Risky Business Cycles*

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Abstract

We identify a shock that explains the bulk of fluctuations in the equity risk premium, 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 a reallocation away from full-time labor positions, and towards part-time and flexible contract workers. We explain the data using a novel real model with labor market frictions and fluctuations in risk appetite. Since safer factors of production have lower marginal products in equilibrium, a "flight-to-safety" from riskier to safer factors precipitates a macroeconomic recession.

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1 Introduction

Keynes (1936) argued that fluctuations in investment are determined not by "a weighted average of quantitative benefits multiplied by quantitative probabilities" but rather by changes in investors' willingness to commit current resources in return for uncertain future payoffs. Furthermore, he believed that such risk appetite-driven investment fluctuations lay at the center of business cycles. Decades of asset pricing research have indeed confirmed that risk premia are volatile and counter-cyclical (Cochrane, 2011). Yet, modern versions of Keynes's business cycle theory often run afoul of a sticky problem: greater perceived risk typically lowers investment, but simultaneously raises current consumption. Such models thus fail to generate macroeconomic comovement, the defining feature of business cycles.

In this paper we propose a resolution to this comovement challenge, based on a flight-to-safety mechanism for real investment. The idea is that at times when risk premia are high, firms invest more in factors of production with safer, but lower, returns. We argue that this portfolio adjustment motive plays an important role in generating risk-driven recessions in which all macro aggregates decline together. Our goal is to provide a link between old and new, by offering a model of risk-driven business cycles that – like Keynes (1936) – puts risky investment decisions at the heart of the business cycle. We estimate our model and show that it provides a novel, quantitatively successful mechanism for macroeconomic comovement without relying on either nominal rigidities or changes in production technology.

We begin with an empirical exercise that aims to estimate the connection between risk premia fluctuations and business cycles in the data. Specifically, we use a vector autoregression (VAR) and a maximum-share identification procedure in the tradition of Faust (1998) and Uhlig (2004) to extract the shock that explains the largest fraction of fluctuations in the equity risk premium. The shock identified in this way explains around 90% of risk premium fluctuations, hence we refer to it as "the main risk premium shock". A positive realization of this shock is associated with substantial and persistent falls in output, consumption, investment, and employment, and the shock explains a large portion of these variables. While we cannot uniquely label the structural origin of this disturbance, these patterns suggest that innovations to risk premia are indeed closely related to business cycles and macroeconomic comovement.

We next examine several additional indicators that could help elucidate the structural forces behind our shock. First, we find that our shock is not associated with significant movements in the present value of firm profits, discounted using risk-free rates. Since our shock captures risk premia fluctuations that are largely unrelated to cash flow fundamentals, we find it difficult to explain our empirical findings using a standard first-moment shock to productivity. Furthermore, our shock has economically small effects on inflation and risk-free rates. This suggests that the likely structural explanation is probably not a textbook New-Keynesian demand shock or a mechanism that operates through intertemporal substitution. Not all factors of production fall following our main risk premium shock, however: while total employment and full-time workers fall significantly, the number of part-time workers *increases* substantially during these risk-associated recessions.

To rationalize our empirical results, we propose a novel real model in which risk premium fluctuations are the main cause of business cycles. In our theory, increases in risk premia generate a recession by prompting firms to shift towards factors of production that are safer, but have lower marginal products. The conjecture that a flight-to-safety mechanism might be central to the business cycle goes back to at least Cochrane (2017), but no formal model of this channel exists in the literature yet. To isolate how our mechanism generates business cycles and comovement without shocks to technology or endowments, we model risk premium fluctuations as caused by exogenous shocks to risk aversion. Nevertheless, even if risk premia also change in response to other economic fundamentals, our reallocation channel would still function as an important propagation mechanism.

Section 3 introduces a simple analytical model to make two points. First, if all factors of production have the same riskiness, fluctuations in risk aversion change only the overall desire to save and there is no role for reallocation across factors of production. We show that, in this case, changes in risk aversion shift overall investment, but they move consumption in the opposite direction, ruling out macroeconomic comovement. Second, when there are two factors of production with different risk characteristics, an increase in risk aversion causes firms to shift towards factors of production that are safer, but offer lower marginal products. This reallocation reduces output *even for the same level of total investment*, triggering a recession and allowing for a decline in consumption.

Motivated by our empirical evidence, we operationalize this general idea by introducing search frictions into the labor market, which transforms labor into a long-lived investment good as in Hall (2017).[1] Furthermore, we extend the usual framework by introducing a distinction between full-time and part-time labor, assuming that part-time wages are more flexible and part-time employment relationships have shorter duration as is true in

[1] Belo et al. (2014), Favilukis and Lin (2016), Donangelo et al. (2019) all provide empirical evidence that labor relationships are a source of priced risk.

the data (Lariau, 2017; Borowczyk-Martins and Lalé, 2019; Grigsby et al., 2021). This makes full-time employment relationships riskier from the viewpoint of the firms, and thus hiring decisions are akin to a portfolio choice across factors of production with different riskiness. In equilibrium, firms are indifferent between hiring either type of labor, hence the higher riskiness of full-time labor implies it must also offer a higher marginal product to compensate. An increase in risk or risk aversion shifts firm vacancy creation away from the riskier full-time positions and towards safer part-time positions (flight-to-safety), thus shifting real investment towards factors with a low marginal product and precipitating a recession.

The quantitative model in Section 4 introduces several realistic features that allow us to take the model to the data. These include an infinite horizon, differences in separation rates between full- and part-time workers, and a search margin between those jobs. That model also introduces a third factor of production, physical capital, and therefore an additional channel for reallocation among factors of production. We estimate the quantitative model with a rich set of empirical targets, encompassing the impulse responses to the risk premium shock we identified in our VAR and various unconditional moments, including asset pricing moments. The model fits the data well, generating realistic business cycle fluctuations and macroeconomic comovement in response to risk aversion shocks, without predicting excessively high or volatile risk premia or labor market fluctuations.

We use our estimated model to perform several exercises that provide additional insight into the quantitative importance of the reallocation channel. Using a counterfactual experiment, we first show that reallocation between labor types alone accounts for about 3/4 of the equilibrium fall in consumption in response to increased risk aversion. Reallocation between investment in vacancies and in physical capital also pushes consumption down substantially, while a fall in the level of combined investment pulls consumption up. The net effect is a fall in consumption that matches the data well. We also show that the risk-premium on full-time labor is essential for the model to explain business cycles, and discuss how our mechanism is different from those in several related papers.

Related Literature

Our paper relates to the investment-based asset pricing literature that studies how risk affects firms' production decisions and firm valuations. These papers typically model firms' partial equilibrium choice of risky inputs, whether investment (Cochrane, 1991, 1996), inventories (Belo and Lin, 2012), or labor with adjustment costs (Belo et al., 2014), and estimate an implicit stochastic discount factor to fit their particular application. Our theory, instead, combines many of these investment channels in general equilibrium, and shows how, when governed by a single stochastic discount factor, changing allocations among these investments deliver macroeconomic comovement and business cycle fluctuations.

In macroeconomics, recent work has rekindled interest in the idea of uncertainty- or risk-driven business cycles (Gilchrist et al., 2014), but this otherwise intuitive research agenda faces difficulty in 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), have therefore complemented risk mechanisms with concurrent first-moment shocks to 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 capital depreciation to obtain drops in consumption and investment, but abstract from labor implications.

One solution to the comovement challenge 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). Similarly, Christiano et al. (2014) exploits the interaction of nominal rigidities and financial frictions with cross-sectional risk to obtain deep recessions. New Keynesian frictions can also help deliver large movements in unemployment following uncertainty shocks in models with labor search frictions (Leduc and Liu, 2016; Challe et al., 2017).[2] 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, suboptimal monetary policy, or potentially controversial markup variation (e.g., Rotemberg and Woodford, 1999 versus Nekarda and Ramey, 2013).

Two recent papers, Di Tella and Hall (2021) 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

[2] 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).

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 for propagating risk and uncertainty fluctuations into macro comovement, which is the reallocation of savings from investments with higher risk premia, and thus higher marginal product, to investments that are safer, but have a lower marginal product. This is a portfolio reallocation story that is conceptually different from existing real mechanisms that operate via fluctuations in the overall desire to save. We are the first to formally model this channel as the source of business cycle comovement, and also argue that it is empirically relevant, and specifically manifests in the data as the reallocation from full-time to part-time labor we document. Second, in the case of Di Tella and Hall (2021), 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 aggregate 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 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), Mitra and Xu (2019), Freund and Rendahl (2020), and Kehoe et al. (2022) 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 we have found in the data.

2 Risk Premium Shocks

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

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

In the above, Y_t is the vector of observed variables, $B(L)$ is the lag polynomial containing the weights on past realizations of Y_t, and u_t is the vector of residuals.

We use U.S. data, with $Y_t \equiv \left[gdp_t, c_t, inv_t, n_t, r^s_t, r^b_t, dp_t\right]'$ consisting of the logs of real per-capita output (gdp_t), consumption (c_t), investment (inv_t), employment (n_t), cum-dividend real stock log-returns (r^s_t), log real ex-post three-month treasury bill rate (r^b_t), and the aggregate dividend-price ratio (dp_t).[3] Our sample is 1954Q1-2018Q4.[4] The VAR is estimated in log-levels using OLS, with three lags in the polynomial $B(L)$.

2.1 Identification Approach

As with most VAR identification schemes, we seek to find a rotation matrix A that maps the reduced form residual u_t to a vector of orthogonalized innovations ϵ_t:

$$u_t = A\epsilon_t$$

To do so, we use a "max-share" approach similar to that introduced by Faust (1998) and Uhlig (2003, 2004). Specifically, we select A so that the shock associated with its first column explains the largest possible share of *expected* equity excess returns.

