time labor towards part-time labor and capital, the model cannot generate a significant fall in output. But absent that, the standard pre-cautionary

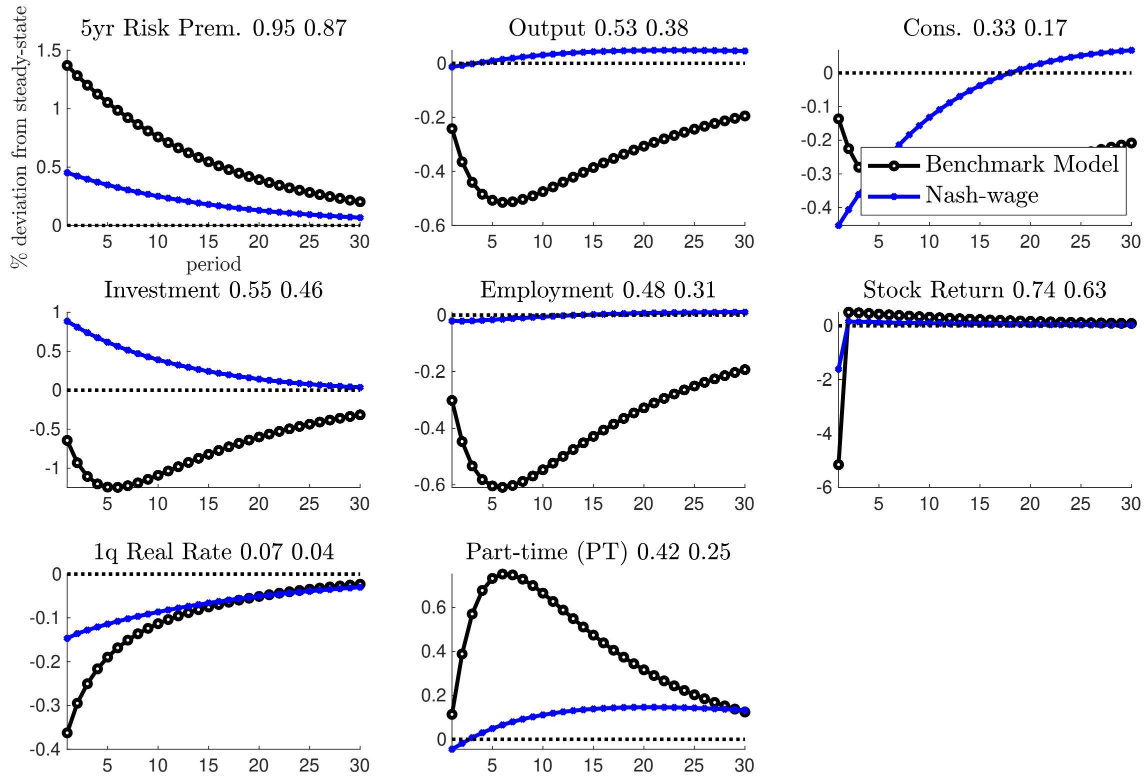

Figure 9: Model responses with Nash-bargained wages.

saving motive dominates, and investment rises – both on impact and persistently. Thus, sticky full-time labor wages play an important role, as otherwise the model has a significant comovement problem, and that is because there is little reallocation away form full-time labor and thus no fall in output.

To showcase further that wage stickiness indeed operates through the risk-premium term, we consider a second counterfactual exercise. Now we keep the full-time wages sticky as estimated, and instead we counterfactually replace the vacancy posting condition for full-time workers, by shutting down the risk-premium term:

$$J_{1,t} = \underbrace{\sum_{j=0}^{\infty}(1-\rho_1)^j \mathbb{E}_t(M_{t,t+j})\mathbb{E}_t(MPL_{1,t+j} - W_{1,t+j})}_{\text{cash flow}} + \underbrace{\cancel{\sum_{j=1}^{\infty}(1-\rho_1)^j Cov_t\,(M_{t,t+j}, MPL_{1,t+j} - W_{1,t+j})}}_{\text{risk premium}}$$

Figure 10 shows the responses to a risk aversion shock in this counterfactual economy, and strikingly, even though wages are sticky this model fails to reproduce the empirical facts we had documented. First, there is the obvious comovement issue between consump-

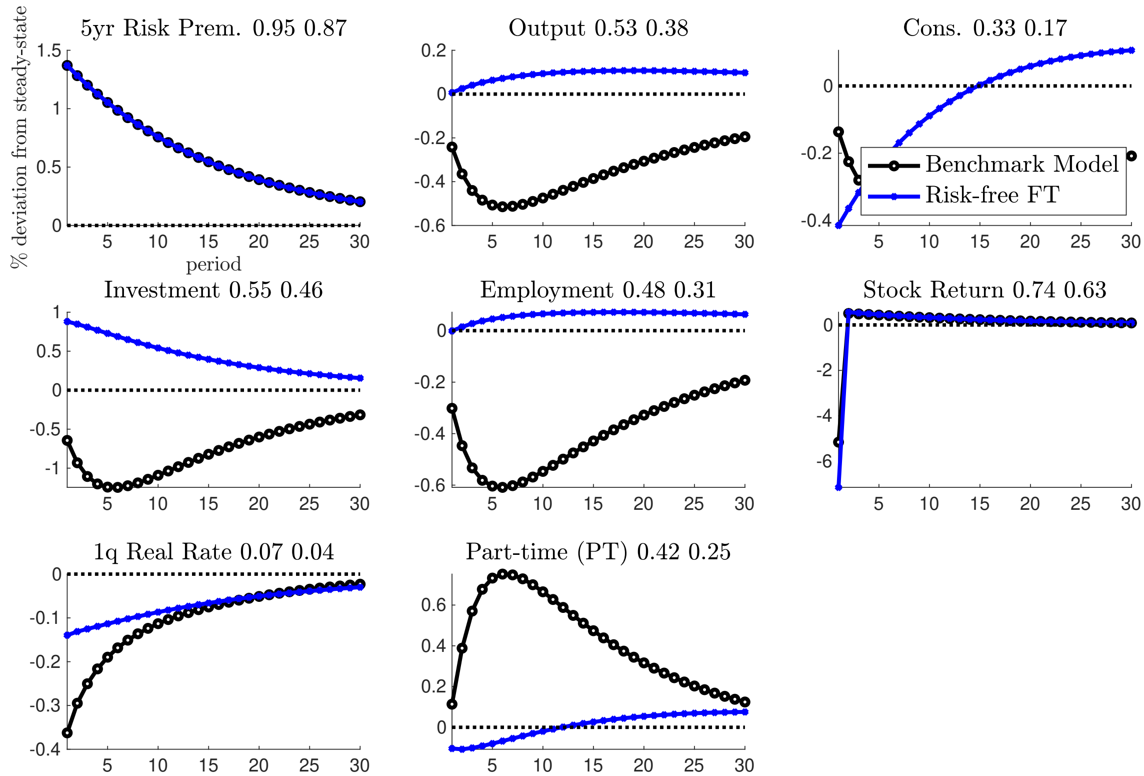

Figure 10: Model responses without risk premia.

tion and investment, with consumption falling and investment rising – once again, this is because the precautionary savings demand dominates, since without a strong incentive to reallocate away from full-time labor, there is no fall in output. But even more so, when full-time labor is completely risk-free, as is the case here, then employment and output actually even *increase*. This is another manifestation of the strong precautionary savings demand – investing in full-time employment positions is now a good deal from the view point of the firm, as they perceive them as risk-free, hence they increase vacancy postings.

Again this is despite the fact that full-time labor has sticky wages. Thus, we see that wage stickiness indeed plays quite a novel role – its main role is not to generate volatility in expected cash-flows (which it does in the counter-factual exercise above), but rather to make full-time labor positions risky, by creating operational leverage for the firm when they hire full time labor.

This sets our model apart from previous contributions, like Hall (2005), which emphasize the role of wage stickiness in making expected cashflows volatile. Instead, we uncover a new way in which wage stickiness can help deliver large changes in the value of workers and thus resolve the Shimer (2005) puzzle: by driving large changes in the risk premia associated with employment.

5 Conclusions

This paper shows that fluctuations in risk premia can be major drivers of macroeconomic fluctuations. Our empirical analysis suggests the possibility of a major causal pathway flowing from risk premia to macroeconomic fluctuations, and our theory embodies one such a pathway. In our model, heightened risk premia cause recessions because they drive reallocation of saving towards safer stores of value, which simultaneously have low instantaneous marginal products. Thus, our theory contrasts with many business cycles models that emphasize the effects of intertemporal substitution, and instead puts risk premia and their effects on precautionary saving at the center of macroeconomic propagation. In this respect, our model bridges a gap between the tradition of risk-driven business cycles à la Keynes and the central lessons of modern macro-finance summarized in Cochrane (2017), all within a real framework.

To focus attention on our novel propagation mechanism, we abstract throughout from many other ingredients that may contribute to risk-driven macroeconomic comovement, including nominal rigidities (Basu and Bundick, 2017), financial frictions (Christiano et al., 2014), uninsurable idiosyncratic risk (Di Tella and Hall, 2020), information frictions (Ilut and Saijo, 2021), and heterogeneous asset valuations (Caballero and Simsek, 2020). All of these features likely play a role in generating the data. Nevertheless, our quantitative analysis demonstrates that the savings reallocation channel is sufficiently powerful to drive a substantial portion of macroeconomic fluctuations on its own.

Our theory emphasizes the labor market implications of savings reallocation primarily because our empirical results suggest a flight to safety in those markets. Nevertheless, the same patters should apply to other forms of saving available in the economy (risky private investments versus safe government bonds, foreign investment for open economies, etc.) Reallocation from new to old capital could also provide a similar amplification mechanism, and there is already intriguing empirical evidence (e.g. Eisfeldt and Rampini, 2006).

Future research should continue to explore the business cycle consequences of such alternative channels of our basic mechanism, both theoretically and empirically.

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Online Appendix

A Model

This section contains a detailed derivation of the real business cycle model that we use in our main analysis.

A.1 Households

The economy is populated by a representative household with a continuum of members of unit measure. In period t, the household chooses aggregate consumption (C_t), government bond holdings (B_{t+1}), corporate bond holdings (B^c_{t+1}), and firm share holdings (X_{t+1}), to maximize lifetime utility

$$V_t = \max \left[(1-\beta)C_t^{1-1/\psi} + \beta(\mathbb{E}_t V_{t+1}^{1-\gamma_t})^{\frac{1-1/\psi}{1-\gamma_t}}\right]^{\frac{1}{1-1/\psi}} \tag{A.1}$$

subject to the period budget constraint, denoted in terms of the consumption numeraire,

$$C_t + P^e_t X_{t+1} + Q^c_t(B^c_{t+1} - dB^c_t) + \frac{1}{R^r_t}B_{t+1} \leq (D^e_t + P^e_t)\, X_t + B^c_t + B_t + E^l_t. \tag{A.2}$$

In the above, Q^c_t is price of a multi-period corporate bond with average duration $(1-d)^{-1}$, R^r_t is the one-period safe real interest rate, P^e_t is the price of a share of the representative firms that pays a real dividend D^e_t, and E^l_t is the household's total labor earnings (detailed below). Risk aversion is denoted by γ_t, while ψ is the intertemporal elasticity of substitution.