In order to target the expected excess return, we first construct this variable from the VAR. Starting with the *realized* j-period cumulative excess return defined as usual,

$$rp_{t,t+j} \equiv [r^s_{t+1} + r^s_{t+2} + ... + r^s_{t+j}] - [r^b_{t+1} + r^b_{t+2} + ... + r^b_{t+j}], \tag{2}$$

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), so that $\tilde{Y}_t$ is a stacked vector of Y_t and its three lags, and $\tilde{\epsilon}_t$ pads ϵ_t with zeros at the bottom to be conformable. Taking expectations over (2) and iterating backwards through the VAR system, we can

[3] Appendix A.1 contains all details on data definitions and sample construction.

[4] 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 shorter sample results, which are very similar, are reported in Appendix A.2.

express the expected excess return as a linear function of innovations $\tilde{\epsilon}_t$

$$\mathbb{E}_t[rp_{t+j}] = (e_5 - e_6)(\tilde{B} + \tilde{B}^2 + ... + \tilde{B}^j)(I - \tilde{B}L)^{-1}\tilde{A}\tilde{\epsilon}_t. \tag{3}$$

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

Next, we apply the max-share method. 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 (3). We can express the variance of $\mathbb{E}_t[rp_{t,t+j}]$ associated with spectra of periodicity $p \equiv [p_1, p_2]$, which we label σ_p^{rp}, as

$$\sigma_p^{rp} = \frac{1}{2\pi}\int_{2\pi/p_2}^{2\pi/p_1} \phi(e^{-i\lambda})\phi(e^{-i\lambda})' d\lambda. \tag{4}$$

In turn, we can express the variance of $\mathbb{E}_t[rp_{t,t+j}]$ over those same frequencies, but when only the first element of the shock vector ϵ_t is active, as

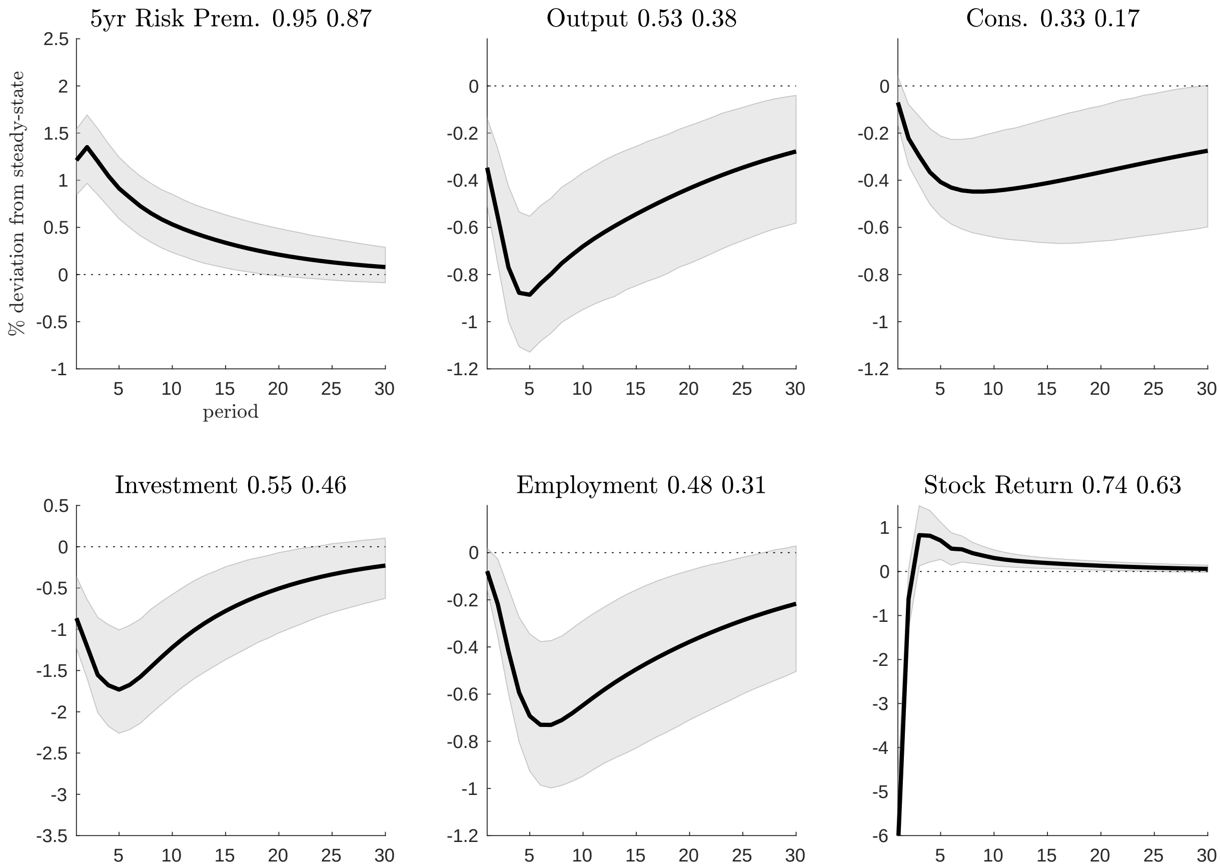
$$\sigma_p^{rp}\Big|_{\epsilon_t^{(2)}=\epsilon_t^{(3)}=\cdots=0} = \frac{1}{2\pi}\int_{2\pi/p_2}^{2\pi/p_1} \phi(e^{-i\lambda})e_1'e_1\phi(e^{-i\lambda})' d\lambda. \tag{5}$$

where again e_1 is a selector vector, this time with 1 in the first position and zeroes everywhere else, and $\epsilon_t^{(k)}$ is the $k-th$ element of the shock vector ϵ_t.

We can then find the matrix A by maximizing (5) (recall that $\phi(z)$ is a function of A). This procedure yields a partially identified system, in the sense that the above maximization problem will uniquely determine the first column of A and thus the first element of the shock vector of ϵ_t, but not the rest. This is sufficient for our purposes, because we are just interested in $\epsilon_t^{(1)}$, the orthogonal innovation that has the largest possible contribution to fluctuations in the risk premium $\mathbb{E}_t(rp_{t,t+j})$.

To implement our 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 ($[p_1, p_2]$). First, we choose $j = 20$, consistent with the common practice in the finance literature of emphasizing the predictability of the 5-year excess equity return (e.g., Cochrane, 2011). Indeed, the 5-year expected excess stock return as estimated by our VAR, $\mathbb{E}_t(rp_{t,t+20})$, tracks the ex-post stock return reasonably well and explains 49% of its sample variation. We show the time series of our risk-premium proxy and examine the sources of the underlying explanatory power in Appendix A.3.

Second, we choose the frequency band $p = [2{,}500]$ to include fluctuations of periodicity between 2 and 500 quarters. This effectively corresponds to targeting unconditional variances when variables are stationary, but allows us to perform robustness checks using



Note: Shaded lines are the 10th- and 90th-percentile bootstrapped responses. Y-axis values are in annualized percentage points for the risk premium and stock return; all other numbers are in percentage deviations. Numbers in subplot titles correspond to the percent of variance explained at the business cycle (6-32 quarters) and unconditional frequencies (2-500 quarters), respectively.

Figure 1: Impulse responses to VAR-identified risk premium shock.

VECM techniques, in which case the lag polynomial $B(L)$ has a unit root. We have found that our results are robust to estimating the VAR in VECM form so long as we allow for more than two independent trends in the data. Our results are also robust to increasing the lags in our VAR and changes in the VAR information set, including adding the 5-year Treasury yield or replacing the dividend-price ratio with the earnings-price ratio.

2.2 Empirical Results

Figure 1 plots the resulting impulse responses of the major business cycle variables to a one standard deviation change in $\epsilon_t^{(1)}$. The numbers in the panel titles represent the percent of the variance of each variable explained by our shock, either at business cycle frequency (first number, periodicities between 6 and 32 quarters) or essentially the unconditional variance (second number, periodicities between 2 and 500 quarters).

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 $\epsilon_t^{(1)}$ leads to 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 and persistent, with a half-life of 9 quarters. Naturally, we find that this persistent rise in the risk premium is associated with a sharp drop in stock prices on impact (panel 6). This is followed by a prolonged period of higher-than-average stock returns, which underlie the elevated expected excess returns $\mathbb{E}_t(rp_{t,t+j})$.

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. While we cannot uniquely label the structural origin of the shock, the very high share of the risk premium variance explained by $\epsilon_t^{(1)}$ means that a single factor is sufficient to explain the dynamics of the equity risk premium. Thus, given that this is the chief source of fluctuations in the equity risk premium in the data, for conciseness we call it the the "risk premium shock."

Next, we assess the broader macroeconomic footprint of this shock. To this end, Figure 1 plots the responses of the four main macro aggregates: output, consumption, investment and employment. We find that all of these variables exhibit a substantial and persistent contraction following the risk premium shock, with hump-shaped dynamics. These strong dynamic responses are also reflected in the variance decomposition, which shows that the shock accounts for roughly half of the variance in output, investment, and employment at business cycle frequencies, and about a third of the variance in consumption. The shock's contribution to unconditional variances is slightly lower, consistent with its persistent but clearly stationary nature (as shown in the first panel).

In summary, our findings show that the main risk premium shock is also an important driver of business cycles, both in terms of generating macro fluctuations and in driving the classic observation of macroeconomic comovement. It is interesting to contrast our results with the "main business cycle" shock of Angeletos et al. (2020). To extract their shock, they also follow a max-share procedure but instead isolate the main driver of output (or employment, depending on the specification), and not risk premia as we do.[5] Yet our shock captures a similar portion of business cycles and is correlated – with a coefficient of 0.75 – with their main business cycle shock. Overall, the results show that there is indeed a close connection between business cycles and risk premia fluctuations in the data.