Epstein-Zin preferences imply the following stochastic discount factor:

$$M_{t,t+1} = \left(\frac{\partial V_t/\partial C_{t+1}}{\partial V_t/\partial C_t}\right) = \beta\left(\frac{C_{t+1}}{C_t}\right)^{1-1/\psi}\left(\frac{C_t}{C_{t+1}}\right)\left(\frac{V_{t+1}}{(\mathbb{E}_t V_{t+1}^{1-\gamma_t})^{\frac{1}{1-\gamma_t}}}\right)^{1/\psi-\gamma_t}. \tag{A.3}$$

The first order conditions for the households yield

$$\begin{aligned}
1 &= R^r_t \mathbb{E}_t M_{t,t+1}, \\
P^E_t &= \mathbb{E}_t\left[M_{t,t+1}\left(D^E_{t+1} + P^E_{t+1}\right)\right], \\
Q^c_t &= \mathbb{E}_t\left[M_{t,t+1}(dQ^c_{t+1} + 1)\right].
\end{aligned}$$

A.2 Firms

The representative firm chooses $N_{1,t}$, $N_{2,t}$,$v_{1,t}$, $v_{2,t}$, K_{t+1}, and I_t to maximize its discounted cash flow:

$$\max \mathbb{E}_t \sum_{s=0}^{\infty} \left(\frac{\partial V_t / \partial C_{t+s}}{\partial V_t / \partial C_t} \right) D_{t+s}, \tag{A.4}$$

subject to the production function:

$$Y_t \leq (K_t)^{\alpha} (Z_t N_t)^{1-\alpha}, \tag{A.5}$$

and the labor aggregator:

$$N_t = \left((1-\Omega) N_{1,t}^{\frac{\theta-1}{\theta}} + \Omega N_{2,t}^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}}, \tag{A.6}$$

The capital accumulation equation is

$$K_{t+1} = \left(1 - \delta - \frac{\phi_K}{2} \left(\frac{I_t}{K_t} - \delta \right)^2 \right) K_t + I_t, \tag{A.7}$$

and the laws of motion for employment in the full-time and part-time sectors are given by

$$N_{1,t} = (1-\rho_1) N_{1,t-1} + \Theta_{1,t} v_{1,t}, \tag{A.8}$$

$$N_{2,t} = (1-\rho_2) N_{2,t-1} + \Theta_{2,t} v_{2,t}. \tag{A.9}$$

where ρ_1 and ρ_2 are exogenous separation rates. The cash flows of of the firm are given by

$$D_t = Y_t - W_{1,t} N_{1,t} - W_{2,t} N_{2,t} - I_t - \gamma_{1,t}^l v_{1,t} - \gamma_{2,t}^l v_{2,t}. \tag{A.10}$$

The problem of the firms yields the following equilibrium conditions:

$$\begin{aligned} q_t =& \mathbb{E}_t \Big[M_{t+1} \Big(R_{t+1}^K + \\ & + q_{t+1} \left(1 - \delta - \frac{\phi_K}{2} \left(\frac{I_{t+1}}{K_{t+1}} - \delta \right)^2 + \phi_K \left(\frac{I_{t+1}}{K_{t+1}} - \delta \right) \frac{I_{t+1}}{K_{t+1}} \right) \Big) \Big] \end{aligned} \tag{A.11}$$

$$\frac{1}{q_t} = 1 - \phi_K\left(\frac{I_t}{K_t} - \delta\right), \tag{A.12}$$

$$R_t^K K_t = \alpha(K_t)^\alpha (Z_t N_t)^{1-\alpha}, \tag{A.13}$$

$$\tag{A.14}$$

and finally

$$\frac{\gamma_{1,t}^l}{\Theta_{1,t}} = (1-\Omega)(1-\alpha)Z_t\left(\frac{K_t}{Z_t N_t}\right)^\alpha\left(\frac{N_t}{N_{1,t}}\right)^{\frac{1}{\theta}} - W_{1,t} + \mathbb{E}_t\left\{M_{t,t+1}\frac{(1-\rho_1)\gamma_{1,t+1}^l}{Q_{1,t+1}^m}\right\}, \tag{A.15}$$

$$\frac{\gamma_{2,t}^l}{\Theta_{2,t}} = \Omega(1-\alpha)Z_t\left(\frac{K_t}{Z_t N_t}\right)^\alpha\left(\frac{N_t}{N_{2,t}}\right)^{\frac{1}{\theta}} - W_{2,t} + \mathbb{E}_t\left\{M_{t,t+1}\frac{(1-\rho_2)\gamma_{2,t+1}^l}{Q_{2,t+1}^m}\right\}. \tag{A.16}$$

In equilibrium $\Theta_{i,t} = \frac{m_i(S_{i,t},v_{i,t})}{v_{i,t}}$ where m_i is the Cobb-Douglas matching function for sector i. The equilibrium wages in each sector are given by:

$$W_{1,t} = \Gamma_t\eta_1\left[(1-\Omega)(1-\alpha)\left(\frac{K}{N}\right)^\alpha\left(\frac{N}{N_1}\right)^{\frac{1}{\theta}} + \gamma_1^l v_1/S_1\right] + (1-\eta_1)\Gamma_t b_1, \tag{A.17}$$

$$W_{2,t} = \eta_2\left[\Omega(1-\alpha)Z_t\left(\frac{K_t}{Z_t N_t}\right)^\alpha\left(\frac{N_t}{N_{2,t}}\right)^{\frac{1}{\theta}} + \gamma_{2,t}^l v_{2,t}/S_{2,t}\right] + (1-\eta_2)b_{2,t}. \tag{A.18}$$