[5] Another difference is that Angeletos et al. (2020) target business cycle frequencies while we target the unconditional variance. However, targeting business cycle frequencies in our procedure leaves the results unchanged – in that case we obtain a $\epsilon_t^{(1)}$ series that is correlated 98.3% with our baseline series.

2.3 Additional Results

Our approach to identification is consistent with many structural interpretations for our shock. To explore some potential interpretations, we study our shock's implications for several additional macroeconomic variables. To save on degrees of freedom (and because not all of the additional variables are available starting in 1954:Q1), we augment our VAR with a set of auxiliary variables S_t, by projecting S_t on current and past observations of Y_t:

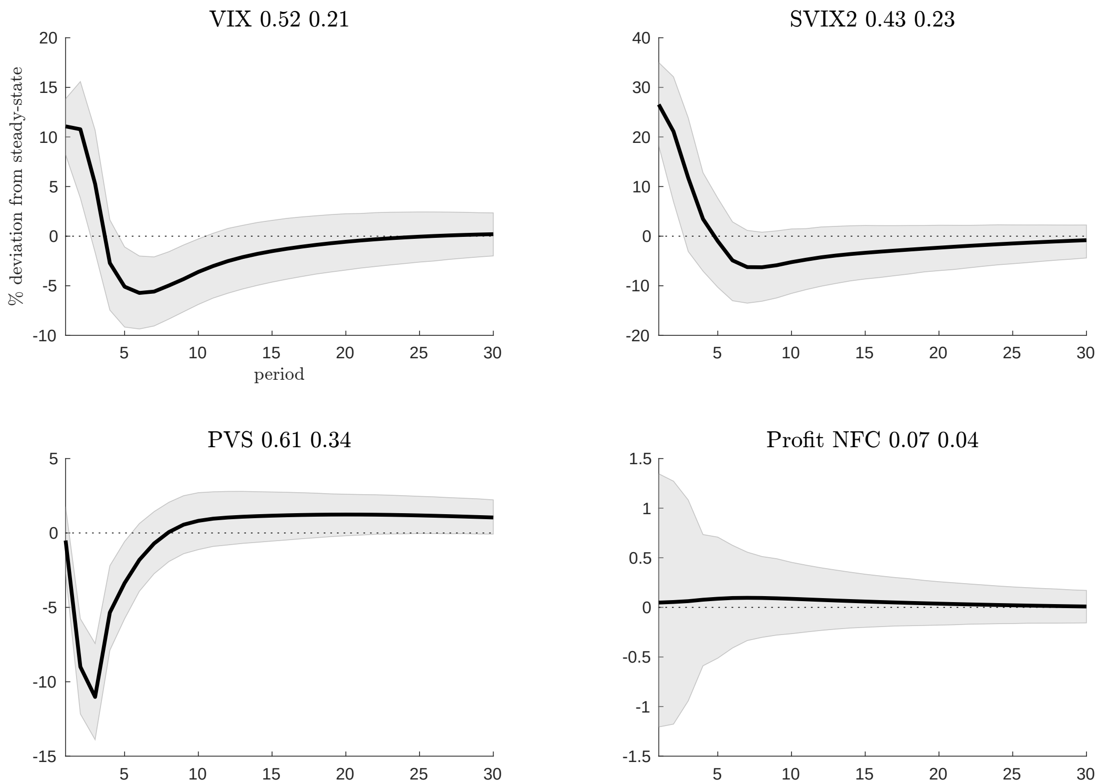
$$S_t = \Gamma(L)Y_t + v_t, \tag{6}$$

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 of Y_t implied by our VAR in (1).

Firm Profitability and Perceived Equity Risk

To explore the broader connection between our shock and equity market risk, the first row of panels in Figure 2 show that the VIX and Ian Martin's (2017) more precise proxy for the (1-month) equity premium (SVIX2) react positively but transitorily to our shock. The Pflueger et al. (2020) equity-based perceived risk measure is displayed in the bottom-left of the figure. The series, which is normalized to fall when perceived risk is high, drops on impact but also reverses quickly a couple of quarters after our shock. This shows that our shock, which is identified out of variation in our proxy of the 5-year equity risk-premium and thus has more of a medium-run nature, is also related to spikes in a wide range of short-run (1-month) equity risk premium measures.

A seminal finding of the finance literature is that asset price fluctuations are largely driven by changes in risk premia (i.e. discount rates), rather than changes in expected firm cash flows (e.g. Cochrane, 2011). To explore if our identified shock captures this well established unconditional fact, the last panel of Figure 2 plots the response of the present discounted value of expected real non-financial corporate profits to our shock. The time discount we use is the average safe real interest rate over our sample, and the present value of future expected profits is computed by iterating on the VAR and equation (6). The Figure shows that the present value of profits barely moves in response to the shock, implying that the stock price decrease in response to our shock is indeed due to changes in risk premia and not expected cash flows. This is an indication that, while we do not uniquely know the structural origins of $\epsilon_t^{(1)}$, this is a shock that primarily moves risk premia and not cash flows.



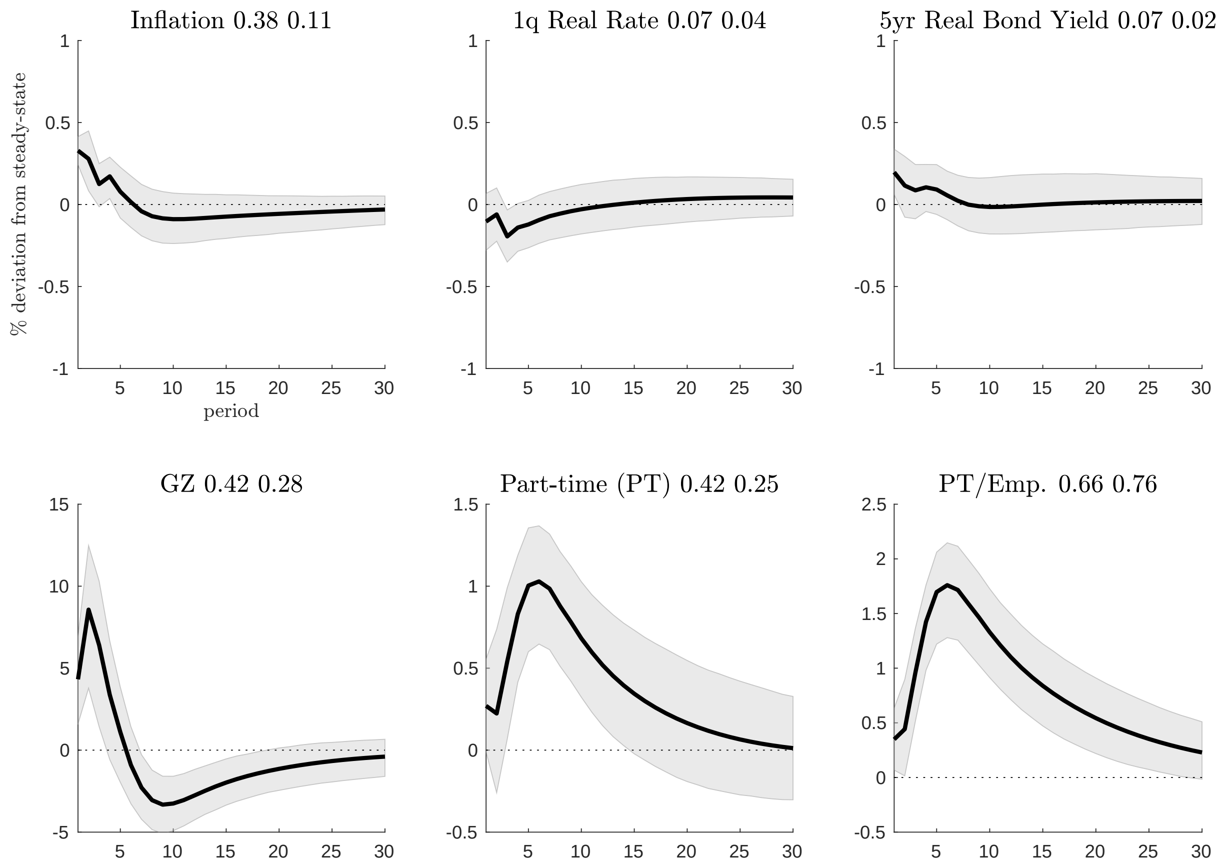
Note: Shaded lines are the 10th- and 90th-percentile bootstrapped responses. Numbers in subplot titles correspond to the percent of variance explained at the business cycle (6-32 quarters) and unconditional frequencies (2-500 quarters), respectively.

Figure 2: Impulse responses to VAR-identified risk premium shock for additional variables.

Inflation

These results make us conjecture that the likely deep origins of our shock are related to higher-order moments that primarily affect risk premia, and then spill over to the rest of the macroeconomy. However, risk premium (or more broadly uncertainty) shocks face significant hurdles in generating the macroeconomic comovement we found in Figure 1. In standard models, uncertainty shocks would typically raise precautionary savings demand and thus increase investment rather than decrease it.

One way of overcoming these classic hurdles is to introduce New Keynesian frictions, in which case the fall in consumption demand can depress aggregate demand enough to cause a broad recession across all four macro aggregates (Basu and Bundick (2017)). If this aggregate demand channel was dominant, we would expect the shock to have a negative impact on inflation. However, we find that if anything our risk premium shock is associated with a modest *increase* in inflation, as shown in the top-left panel of Figure 3. This observation encourages us to consider alternatives to the Keynesian narrative.



Note: 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 (2-500 quarters), respectively.

Figure 3: Impulse responses to VAR-identified risk premium shock for additional variables.