Workers search sequentially in the two sectors. All unemployed workers at the beginning of period t first try to find a job in sector one. If the search is unsuccessful, a given worker searches in the second sector. Accordingly, the mass of searchers in the two sectors is given by

$$S_{1,t} = 1 - (1-\rho_1)N_{1,t-1} - (1-\rho_2)N_{2,t-1}, \tag{A.19}$$

$$S_{2,t} = 1 - N_{1,t} - (1-\rho_2)N_{2,t-1}, \tag{A.20}$$

where the total labor force has been normalized to unity.

A.3 Equilibrium

An equilibrium of the economy is a sequence for $\{Y_t, C_t, I_t, G_t, K_t, v_{1,t}, v_{2,t}, N_t, N_{1,t}, N_{2,t}, S_{1,t}, S_{2,t}, R_t^K, q_t, R_t^r, M_t, V_t, W_{1,t}, W_{2,t}, P_t^E, D_t^E, B_t^c, Q_t^c, \Gamma_t\}$ that satisfies the following conditions:

$$
\begin{aligned}
Y_t =& (K_t)^{\alpha}(Z_t N_t)^{1-\alpha}, && \text{(A.21)}\\
N_t =& \left((1-\Omega)N_{1,t}^{\frac{\theta-1}{\theta}} + \Omega N_{2,t}^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}}, && \text{(A.22)}\\
N_{2,t} =& (1-\rho_1)N_{2,t-1} + m_2(S_{2,t}, v_{2,t}), && \text{(A.23)}\\
N_{1,t} =& (1-\rho_2)N_{2,t-1} + m_1(S_{1,t}, v_{1,t}), && \text{(A.24)}\\
S_{1,t} =& 1-(1-\rho_1)N_{1,t-1} - (1-\rho_2)N_{2,t-1}, && \text{(A.25)}\\
S_{2,t} =& 1 - N_{1,t} - (1-\rho_2)N_{2,t-1}, && \text{(A.26)}\\
\frac{\gamma_{1,t}^{l} v_{1,t}}{m_1(S_{1,t}, v_{1,t})} =& (1-\Omega)(1-\alpha)Z_t\left(\frac{K_t}{Z_t N_t}\right)^{\alpha}\left(\frac{N_t}{N_{1,t}}\right)^{\frac{1}{\theta}} - W_{1,t} + && \text{(A.27)}\\
& + \mathbb{E}_t\left\{M_{t,t+1}\frac{(1-\rho_1)\gamma_{1,t+1}^{l} v_{1,t+1}}{m_1(S_{1,t+1}, v_{1,t+1})}\right\}, &&\\
\frac{\gamma_{2,t}^{l} v_{2,t}}{m_2(S_{2,t}, v_{2,t})} =& \Omega(1-\alpha)Z_t\left(\frac{K_t}{Z_t N_t}\right)^{\alpha}\left(\frac{N_t}{N_{2,t}}\right)^{\frac{1}{\theta}} - W_{2,t} + && \text{(A.28)}\\
& + \mathbb{E}_t\left\{M_{t,t+1}\frac{(1-\rho_2)\gamma_{2,t+1}^{l} v_{2,t+1}}{m_2(S_{2,t+1}, v_{2,t+1})}\right\}, &&\\
W_{1,t} =& \Gamma_t \eta\left[(1-\Omega)(1-\alpha)\left(\frac{K}{N}\right)^{\alpha}\left(\frac{N}{N_1}\right)^{\frac{1}{\theta}} + \gamma_1^{l}\frac{v_1}{S_1}\right] + (1-\eta)\Gamma_t b_1, && \text{(A.29)}\\
W_{2,t} =& \eta\left[\Omega(1-\alpha)Z_t\left(\frac{K_t}{Z_t N_t}\right)^{\alpha}\left(\frac{N_t}{N_{2,t}}\right)^{\frac{1}{\theta}} + \gamma_{2,t}^{l}\frac{v_{2,t}}{S_{2,t}}\right] + (1-\eta)b_{2,t}, && \text{(A.30)}\\
M_{t,t+1} =& \beta\left(\frac{C_{t+1}}{C_t}\right)^{1-1/\psi}\left(\frac{C_t}{C_{t+1}}\right)\left(\frac{V_{t+1}}{(\mathbb{E}_t V_{t+1}^{1-\gamma_t})^{\frac{1}{1-\gamma_t}}}\right)^{1/\psi-\gamma_t}, && \text{(A.31)}\\
P_t^{E} =& \mathbb{E}_t\left[M_{t,t+1}\left(D_{t+1}^{E} + P_{t+1}^{E}\right)\right], && \text{(A.32)}\\
Q_t^{c} =& \mathbb{E}_t\left[M_{t,t+1}(dQ_{t+1}^{c} + 1)\right], && \text{(A.33)}\\
1 =& R_t^{r}\mathbb{E}_t M_{t,t+1}, && \text{(A.34)}\\
R_t^{K} =& \alpha\left(\frac{K_t}{Z_t N_t}\right)^{\alpha-1}, && \text{(A.35)}\\
q_t =& \mathbb{E}_t\Big[M_{t+1}\Big(R_{t+1}^{K} + && \text{(A.36)}\\
& + q_{t+1}\left(1-\delta-\frac{\phi_K}{2}\left(\frac{I_{t+1}}{K_{t+1}}-\delta\right)^2 + \phi_K\left(\frac{I_{t+1}}{K_{t+1}}-\delta\right)\frac{I_{t+1}}{K_{t+1}}\right)\Big)\Big], &&
\end{aligned}
$$

$$K_{t+1} = \left(1 - \delta\frac{\phi_K}{2}\left(\frac{I_t}{K_t} - \delta\right)^2\right) K_t + I_t, \tag{A.37}$$

$$\frac{1}{q_t} = 1 - \phi_K\left(\frac{I_t}{K_t} - \delta\right), \tag{A.38}$$

$$Y_t = C_t + I_t + \gamma_1 v_{1,t} + \gamma_2 v_{2,t} + G_t, \tag{A.39}$$

$$G_t = \bar{g} Y_t, \tag{A.40}$$

$$D_t^E = Y_t - W_{1,t}N_{1,t} - W_{2,t}N_{2,t} - I_t - \gamma_{1,t}^l v_{1,t} - \gamma_{2,t}^l v_{2,t} - B_t^c + \xi K_{t+1}, \tag{A.41}$$

$$B_{t+1}^c = dB_t^c + \xi K_{t+1}/Q_t^c, \tag{A.42}$$

$$V_t = \max\left[(1-\beta)(C_t)^{1-1/\psi} + \beta(\mathbb{E}_t V_{t+1}^{1-\gamma_t})^{\frac{1-1/\psi}{1-\gamma_t}}\right]^{\frac{1}{1-1/\psi}}, \tag{A.43}$$

$$\Gamma_{t+1} = \Gamma_t^\omega Z_t^{1-\omega}. \tag{A.44}$$

A.4 Stationary Equilibrium

The model economy follows a balanced-growth path driven by the technology process, Z_t, which we assume is integrated of order one and follows an AR(1) in log-growth rates:

$$\log(Z_t) = \log(Z_{t-1}) + \sigma_z \epsilon_t^z, \tag{A.45}$$

To describe the dynamics of the model in terms of stationary variables, we stationarize any of the trending variables, X_t, by defining their stationary counterpart, $\hat{X}_t \equiv \frac{X_t}{Z_{t-1}}$. The equilibrium of the economy in terms of these stationary variables is a sequence for $\{\hat{Y}_t, \hat{C}_t, \hat{I}_t, \hat{G}_t, \hat{K}_t, \hat{v}_{1,t}, v_{2,t}, N_t, N_{1,t}, N_{2,t}, S_{1,t}, S_{2,t}, R_t^K, q_t, R_t^r, M_t, \hat{V}_t, \hat{W}_{1,t}, \hat{W}_{2,t}, \hat{P}_t^E, \hat{D}_t^E,$ $\hat{B}_t^c, Q_t^c, \hat{\Gamma}_t\}$ that satisfies the following conditions:

$$\hat{Y}_t = (\hat{K}_t)^\alpha (\Delta Z_t N_t)^{1-\alpha}, \tag{A.46}$$

$$N_t = \left((1-\Omega)N_{1,t}^{\frac{\theta-1}{\theta}} + \Omega N_{2,t}^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}}, \tag{A.47}$$

$$N_{2,t} = (1-\rho_1)N_{2,t-1} + m_2(S_{2,t}, v_{2,t}), \tag{A.48}$$

$$N_{1,t} = (1-\rho_2)N_{2,t-1} + m_1(S_{1,t}, v_{1,t}), \tag{A.49}$$

$$S_{1,t} = 1 - (1-\rho_1)N_{1,t-1} - (1-\rho_2)N_{2,t-1}, \tag{A.50}$$

$$S_{2,t} = 1 - N_{1,t} - (1-\rho_2)N_{2,t-1}, \tag{A.51}$$

$$\frac{\hat{\Gamma}_t \gamma_1^l v_{1,t}}{m_1(S_{1,t}, v_{1,t})} = (1-\Omega)(1-\alpha)\Delta Z_t \left(\frac{\hat{K}_t}{\Delta Z_t N_t}\right)^\alpha \left(\frac{N_t}{N_{1,t}}\right)^{\frac{1}{\theta}} - \hat{W}_{1,t} + \tag{A.52}$$

$$
\begin{aligned}
&+ \mathbb{E}_t \left\{ M_{t,t+1} \Delta Z_t \frac{(1-\rho_1)\hat{\Gamma}_{t+1}\gamma_1^l v_{1,t+1}}{m_1(S_{1,t+1}, v_{1,t+1})} \right\},
\end{aligned}
$$

$$
\frac{\hat{\Gamma}_t \gamma_{2,t}^l v_{2,t}}{m_2(S_{2,t}, v_{2,t})} = \Omega(1-\alpha)\Delta Z_t \left(\frac{\hat{K}_t}{\Delta Z_t N_t}\right)^{\alpha} \left(\frac{N_t}{N_{2,t}}\right)^{\frac{1}{\theta}} - \hat{W}_{2,t} + \tag{A.53}
$$

$$
+ \mathbb{E}_t \left\{ M_{t,t+1} \Delta Z_t \frac{(1-\rho_2)\hat{\Gamma}_{t+1}\gamma_2^l v_{2,t+1}}{m_2(S_{2,t+1}, v_{2,t+1})} \right\},
$$