Interest Rates and Bond Returns

Successful real propagation mechanisms typically rely on tilting intertemporal forces in just the right way, so that an increase in uncertainty leads to a drop in the desire to invest (e.g. Di Tella and Hall (2021), Ilut and Saijo (2021)), which would imply a rise in real interest rates. Another alternative could be that uncertainty magnifies financial frictions, in which case $\epsilon_t^{(1)}$ should also significantly increase credit spreads.

However, Figure 3 shows that our shock has virtually no effect on interest rates, whether short-term or longer-term (five year) rates. On the other hand, while the excess bond premium measure of Gilchrist and Zakrajšek (2012) does rise for several quarters after the shock, this effect is much shorter lived than the rise in the 5-year equity risk premium and the impact on the real variables we documented earlier. Moreover, we have found that our "risk premium" shock is distinct from the "bond premia" shocks in Gilchrist and Zakrajšek (2012) and Kurmann and Otrok (2013), due in part to having very different effects on inflation and real investment. Thus, our shock seems to be something different from a direct shock to credit constraints or intertemporal forces.[6]

Part-time Employment

Instead, we propose an alternative channel, inspired by the intuitive argument in Cochrane (2017), that relies on a flight-to-safety effect to generate a recession in response to an uncertainty shock. Our key intuition is that a decrease in the risk-bearing capacity in the economy causes a shift towards factors of production that are safer, but also carry a lower marginal product (i.e. lower return). We conjecture that such reallocation might occur between part-time and full-time labor demand specifically, since full-time arrangements have less flexible wages and a duration that is 8 times longer than part-time (e.g. Lariau, 2017). Both features makes the value of a full-time worker more cyclical and, thus, riskier to firms.

The final panels of Figure 3 shows that part-time employment does indeed rise significantly in response to our shock. This response is persistent, and peaks at an increase of 1% in the number of part-timers, and 1.75% in terms of their share of total employment. This increase in part-time employment happens at the same time as the economy experiences an overall employment *fall* (0.7% at its trough) and a significant rise in the aggregate risk premium. Thus, the data is consistent with the flight-to-safety hypothesis described above and this is the hypothesis we focus on exploring further in the rest of the paper.

Disentangling Supply Shocks

One possible concern with our maximum share approach is that the estimated shocks could reflect a combination of underlying shocks, rather than a single structural disturbance. For example, the small estimated effects on inflation might result from the commingling of supply and demand disturbances that have a similar effect on real quantities but opposed effects on inflation. We try to address this specific concern by first identifying productivity or supply shocks and controlling for ("cleaning out") these shocks before estimating our risk premium shock. If the baseline estimation approach commingles risk with a first-moment supply shock then this cleaning step might qualitatively change our results.

[6] López-Salido et al. (2017), who show that a predictable change in the risk premium on corporate bonds forecasts changes in real economic activity, argue that stock returns predicted using a set of lagged mostly financial variables do not robustly predict macroeconomic activity. We use a different set of predictive variables to forecast the equity excess return over a longer time horizon and find sharply different results. Our equity risk premium shock is in fact a more important business cycles driver (in terms of variance decomposition), as compared to alternative credit market shocks and measures.

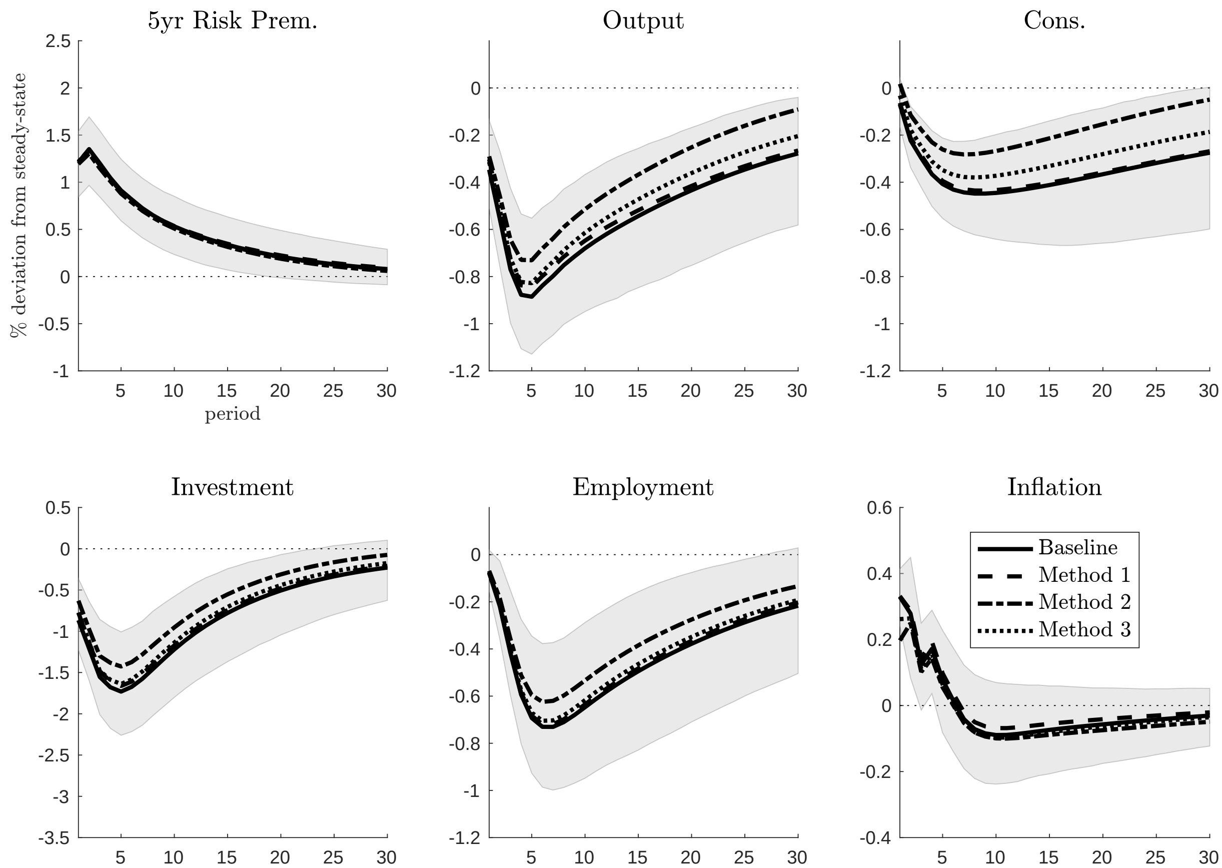


Figure 4: Different approaches to controlling for supply shocks.

Our general approach is to include the utilization-adjusted TFP series by Fernald (2014) in our set of auxiliary variables, and then use TFP to identify supply shocks using one of several different procedures. In each case, we first extract TFP-related supply shocks, then identify the risk premium shock using the max-share approach after controlling for the supply disturbances. The bottom line is that accounting for supply shocks leaves our main results unchanged, which suggests to us that our shock is not conflating supply and demand in an important way.

We consider three distinct versions of this approach. In "Method 1", we identify supply shocks using the pure surprise in TFP, following a traditional Cholesky identification with TFP ordered first. In "Method 2", we use the approach of Chahrour et al. (2023), which extends Kurmann and Sims (2020) to identify both a news and surprise component of TFP. Combined, these two productivity disturbances absorb more than 80% of the unconditional variation in TFP, further reducing the risk of conflating supply fluctuations with the risk premium shock. Finally, "Method 3" addresses the concern raised by Bouakez and Kemoe (2023) regarding the weak unconditional correlation between measured TFP and inflation by identifying the supply shock as that which induces the largest possible negative covariance between inflation and TFP. The implementation of these procedures is described in Appendix A.4.

Regardless of the method used to control for supply shocks, Figure 4 shows that the properties of the resulting risk premium shock $\epsilon_t^{(1)}$ are essentially unchanged. The impulse responses of macro variables to the risk premium shock, including the increase in part-time employment and the weak relationship with inflation are unaffected. Indeed, we find that in all cases the time series of the identified risk premium shock is correlated by 95% or more with the shock identified under our baseline procedure. While our shock could still in principle be associated with more than one deeper structural disturbance, we think this evidence points away from an explanation of offsetting supply and demand channels, and towards a story of a consistent propagation mechanism for changes in risk premia that is independent of standard supply-side shocks.

Taking Stock

Taken together, we believe our results suggest that flight-to-safety could be central to understanding how shocks to risk premia propagate to the macroeconomy. Both the asset pricing patterns and real input decisions by firms are consistent with a shift toward safety. The same evidence points away from mechanisms that rely on strong first-moment shocks or aggregate demand-driven channels.

An open question is how a reallocation towards safety can result in a simultaneous fall in all of the main macroeconomic aggregates in equilibrium. To build intuition for how the mechanism we propose works, Section 3 formalizes the flight-to-safety argument in an analytically tractable two-period model. To keep things simple, in that model we abstract from physical capital and focus on the full-time to part-time labor reallocation we have identified in the data. In Section 4, we quantify the mechanism in a richer version of the model with an infinite horizon and capital accumulation, among other extensions.

3 Analytical Model and Intuition

In this section, we present a simple, analytically tractable model of the reallocation mechanism we propose. We use this model to highlight two qualitative insights. First, when all factors of production are equally risky, fluctuations in risk or risk aversion can change overall investment demand but cannot generate comovement between aggregate investment and consumption. This is the main challenge a theory of risk-driven business cycles needs to overcome. Second, when factors have *different riskiness*, fluctuations in risk cause a reallocation across different types of investment, with investment shifting towards the less risky factors. The goal of this section is to demonstrate how this "flight to safety" mechanism can lead to aggregate comovement between total investment and consumption.

The analytical model of this section is purposefully stylized to remain tractable. It is a two-period general equilibrium economy with search and matching in labor markets. As is standard in the search literature, employment relationships are durable, meaning that labor hired in the first period produces in both periods. This makes the labor demand choice of the firm a risky *investment* choice, as firms weigh the returns on labor both from production today and from production in the (uncertain) future. To keep things tractable, in this section we abstract from physical capital and focus on firms' choice of two different types of labor, which we label "full-time" (f) and "part-time" (p).

Households consume and supply labor inelastically in both markets, while the firms make vacancy posting decisions. Firms are the main decision makers in the economy: they hire labor by posting vacancies in the two separate labor search markets, V_f and V_p, at a cost per vacancy of φ. These search markets are only open in the initial period, and successfully hired workers produce in both periods $t \in \{0, 1\}$. Matches are formed according to a Cobb-Douglas matching function so that vacancies are filled with a probability $P_i \equiv M(V_i, S)/V_i$ for $i \in \{f, p\}$, where $M(V, S) = V^{\varepsilon} S^{1-\varepsilon}$ is the matching technology.

In the analytical model we consider only one difference between the two labor markets: the wages paid to part-time workers are more flexible than the wages paid to full-time workers, as is true in the data. The rest of the structure of the two labor markets is symmetric – the vacancy posting cost φ and the matching function elasticity ε are the same, and there is simply a unit mass, $S = 1$, of searchers in each market. In the quantitative model in Section 4, we relax these symmetry assumptions and allow households to choose which labor market to search in. Such extensions improve the empirical realism of the model, but they do not change the intuition of our mechanism.

Firms combine labor types using a CES aggregator and output is given by

$$Y_t = Z_t N = Z_t \left(N_f^{\frac{\theta-1}{\theta}} + N_p^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}}, \tag{7}$$

where θ is the elasticity of substitution across labor types. We do not put a time subscript on the labor quantities since here labor is hired once and for all for both periods. We normalize $Z_0 = 1$, and assume Z_1 is log-normal with unit mean, $\log(Z_1) \sim N\left(-\frac{1}{2}\sigma_z^2, \sigma_z^2\right)$.

Period-one productivity, Z_1, is the only source of risk in the economy.

Since vacancies V_i can be expressed as $V_i = N_i/P_i$ and firms take the equilibrium matching probabilities P_i as given, we can express the firm's problem as a choice over labor inputs, N_f and N_p. The representative firm maximizes the sum of its expected profits discounted by the household's stochastic discount factor $M_{0,1}$ (defined below):

$$\max_{N_f,N_p} \pi_0 + E_0[M_{0,1}\pi_1], \tag{8}$$

subject to $N_f \geq 0, N_p \geq 0$, and the expressions for firm profits

$$\pi_0 = \left(N_f^{\frac{\theta-1}{\theta}} + N_p^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} - W_{f,0}N_f - W_{p,0}N_p - \varphi\frac{N_f}{P_f} - \varphi\frac{N_p}{P_p}, \tag{9}$$

$$\pi_1 = Z_1\left(N_f^{\frac{\theta-1}{\theta}} + N_p^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} - W_{f,1}N_f - W_{p,1}N_p. \tag{10}$$

The stochastic discount factor, $M_{0,1}$, in (8) is that of the representative household. The household has Epstein-Zin preferences,

$$\mathbb{V}_0 = \left[(1-\beta)C_0^{1-1/\psi} + \beta(\mathbb{E}_0 C_1^{1-\gamma})^{\frac{1-1/\psi}{1-\gamma}}\right]^{\frac{1}{1-1/\psi}}, \tag{11}$$

owns the representative firm, supplies labor inelastically and consumes subject to

$$C_0 = \pi_0 + W_{f,0}N_f + W_{p,0}N_p,$$
$$C_1 = \pi_1 + W_{f,1}N_f + W_{p,1}N_p,$$

where $W_{f,t}N_f + W_{p,t}N_p$ is the household's time t labor income. Thus, the household's stochastic discount factor is

$$M_{0,1} \equiv \left(\frac{\partial\mathbb{V}_0/\partial C_1}{\partial\mathbb{V}_0/\partial C_0}\right) = \beta\left(\frac{C_1}{C_0}\right)^{-1/\psi}\left(\frac{C_1}{(\mathbb{E}_0 C_1^{1-\gamma})^{\frac{1}{1-\gamma}}}\right)^{1/\psi-\gamma}. \tag{12}$$

The intertemporal elasticity of substitution is denoted by ψ, and risk aversion by γ. In order to isolate how risk premia propagate to the real economy we focus directly on the effects of changes to the risk-aversion coefficient γ. However, changes in risk premia that originate from other sources (e.g., changes in volatility) would propagate in the same way.

To close the model, we need to specify wages. We will consider two options. The first is a flexible wage that is renegotiated each period via Nash bargaining. We assume a household bargaining weight $\eta = 1 - \varepsilon$, which eliminates the congestion externalities in the labor search market. Workers have an outside option of zero, so the wage is η times the marginal product of labor:

$$W_{i,t}^{Nash} = \eta Z_t \left(N_f^{\frac{\theta-1}{\theta}} + N_p^{\frac{\theta-1}{\theta}} \right)^{\frac{1}{\theta-1}} N_i^{-\frac{1}{\theta}}. \tag{13}$$

The second alternative is a wage that does not adjust to the productivity shock in the second period, but is otherwise similarly proportional to the marginal product of labor

$$W_{i,t} = \eta \left(N_f^{\frac{\theta-1}{\theta}} + N_p^{\frac{\theta-1}{\theta}} \right)^{\frac{1}{\theta-1}} N_i^{-\frac{1}{\theta}}. \tag{14}$$

In particular, equation (14) implies $W_{i,t} = E_0[W_{i,1}^{Nash}]$. Thus, *at the time of hiring*, the wage takes into account current conditions and how they affect the expected marginal product of labor going forward. But the wage is *rigid* to the actual realizations of future shocks to the marginal product of labor. This generates operational leverage and makes labor positions *riskier* from the view point of the firm (e.g., Favilukis and Lin, 2016).

Wage rigidity also introduces the possibility that, in some states of the world, the future payments committed to labor could exceed labor's future product. In the remainder of this section, we assume that such states cannot dominate the future return to labor:

Assumption 1. *The present value of the firm's future $t = 1$ surplus, $E_0[M_{0,1}(MPN_{i,1} - W_{i,1})]$, is positive.*

Under the flexible wage in (13), Assumption 1 always holds. Under the rigid wage in (14), Assumption 1 also holds trivially when $\gamma = 0$. However, as risk aversion increases, the household discount factor puts larger weight on those future periods with negative realized returns to labor. Thus, Assumption 1 imposes an upper bound on γ which rules out pathological equilibria where firms perceive *negative* risk-adjusted second period returns to labor and would hence ex-ante prefer to separate at the end of the first period.

3.1 Analytical Results

We now establish our two main analytical results. First, we show that when both labor positions have the same type of wages (whether flexible or rigid), it is impossible to generate comovement across aggregate consumption, output, and labor. Intuitively, in this case both labor types are perfectly symmetric and the economy effectively has only one durable factor of production. Hence an increase in risk aversion only causes fluctuations in the overall desire to save. Second, we show that introducing different wage processes for the two types of labor creates a risk premium differential across labor types. In that case, an increase in risk aversion causes a reallocation of labor demand from one type to the other. We show that this reallocation is essential for generating comovement.

Proposition 1. *Suppose that either (i) wages in both sectors are given by (13); or (ii) both wages are given by (14) and Assumption 1 holds. Then:*

1. *The risk premia on both types of labor, N_f and N_p, are identical.*
2. *(C_0, N, Y_0) cannot all move in the same direction in response to a change in γ.*

Proof. We sketch the key intuitions here; the complete proof is relegated to Appendix B.

We first focus on the case of flexible wages and then describe what parts of the argument change with rigid wages. Under (13), the firms' optimal labor demand condition in both sectors is given by

$$\varphi N_i^{\frac{1-\varepsilon}{\varepsilon}} = \varepsilon \left(N_f^{\frac{\theta-1}{\theta}} + N_p^{\frac{\theta-1}{\theta}} \right)^{\frac{1}{\theta-1}} N_i^{-\frac{1}{\theta}} \left[1 + \frac{1}{R} + Cov(M_{0,1}, Z_1) \right]. \tag{15}$$

Intuitively, (15) equates the cost of hiring an extra unit of labor with the expected benefit. The left-hand side represents the equilibrium cost of hiring an extra unit of labor, where we have used $\frac{\varphi}{P_i} = \varphi N_i^{\frac{1-\varepsilon}{\varepsilon}}$. The right hand side captures the present discounted value the firm earns from having an extra unit of labor; the term $\varepsilon \left(N_f^{\frac{\theta-1}{\theta}} + N_p^{\frac{\theta-1}{\theta}} \right)^{\frac{1}{\theta-1}} N_i^{-\frac{1}{\theta}}$ is the per-period expected marginal surplus of an extra unit of labor of type i, while the term $\left[1 + \frac{1}{R} + Cov(M_{0,1}, Z_1)\right]$ is a present-discounted value multiplier. It includes the inverse of the safe real interest rate, R, and $Cov(M_{0,1}, Z_1) < 0$ is the risk-premium discount which accounts for the stochastic nature of the second period marginal product.

Since N_f and N_p are symmetric from the view point of the firm in this case (same wages and impact on production), they have the same risk-return characteristics. It is useful to define the "price-dividend" ratio of each labor type as the cost of hiring an extra unit of labor divided by the marginal increase in the current-period profits of the firm. Given their identical risk profiles, unsurprisingly both labor types have the same equilibrium "price-dividend" ratio which we can obtain from (15):

$$\frac{\varphi N_i^{\frac{1-\varepsilon}{\varepsilon}}}{\varepsilon \left(N_f^{\frac{\theta-1}{\theta}} + N_p^{\frac{\theta-1}{\theta}} \right)^{\frac{1}{\theta-1}} N_i^{-\frac{1}{\theta}}} \equiv \frac{\varphi N_i^{\frac{1-\varepsilon}{\varepsilon}}}{\varepsilon MPN_{i,0}} = 1 + \frac{1}{R} + Cov(M_{0,1}, Z_1). \tag{16}$$

where $MPN_{i,0} = \left(N_f^{\frac{\theta-1}{\theta}} + N_p^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}} N_i^{-\frac{1}{\theta}}$ is the time-0 marginal product of labor i.