$$
\hat{W}_{1,t} = \hat{\Gamma}_t \eta \left[(1-\Omega)(1-\alpha) \left(\frac{\hat{K}}{N}\right)^{\alpha} \left(\frac{N}{N_1}\right)^{\frac{1}{\theta}} + \gamma_1^l \frac{v_1}{S_1} \right] + (1-\eta)\hat{\Gamma}_t b_1, \tag{A.54}
$$

$$
\hat{W}_{2,t} = \eta \left[\Omega(1-\alpha)\Delta Z_t \left(\frac{\hat{K}_t}{\Delta Z_t N_t}\right)^{\alpha} \left(\frac{N_t}{N_{2,t}}\right)^{\frac{1}{\theta}} + \hat{\Gamma}_t \gamma_2^l \frac{v_{2,t}}{S_{2,t}} \right] + (1-\eta)\hat{\Gamma}_t b_2, \tag{A.55}
$$

$$
M_{t,t+1} = \beta \left(\frac{\hat{C}_{t+1}\Delta Z_t}{\hat{C}_t}\right)^{1-1/\psi} \left(\frac{\hat{C}_t}{\hat{C}_{t+1}\Delta Z_t}\right) \left(\frac{\hat{V}_{t+1}}{(\mathbb{E}_t \hat{V}_{t+1}^{1-\gamma_t})^{\frac{1}{1-\gamma_t}}}\right)^{1/\psi - \gamma_t}, \tag{A.56}
$$

$$
\hat{P}_t^E = \mathbb{E}_t \left[M_{t,t+1} \Delta Z_t \left(\hat{D}_{t+1}^E + \hat{P}_{t+1}^E \right) \right], \tag{A.57}
$$

$$
Q_t^c = \mathbb{E}_t \left[M_{t,t+1} (d Q_{t+1}^c + 1) \right], \tag{A.58}
$$

$$
1 = R_t^r \mathbb{E}_t M_{t,t+1}, \tag{A.59}
$$

$$
R_t^K = \alpha \left(\frac{\hat{K}_t}{\Delta Z_t N_t}\right)^{\alpha-1}, \tag{A.60}
$$

$$
q_t = \mathbb{E}_t \Big[M_{t,t+1} \Big(R_{t+1}^K + \tag{A.61}
$$

$$
+ q_{t+1} \left(1 - \delta - \frac{\phi_K}{2} \left(\frac{\hat{I}_{t+1}}{\hat{K}_{t+1}} - \delta \right)^2 + \phi_K \left(\frac{\hat{I}_{t+1}}{\hat{K}_{t+1}} - \delta \right) \frac{\hat{I}_{t+1}}{\hat{K}_{t+1}} \right) \Big) \Big],
$$

$$
\hat{K}_{t+1} = \left(1 - \delta - \frac{\phi_K}{2} \left(\frac{\hat{I}_t}{\hat{K}_t} - \delta \right)^2 \right) \frac{\hat{K}_t}{\Delta Z_t} + \frac{\hat{I}_t}{\Delta Z_t}, \tag{A.62}
$$

$$
\frac{1}{q_t} = 1 - \phi_K \left(\frac{\hat{I}_t}{\hat{K}_t} - \delta \right), \tag{A.63}
$$

$$
\hat{Y}_t = \hat{C}_t + \hat{I}_t + \hat{\Gamma}_t \gamma_1 v_{1,t} + \hat{\Gamma}_t \gamma_2 v_{2,t} + \Delta Z_t \bar{g} Y, \tag{A.64}
$$

$$
\hat{G}_t = \Delta Z_t \bar{g} Y, \tag{A.65}
$$

$$
\hat{D}_t^E = \hat{Y}_t - \hat{W}_{1,t} N_{1,t} - \hat{W}_{2,t} N_{2,t} - \hat{I}_t - \Gamma_t (\gamma_1^l v_{1,t} + \gamma_2^l v_{2,t}) - \hat{B}_t^c + \xi \frac{\hat{K}_{t+1}}{\Delta Z_t}, \tag{A.66}
$$

$$
\hat{B}_{t+1}^c = d \hat{B}_t^c / \Delta Z_t + \xi \hat{K}_{t+1} / Q_t^c, \tag{A.67}
$$

$$
\hat{V}_t = \max \left[(1-\beta)(\hat{C}_t)^{1-1/\psi} + \Delta Z_t^{1-1/\psi} \beta (\mathbb{E}_t \hat{V}_{t+1}^{1-\gamma_t})^{\frac{1-1/\psi}{1-\gamma_t}} \right]^{\frac{1}{1-1/\psi}}, \tag{A.68}
$$

$$\hat{\Gamma}_{t+1} = \hat{\Gamma}_t^{\omega}(\Delta Z_t)^{-\omega}. \tag{A.69}$$

A.5 Labor Market Search

We assume that workers in the economy search for a job sequentially, first in the full-time and, if they fail to find a full-time job, then in the part-time sector. In what follows, we derive conditions under which this sequence is optimal. We verify *ex post* that these conditions hold in our estimated model.