Given this symmetry, it is straightforward to conclude that the firm optimally sets $N_f = N_p$. That is, labor demand for both types is the same, and the economy effectively has only one factor of production – aggregate labor. Whether aggregate labor demand goes up or down depends on the value of ψ. When $\psi > 1$ an increase in risk aversion lowers the present discounted value of risky future output, since $\frac{1}{R} + Cov(M_{0,1}, Z_1)$ is decreasing in γ. Intuitively, this is because agents with high IES care less about smoothing the resulting decline in the certainty equivalent of future consumption, and care more the fact that future output is risky (the risk-premium force dominates). As a result, in this case aggregate labor is decreasing in risk aversion, $\frac{\partial N_f}{\partial \gamma} = \frac{\partial N_p}{\partial \gamma} = \frac{\partial N}{\partial \gamma} < 0$. The converse is true for $\psi < 1$ and, when $\psi = 1$, the aggregate demand for labor does not change with γ.

Lastly, the impact on consumption is given by differentiating the resource constraint:

$$\frac{\partial C_0}{\partial \gamma} = \left(MPN_{f,0} - \frac{\varphi N_f^{\frac{1-\varepsilon}{\varepsilon}}}{\varepsilon}\right)\frac{\partial N_f}{\partial \gamma} + \left(MPN_{p,0} - \frac{\varphi N_p^{\frac{1-\varepsilon}{\varepsilon}}}{\varepsilon}\right)\frac{\partial N_p}{\partial \gamma} \tag{17}$$

The terms in parenthesis are the marginal products of labor net of the social cost of hiring an extra unit of labor. The equilibrium price-dividend ratios in (16) give us a direct relationship between $\varepsilon MPN_{i,0}$ and $\varphi N_i^{\frac{1-\varepsilon}{\varepsilon}}$, and since $\frac{1}{R} + Cov(M_{0,1}, Z_1) = E_0(M_{0,1}Z_1) > 0$, from (16) we have

$$MPN_{i,0} < \frac{\varphi N_i^{\frac{1-\varepsilon}{\varepsilon}}}{\varepsilon}. \tag{18}$$

In other words, the price-dividend ratio is necessarily greater than one. The key intuition is that the marginal cost of hiring an extra unit of labor today is higher than the marginal profit the worker brings in the first period (i.e. $\varepsilon MPN_{i,0}$), since a worker match also brings positive expected profits next period. As a result, $MPN_{i,0} - \frac{\varphi N_i^{\frac{1-\varepsilon}{\varepsilon}}}{\varepsilon}$ is negative, and hence equation (17) implies that labor inputs and consumption always move in opposite directions: macroeconomic comovement due to changes in γ is impossible.

We conclude the discussion of the flexible wage case by stating a Corollary that summarizes all of the key equilibrium responses to an increase in risk aversion:

Corollary 1. *With the flexible wages in (13), an increase in γ causes C_0 to rise while N and Y_0 both fall when intertemporal elasticity $\psi > 1$. The converse happens when $\psi < 1$.*

In the case of rigid wages (equation (14)), Proposition 1 highlights a general equilibrium challenge for the partial equilibrium insight of Hall (2017): with rigid wages, changes in risk aversion can push down labor for a larger range of ψ (not just $\psi < 1$) since rigid wages amplify the risk-premium on labor. Nevertheless, rigid wages alone cannot generate macroeconomic comovement.

In the case of rigid wages, the labor demand optimality condition is replaced by

$$\varphi N_i^{\frac{1-\varepsilon}{\varepsilon}} = \varepsilon MPN_{i,0}\left[1 + \frac{1}{R} + \frac{Cov(M_{0,1}, Z)}{\varepsilon}\right] \tag{19}$$

The only difference between (15) and (19) is the division of the $Cov(M_{0,1}, Z)$ term by ε in (19), implying that the risk premium discount applied to expected labor returns is higher when wages are rigid (since $\varepsilon < 1$). Intuitively, whereas the Nash-bargained wage rises and falls with Z_1, a rigid wage leaves the firm fully exposed to Z_1 fluctuations, making the surplus of labor matches riskier. Still, both labor types remain symmetric and hence in equilibrium $N_f = N_p$, and both again have the same price-dividend ratios.

Lastly, with rigid wages and sufficiently high risk aversion, the present discounted value of future profits can turn negative, i.e. $\frac{1}{R} + \frac{Cov(M_{0,1},Z)}{\varepsilon} < 0$. Assumption 1, however, rules out such cases where the firm would *ex-ante* prefer to separate from labor at the end of period 0 rather than risk the losses associated with paying rigid wages in the worst states of the world in period 1. Thus, (19) still implies the price-dividend ratio for labor is above one. Hence, the terms in parentheses in (17) are negative and the same impossibility of C and N moving in the same direction is established. □

Next, we analyze the case featuring our novel reallocation mechanism, where one labor type's wage, the full-time wage, is rigid and the other is not. In not adjusting to the specific realization of the productivity shock Z_1, the rigid wage process makes full-time labor matches relatively riskier for the firm. Specifically, under this differential wage structure, the labor optimality condition (19) applies to full-time labor demand, while condition (15) applies to part-time labor demand. The relatively higher risk premium for full-time labor positions is captured by the division of the covariance term in (19) by $\varepsilon < 1$. As a result, the risk-premium on N_f is both higher on average and more sensitive to changes in γ. This has two important implications.

First, the higher average risk premium manifests in the fact that the "price-dividend" ratio on part-time positions is higher. Combining (15) and (19), we have

$$\frac{\varphi N_f^{\frac{1-\varepsilon}{\varepsilon}}}{\varepsilon MPN_{f,0}} < \frac{\varphi N_p^{\frac{1-\varepsilon}{\varepsilon}}}{\varepsilon MPN_{p,0}}. \tag{20}$$

This means that in equilibrium the marginal product of full-time labor is high (relative to the cost of hiring) as compared to part-time labor. This marginal product gap reflects the fact that riskier factors of production compensate the firm with higher average returns.

Second, the lower sensitivity to risk in N_p labor demand generates a flight-to-safety effect: an increase in risk aversion leads to a reallocation of vacancy postings from the full-time sector to the part-time sector. Intuitively, this implies that the equilibrium quantities of the two types of labor would generally move in the opposite direction following an increase in risk aversion, that is $\frac{\partial N_f}{\partial \gamma} < 0$ and $\frac{\partial N_p}{\partial \gamma} > 0$. These two implications generate a novel and conceptually distinct effect on equilibrium consumption.

To illustrate the key intuition, consider the thought experiment of reallocating one unit of vacancy expenditures from hiring full-time labor to hiring part-time labor. This only reshuffles labor demand across different types, leaving total hiring cost unchanged. The change in first-period consumption due to this reallocation, ΔC_0, is given by the differential marginal impact on output of a unit change in the hiring expenditure of each type of labor, that is:

$$\Delta C_0 = \frac{MPN_{p,0}}{\varphi/\varepsilon N_p^{\frac{1-\varepsilon}{\varepsilon}}} - \frac{MPN_{f,0}}{\varphi/\varepsilon N_f^{\frac{1-\varepsilon}{\varepsilon}}} < 0 \tag{21}$$

Specifically, since full time labor has a larger marginal product (relative to marginal hiring costs, as seen by equation (20)), this reallocation of labor demand *lowers* equilibrium output. Thus, a pure change in the composition of hiring, leaving total hiring expenditure constant, also pushes consumption down, giving us the inequality above.

The total equilibrium response of consumption to a change in risk aversion entails a mix of this pure reallocation experiment and the effect of changes in aggregate labor demand described in Proposition 1 (which would push consumption in the opposite direction). Thus, in general, consumption could go up or down when risk aversion rises. Proposition 2 below highlights an analytically tractable case, showing that there is a threshold of risk aversion above which the reallocation channel dominates. In this region, labor, output, and consumption all fall if risk aversion rises.

Proposition 2. *With $\psi = 1$, $\theta \to \infty$, rigid wages satisfying Assumption 1 in the full-time sector, and flexible wages in the part-time sector:*

1. *The risk premium on full-time labor is larger than the risk premium on part-time labor.*

2. *There is a threshold $\tilde{\gamma}$, such that all of (C_0, Y, N) are falling in risk aversion, γ, for $\gamma > \tilde{\gamma}$.*

Proof. The details are left in the Appendix □

We make two simplifying assumptions for this Proposition. First, we consider the case of $\psi = 1$, which simplifies the stochastic discount factor. Second, we take the limit of perfect elasticity of substitution across labor in production, which eliminates the cross-effects of the change in labor demand in one sector on the marginal product, and hence optimal labor demand, in the other sector. These assumptions have no material impact on the economic intuition of our mechanism, and we relax both in the quantitative model.

The main result is that when γ is high enough ($\gamma > \tilde{\gamma}$), then we have full macroeconomic comovement and output, consumption and aggregate labor/investment all fall in equilibrium. The key intuition is twofold. First, because the full-time labor demand is more sensitive to changes in risk aversion (equation (19)) than part-time labor demand (equation (16)), we can show that *aggregate* employment necessarily falls when γ increases. By extension, since the price-dividend ratio of full-time labor is lower, and hence its equilibrium marginal product is relatively higher (see equation (20)), output is falling too.

Lastly, since we have an overall fall in aggregate labor, the forces underlying Proposition 1 push equilibrium consumption up. However, as discussed above, we now also have the novel reallocation mechanism which pushes consumption down. This reallocation mechanism relies on a sufficiently large difference in the marginal products of full-time and part-time labor, and that difference is intuitively increasing with γ since a large γ implies a bigger price-dividend differential across full-time and part-time labor. As Proposition 2 shows formally, there always exists an admissible level of risk aversion $\tilde{\gamma}$ such that, for any $\gamma > \tilde{\gamma}$, the reallocation mechanism dominates and a risk-aversion increase drive a recession with full macroeconomic comovement.

4 Quantifying the Mechanism

In this section, we quantify the potential importance of our mechanism by estimating an extended version of the model to match the impulse responses identified in Section 2, as well as several unconditional moments in the data related to labor markets and risk premia. We use the estimated model to perform several counterfactual exercises that elucidate the importance of reallocation in driving macroeconomic comovement.

4.1 Extended Model

The model consists of a representative household and a representative firm. The household consumes, supplies labor inelastically, and invests in firm equity as well as corporate and government debt instruments. The firm produces final goods and invests in capital and in two types of labor (via labor search markets) in order to maximize shareholder value.

Households

There is a unit mass of identical households. 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,

$$\mathbb{V}_t = \max \left[(1-\beta)C_t^{1-1/\psi} + \beta(\mathbb{E}_t \mathbb{V}_{t+1}^{1-\gamma_t})^{\frac{1-1/\psi}{1-\gamma_t}}\right]^{\frac{1}{1-1/\psi}}, \tag{22}$$

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

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

In the above, Q^c_t is the price of a multi-period corporate bond, R_t is the one-period safe real interest rate, P^e_t is the price of a share of the representative firm 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. We model corporate bonds following Gourio (2012), and assume they repay a constant fraction $1-d$ of the principal each period. These bonds are only needed to create an empirically relevant amount of financial leverage in firms, since we will eventually match the average equity risk premium in the data. Government bonds are in zero net supply, and serve to define the safe real rate.

The Epstein-Zin preferences in equation (22) give the stochastic discount factor:

$$M_{t,t+1} \equiv \left(\frac{\partial \mathbb{V}_t / \partial C_{t+1}}{\partial \mathbb{V}_t / \partial C_t}\right) = \beta \left(\frac{C_{t+1}}{C_t}\right)^{1-1/\psi} \left(\frac{C_t}{C_{t+1}}\right) \left(\frac{\mathbb{V}_{t+1}}{(\mathbb{E}_t \mathbb{V}_{t+1}^{1-\gamma_t})^{\frac{1}{1-\gamma_t}}}\right)^{1/\psi-\gamma_t}. \tag{23}$$

In parallel with the analytical model, we are interested in shocks to risk aversion, so γ_t is allowed to vary exogenously over time.

Labor markets are subject to search and matching frictions. We assume that total labor supplied by the representative household is fixed, but model an optimal choice between search in either of two labor markets, full-time or part-time. Full-time positions involve longer-term relationships and sticky wages, $W_{f,t}$, while part-time labor involves shorter employment spells and flexible wages, $W_{p,t}$. Both of these features – the difference in duration and wage rigidity – are consistent with micro data as we discuss below.

Household labor search works as follows. At the end of each period, call it $t-1$, employed workers separate from their previous job with probability $(1-\rho_f)$ or $(1-\rho_p)$, depending on which sector they were employed.[7] Normalizing total labor supply to unity, this leaves a mass of $1-(1-\rho_f)N_{f,t-1}-(1-\rho_p)N_{p,t-1}$ not-employed workers who must choose which market to search in. The household allocates the search effort of these potential workers to whichever market brings a higher contribution to household utility, dividing the available search effort according to

$$\tilde{S}_{f,t}+S_{p,t}=1-(1-\rho_f)N_{f,t-1}-(1-\rho_p)N_{p,t-1}. \tag{24}$$

In addition to the search effort from non-employed workers, we assume that workers in the part-time sector who do not experience an exogenous separation have the opportunity to do "on-the-job" search in the full-time sector. Hence, total search effort in the full-time sector is given by $S_{f,t}=\tilde{S}_{f,t}+(1-\rho_p)N_{p,t-1}$. This assumption captures the empirical fact that workers often transition from part-time to full-time employment without passing through a spell of unemployment.

Let $\mathbb{S}_{i,t}$, $i\in\{f,p\}$, be the utility of providing a unit of search effort in market i. If search effort is to be positive in both markets, the household must be indifferent between searching in either market, so that in each period

$$\mathbb{S}_{f,t}=\mathbb{S}_{p,t}. \tag{25}$$

We provide explicit derivations of the $\mathbb{S}_{i,t}$ in Appendix C.3.

Workers who find no employment in either market are unemployed, and receive a benefit b_t that corresponds to monetary unemployment benefits as well any other time-use benefits they might accrue from not working. Workers employed in the part-time sector receive a wage as well as a flow κ_t that corresponds to the benefits (e.g., of home production) from the additional time made available by only working part-time. Both b_t and κ_t are time-varying only because they are cointegrated with the stochastic trend in

[7] There is some counter-cyclicality in the rate of layoffs but quit rates are procyclical. Together, total separation rates seem to be fairly acyclical, which is why we model them as constant.

our economy. Aggregate household earnings are given by:

$$E_t^l = W_{f,t}N_{f,t} + (W_{p,t} + \kappa_t)N_{p,t} + b_t(1 - N_{f,t} - N_{p,t}). \tag{26}$$

Firms

The representative firm has cash flows,

$$D_t = Y_t - W_{f,t}N_{f,t} - W_{p,t}N_{p,t} - I_t - \varphi_{f,t}V_{f,t} - \varphi_{p,t}V_{p,t}. \tag{27}$$

It maximizes profits by choosing employment for the two types of contracts, $N_{f,t}$ and $N_{p,t}$, the two types of vacancies, $V_{f,t}$ and $V_{p,t}$, physical capital, K_{t+1}, and investment, I_t. The variables $W_{i,t}$ and $\varphi_{i,t}$ denote the real wage and the vacancy posting cost for the labor contract of type $i \in \{f, p\}$, all of which the firm takes as given.

The firm's objective is to maximize

$$\tilde{P}_t^e \equiv \mathbb{E}_t \sum_{s=0}^{\infty} M_{t,t+s}D_{t+s}, \tag{28}$$

subject to a production function with labor-augmenting technology Z_t

$$Y_t \leq K_t^{\alpha}(Z_tN_t)^{1-\alpha}, \tag{29}$$

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

$$N_t = \left((1 - \Omega)N_{f,t}^{\frac{\theta-1}{\theta}} + \Omega N_{p,t}^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}}, \tag{30}$$

a capital accumulation equation with quadratic capital adjustment costs,

$$K_{t+1} = \left(1 - \delta - \frac{\phi_K}{2}\left(\frac{I_t}{K_t} - \delta\right)^2\right)K_t + I_t, \tag{31}$$

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

$$N_{f,t} = (1 - \rho_f)N_{f,t-1} + \Theta_{f,t}V_{f,t}, \tag{32}$$

$$N_{p,t} = (1 - \rho_{p,t})N_{p,t-1} + \Theta_{p,t}V_{p,t}, \tag{33}$$

where $\Theta_{i,t}$ is the probability of filling a type-i vacancy and again $\rho_{p,t} \equiv \rho_p + (1-\rho_p)P_{f,t}$ takes into account part-timers that experience a job-to-job transition from a part-time position to a full-time position. Equations (32)-(33) imply that workers engage in production as soon as they are hired. We adopt this timing assumption following Christiano et al. (2016) because a period in our model corresponds to one quarter and it would be implausible to assume a whole quarter of 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. As in Gourio (2012), this financing occurs with multi-period riskless bonds. Firm debt evolves according to $B^c_{t+1} = dB^c_t + L_t$, 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 $\frac{1}{1-d}$ quarters. The net amount of new borrowing each period, $Q^c_t L_t = \xi K_{t+1}$, 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 $B^c/K = \xi/(1-d) \equiv \nu$. This is a parameter we will estimate. The price of the multi-period bond (Q^c_t) is determined by the pricing equation

$$Q^c_t = \mathbb{E}_t \left[M_{t,t+1}(dQ^c_{t+1} + 1) \right]. \tag{34}$$

Total firm cash flows are divided between payments to bond holders and equity holders according to: $D^E_t = D_t - B^c_t + \xi K_{t+1}$.

Since the Modigliani and Miller (1958) theorem holds in our model, 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.

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.

The initial value of the wages in both sectors are the Nash-bargained wages that would emerge in a non-stochastic steady-state with $Z = 1$. Denoting with η_f and η_p the bargaining power of full-time and part-time workers, Nash bargaining implies:

$$\mathbb{W}_i - \mathbb{U} = \frac{\eta_i}{1-\eta_i} \frac{\varphi_i}{\Theta_i}. \tag{35}$$

Here, $\mathbb{W}_i - \mathbb{U}$ represents the value of a match to the worker net of the value of unemployment. Nash bargaining implies that this is proportional to the value of the match to the firm. Given free entry, the latter equals the expected cost of filling a vacancy, $\frac{\varphi_i}{\Theta_i}$, where Θ_i is the job-filling probability. We provide additional details in Appendix C.3.

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 (detailed below). The wage in the part-time sector is flexibly Nash-bargained. These assumptions qualitatively match the observation of Lariau (2017) that part-time positions have more flexible wages than full-time positions. Moreover, both Lariau (2017) and Borowczyk-Martins and Lalé (2021) document that part-time positions have separation rates that are eight times higher than full-time positions, implying that $\rho_p > \rho_f$.