Let us define the value of a matched worker in sector 1 and 2 and the value of unemployment as:

$$\mathbb{W}_t^1 = W_{1,t} + \mathbb{E}_t \left\{ M_{t,t+1} \left[(1-\rho_1)\mathbb{W}_{t+1}^1 + \rho_1 \max\{\mathbb{S}_{t+1}^1, \mathbb{S}_{t+1}^2, \mathbb{U}_{t+1}\} \right] \right\}, \tag{A.70}$$

$$\mathbb{W}_t^2 = (W_{2,t} + \kappa_t) + \mathbb{E}_t \left\{ M_{t,t+1} \left[(1-\rho_2)\mathbb{W}_{t+1}^2 + \rho_2 \max\{\mathbb{S}_{t+1}^1, \mathbb{S}_{t+1}^2, \mathbb{U}_{t+1}\} \right] \right\}, \tag{A.71}$$

$$\mathbb{U}_t = b_2 + \mathbb{E}_t \left\{ M_{t,t+1} \max\{\mathbb{S}_{t+1}^1, \mathbb{S}_{t+1}^2, \mathbb{U}_{t+1}\} \right\}, \tag{A.72}$$

where $\mathbb{S}_t^1$ and $\mathbb{S}_t^2$ are, respectively, the expected value of searching in both sectors sequentially or just in the part-time sector:

$$\mathbb{S}_t^1 = P_{1,t}^m \mathbb{W}_t^1 + (1 - P_{1,t}^m)\mathbb{S}_t^2. \tag{A.73}$$

$$\mathbb{S}_t^2 = P_{2,t}^m \mathbb{W}_t^2 + (1 - P_{2,t}^m)\mathbb{U}_t. \tag{A.74}$$

Equations (A.70)-(A.72) reflect the assumption that as soon as workers separate from their employers, they can immediately begin to search. A worker will always prefer to search at least in the part time sector instead of foregoing search if

$$\mathbb{S}_t^2 \geq \mathbb{U}_t. \tag{A.75}$$

Looking the definition of $\mathbb{U}_t$ makes clear that this condition will be satisfied if $b_{2,t}$ is not too large. In other words, the monetary compensations from not searching at all cannot be too high. We verify this condition ex post and we assume it for the rest of the argument so that $\max\{\mathbb{S}_{t+1}^1, \mathbb{S}_{t+1}^2, \mathbb{U}_{t+1}\} = \max\{\mathbb{S}_{t+1}^1, \mathbb{S}_{t+1}^2\}$. For a worker to weakly strictly prefer to search in both sectors we need:

$$\mathbb{S}_t^1 \geq \mathbb{S}_t^2. \tag{A.76}$$

Inspection of the above equations reveals that a necessary condition for this to hold is that κ_t be not too large. That is, the non-wage compensation from working only part-time should not be too high. If both these conditions are satisfied, we can replace the definitions in (A.70)-(A.72) with

$$\mathbb{W}_t^1 = W_{1,t} + \mathbb{E}_t\left\{M_{t,t+1}\left[(1-\rho_1)\mathbb{W}_{t+1}^1 + \rho_1\mathbb{S}_{t+1}^1\right]\right\}, \tag{A.77}$$

$$\mathbb{W}_t^2 = (W_{2,t} + \kappa_t) + \mathbb{E}_t\left\{M_{t,t+1}\left[(1-\rho_2)\mathbb{W}_{t+1}^2 + \rho_2\mathbb{S}_{t+1}^1\right]\right\}, \tag{A.78}$$

$$\mathbb{U}_t = b_2 + \mathbb{E}_t\left\{M_{t,t+1}\mathbb{S}_{t+1}^1\right\}, \tag{A.79}$$

Equations (A.77)-(A.79) together with (A.73)-(A.74) define the variables $\{\mathbb{W}_t^1, \mathbb{W}_t^2, \mathbb{S}_t^1, \mathbb{S}_t^2, \mathbb{U}_t\}$ under the assumption that conditions (A.75)-(A.76) hold.

We verify the inequalities above in our estimated model and find that they each hold in the (non-stochastic) steady-state of our economy. Since our model is estimated locally, this is all that is required for our procedure to be coherent. As an additional check, however, we verified the conditions also hold in the stochastic steady-state of the model. Finally, across a long simulation of the economy, we find each conditions holds in at least 95% of realizations.

B Data Construction

Our baseline VAR specification consists of output, consumption, investment, employment, ex-post real stock returns, ex-post real bond returns, and the dividend price ratio. Our auxiliary series include measures of part-time employment, hours-per-worker, bond returns, and bond-risk premia.

Quantity variables were downloaded from the FRED database of the St. Louis Federal Reserve Bank and are included in seasonally-adjusted, real, per-capita terms. Our population series is the civilian non-institutional population ages 16 and over, produced by the BLS. We convert our population series to quarterly frequency using a three-month average and smooth it using an HP-filter with penalty parameter $\lambda = 1600$ to account for occasional jumps in the series that occur after census years and CPS rebasing (see Edge and Gürkaynak, 2010). Our deflator series is the GDP deflator produced by the BEA national accounts.

For output, we use nominal output produced by the BEA. Our investment measure is inclusive: we take the sum of nominal gross private domestic investment, personal expenditure on durable goods, government gross investment, and the trade balance (i.e. investment abroad). Consumption consists of nominal personal consumption expenditures on non-durables and services.

Our measure of employment is Total Nonfarm Employees (FRED code: PAYEMS) produced by the BLS and divided by population. The measure of part-time employment is the number of people "employed, usually part-time work" (FRED code: LNS12600000) produced by the BLS and again divided by our population series. This series includes a large discrete jump in the first month of 1994, associated with a reclassification of part-time work. We splice the series by assuming there was no change in employment between 1993M12 and 1994M1. Our measure of hours is Non-farm Business Sector: Hours of All Persons (FRED code: HOANBS). Finally, our measure of profits is Corporate Profits with inventory valuation adjustments: Nonfinancial Domestic Industries (FRED code: A399RC1Q027SBEA) and our measure of inflation is the log change in the GDP deflator (FRED code: GDPDEF).

Our asset return series are all based on quarterly NYSE/AMEX/NASDAQ value-weighted indexes from CRSP. Asset returns are computed inclusive of dividends, and are also deflated by the GDP deflator. Our measure of bond risk premia comes from Moody's corporate bond yield relative 10-year treasury bonds (FRED code: BAA10YM).

C Excess Stock Return Predictability

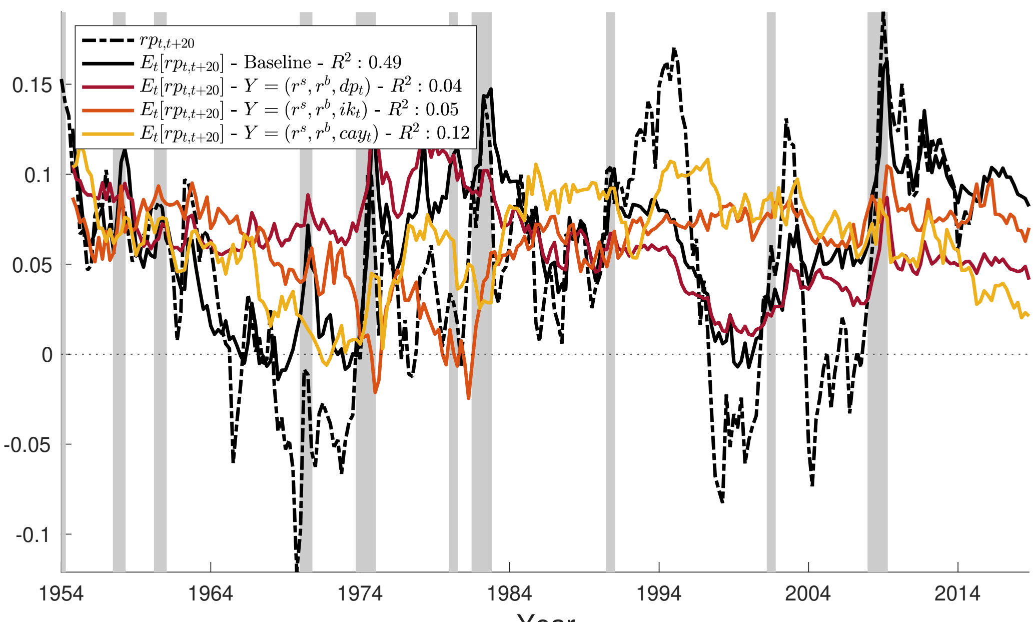

Figure C.1: Ex-ante excess stock returns from a sequence of VARs.

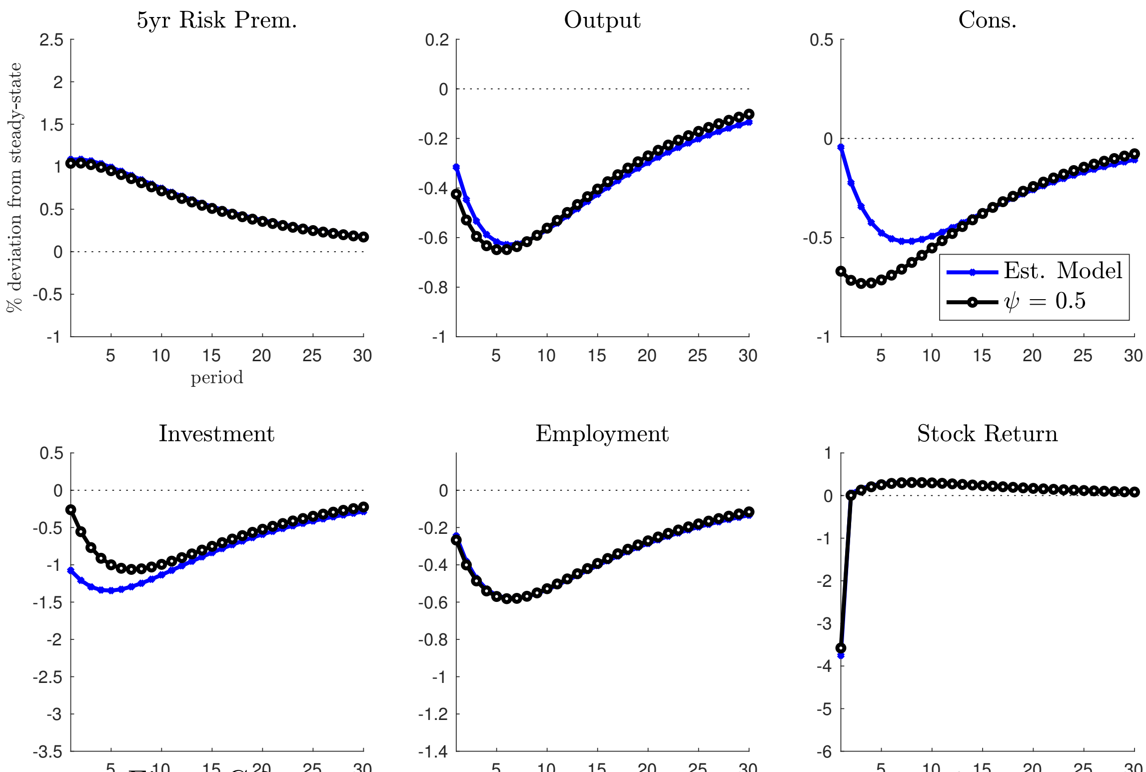

Figure C.2: Model responses with low intertemporal elasticity of substitution.