Government

The government finances an exogenous stream of expenditures that slowly adjusts to the productivity level of the economy. The initial value of the government expenditure in a non-stochastic steady-state with $Z = 1$ is

$$G = \bar{g}Y. \tag{36}$$

The government finances a balanced budget via lump sum taxes, and as a result government bonds are always 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:

$$N_{f,t} = (1 - \rho_f)N_{f,t-1} + \mathcal{M}_{f,t}, \tag{37}$$

$$N_{p,t} = (1 - \rho_{p,t})N_{p,t-1} + \mathcal{M}_{p,t}, \tag{38}$$

where $\mathcal{M}_{f,t}$ and $\mathcal{M}_{p,t}$ are the matches from the Cobb-Douglas matching functions of the full-time and part-time sectors, respectively. These matching functions are given by

$$\mathcal{M}_{i,t} = \chi_i V_i^{\epsilon_i} S_i^{1-\epsilon_i}, \tag{39}$$

for $i \in \{f, p\}$. The corresponding job-finding and vacancy-filling probabilities as a function of labor market tightness $\theta_{i,t} = \frac{V_{i,t}}{S_{i,t}}$ are respectively: $P^m_{i,t} = \chi_i \theta_{i,t}^{\epsilon_i}$ and $\Theta_{i,t} = \chi_i \theta_{i,t}^{\epsilon_i - 1}$.

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

$$Y_t = C_t + I_t + \varphi_{f,t}V_{f,t} + \varphi_{p,t}V_{p,t} + G_t. \tag{40}$$

In order to ensure our model satisfies the national accounting identity, we follow den Haan and Kaltenbrunner (2009) by including job posting costs in defining our model analogue to measured investment, i.e., $\tilde{I}_t \equiv I_t + \varphi_{f,t}V_{f,t} + \varphi_{p,t}V_{p,t}$.

Exogenous Processes

The economy is perturbed by two disturbances. Technology, Z_t, follows a random walk, consistent with the utilization-adjusted U.S. TFP data of Fernald (2014), while risk aversion, γ_t, follows an AR(1) process in logs:

$$\log(Z_t) = \log(Z_{t-1}) + \sigma_z \epsilon_t^z \tag{41}$$

$$\log(\gamma_t/\gamma_{ss}) = \rho_\gamma \log(\gamma_{t-1}/\gamma_{ss}) + \sigma_\gamma \epsilon_t^\gamma. \tag{42}$$

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 $X \in \{\varphi_{f,t}, \varphi_{p,t}, \kappa_t, b_t, W_{f,t}, G_t\}$, we assume that $X_t = \Gamma_t \bar{X}$ where $\bar{X}$ is the deterministic steady-state value, and $\Gamma_{t+1} = \Gamma_t^\omega Z_t^{1-\omega}$. 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.

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

$$W_{f,t} = \left(\frac{Z_{t-1}}{\Gamma_{t-1}}\right)^{1-\omega} W_{f,t-1}. \tag{43}$$

Thus, the full-time wage only partially adjusts for the change in productivity, to the extent that $\omega > 0$.

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 counterfactual path in which a single one-standard deviation shock to γ_t is realized. We present the full set of conditions that describe the equilibrium in Appendix C.

Table 1: Calibrated Parameters

Name	Description	Value
β	Discount rate	0.994
ϕ_k	Capital Adj. Cost	10.000
ψ	Intertemporal elasticity of substitution	2.500
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_f	Separation Rate - full-time	0.042
ρ_p	Separation Rate - part-time	0.335
η_f	HH's bargaining power - full-time	0.500
η_p	HH's bargaining power - part-time	0.500
	Exogenous Processes	
σ_z	Std. dev. of tech shock	0.008

4.2 Calibrated Parameters and Steady-State Targets

To begin, we calibrate a set of standard parameters to values that are consistent with the literature and summarized in Table 1. We set $\beta = 0.994$ as in Basu and Bundick (2017). We fix the depreciation rate to $\delta = 0.025$ and the capital share parameter to $\alpha = 0.3$. Because the estimated model includes risk, this will imply an unconditional capital income share that is slightly less than 0.3. We fix the long-run share of government expenditures to GDP to 20% and the bond duration parameter $d = 0.975$ as in Gourio (2012), which implies corporate debt has a 10-year maturity.

Estimates of capital adjustment costs vary considerably in the literature, and range from values around 2 in macro contexts (e.g., Basu and Bundick, 2017) to values of 18 or higher in micro studies (e.g., Galeotti and Schiantarelli, 1991). We set our adjustment cost parameter $\phi_k = 10$. This value lies in the middle of this range and is in line with the value obtained by Belo et al. (2022), which estimates neoclassical investment models on a rich dataset of market value data of U.S. publicly-traded firms.

We set the elasticity of intertemporal substitution to $\psi = 2.5$, which is in line with the macro-finance practice of picking IES higher than one (Schorfheide et al., 2018). This value is relatively high compared to the macro literature that focuses on quantities only, but overall the quantitative fit of the model does not rely on any particular restriction on ψ. To illustrate this, in Appendix F we reestimate the model assuming $\psi = 0.5$, and find that the overall difference in fit with our benchmark is modest.

We calibrate the separation rates of full-time and part-time workers, ρ_f and ρ_p, to satisfy two features of the data. First, we fix $\rho_p/\rho_f = 8$, 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 (CPS) (Lariau, 2017; Borowczyk-Martins and Lalé, 2021). Second, we fix the level of separations in the full-time sector (ρ_f) so that the average separation rate across both labor sectors equals the aggregate quarterly rate in the U.S. economy of 10% (Yashiv, 2008). We also fix the Nash bargaining parameters to $\eta_f = \eta_p = 0.5$, the midpoint of empirical estimates (e.g., Flinn, 2006) but have found that alternative choices for these parameters make very little difference.

Finally, we use the Basu et al. (2006) utilization adjustments to U.S. TFP, as implemented in quarterly data by Fernald (2014), to calibrate the process for productivity. Over our sample period, productivity is an almost perfect random walk with standard deviation in growth rates of $\sigma_z = 0.008$.

The remaining parameters are estimated by matching the impulse responses in the model to a risk-aversion shock ϵ_t^γ to the empirical responses from Section 2.1 along with the eight additional unconditional moments reported in Table 2. Our approach is to place extremely high weight on the unconditional moment targets in the estimation procedure to force the model to match the unconditional moments perfectly, and then see how the model does in terms of conditional dynamics.

Among these unconditional moments, 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 targeted average vacancy rate of 3.5% comes from the full-sample average of the JOLTS dataset (which starts in 2000). In line with Blanchard and Galí (2010), we target a ratio of hiring costs to GDP is 1%.

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 it successfully matches both of these moments, our model is not subject to the Shimer critique – this is because in our model the risk aversion shocks generate large fluctuations in employment and vacancies.

Finally, we target a ratio of part-time to full-time earnings of 0.375. We arrive at this ratio by assuming that part-time workers work one-half the number of hours of full-time workers (in line with CPS averages), and earn an hourly wage that is 25% lower than similar full-time workers ($0.375 = 0.5 \times 0.75$), in line with studies on this wage penalty

Table 2: Unconditional Target Moments

Description	**Data**	**Model**
Equity risk premium	0.054	0.054
Share of part-time	0.198	0.197
LR unemployment	0.059	0.059
Vancancy Rate	0.035	0.035
Hiring cost/GDP	0.010	0.010
Part-time earn./Full-time earn.	0.375	0.374
Std. HP log(Emp/Pop)	0.013	0.013
Std. HP log(vacan.)	0.138	0.138

(Aaronson and French, 2004; Bick et al., 2022).[8] Our results change very little if we make substantially different assumptions about the part-time wage penalty.

4.3 Estimation Procedure

Aside from the long-run targets in Table 2, our impulse response matching exercise is standard. We target the impulse responses of output, consumption, investment, total employment, part-time employment, equity returns, and the real interest rate estimated using "Method 1" for controlling for the effects of supply shocks. The set of estimated parameters, denoted by Π, includes the steady-state risk aversion parameter γ, the aggregate leverage ratio ν, the vacancy posting costs, φ_f and φ_p, the value of outside options κ and b, the production share of part-time labor Ω, the elasticity of substitution between the two types of labor θ, the four parameters governing the aggregate matching technologies, the cointegration parameter ω, and the parameters of the risk aversion shock, ρ_γ and σ_γ.

Let $\hat{\Psi}$ denote the column vector stacking point estimates of each impulse response at each horizon along with our unconditional target moments and let $\Psi(\Pi)$ denote the corresponding theoretical responses and moments. The estimated parameter vector is

$$\hat{\Pi} \equiv \arg\min_{\Pi}(\hat{\Psi} - \Psi(\Pi))' W (\hat{\Psi} - \Psi(\Pi)). \tag{44}$$

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 8 unconditional targets, we are essentially targeting $7 \times 30 = 210$ impulse response moments with just 7 degrees of freedom.

[8]See also: https://www.epi.org/publication/part-time-pay-penalty.

Table 3: Estimated Parameters

Name	Description	Point Est.	Std Err.
γ_{ss}	Steady-state risk aversion	34.726	5.598
ν	Leverage Ratio	0.748	0.023
	Labor Markets		
φ_f	Vacancy posting cost - full-time	1.145	0.132
φ_p	Vacancy posting cost - part-time	0.155	0.023
κ	Value if no perm posit.	1.189	0.013
b	Value if unemployed	0.709	0.012
Ω	Labor contrib. of part-time	0.230	0.006
θ	Elas. between full- & part-time	5.943	0.896
ϵ_f	Matching elasticity - full-time	0.411	0.030
ϵ_p	Matching elasticity - part-time	0.025	0.034
χ_f	Matching technology - full-time	0.454	0.039
χ_p	Matching technology - part-time	2.462	0.368
ω	Gradual wage adj.	0.977	0.004
	Risk Aversion Process		
ρ_γ	AR(1) risk av. shock	0.935	0.022
σ_γ	Std. dev. of risk av. shock	0.424	0.090

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

4.4 Estimation Results and Model Fit

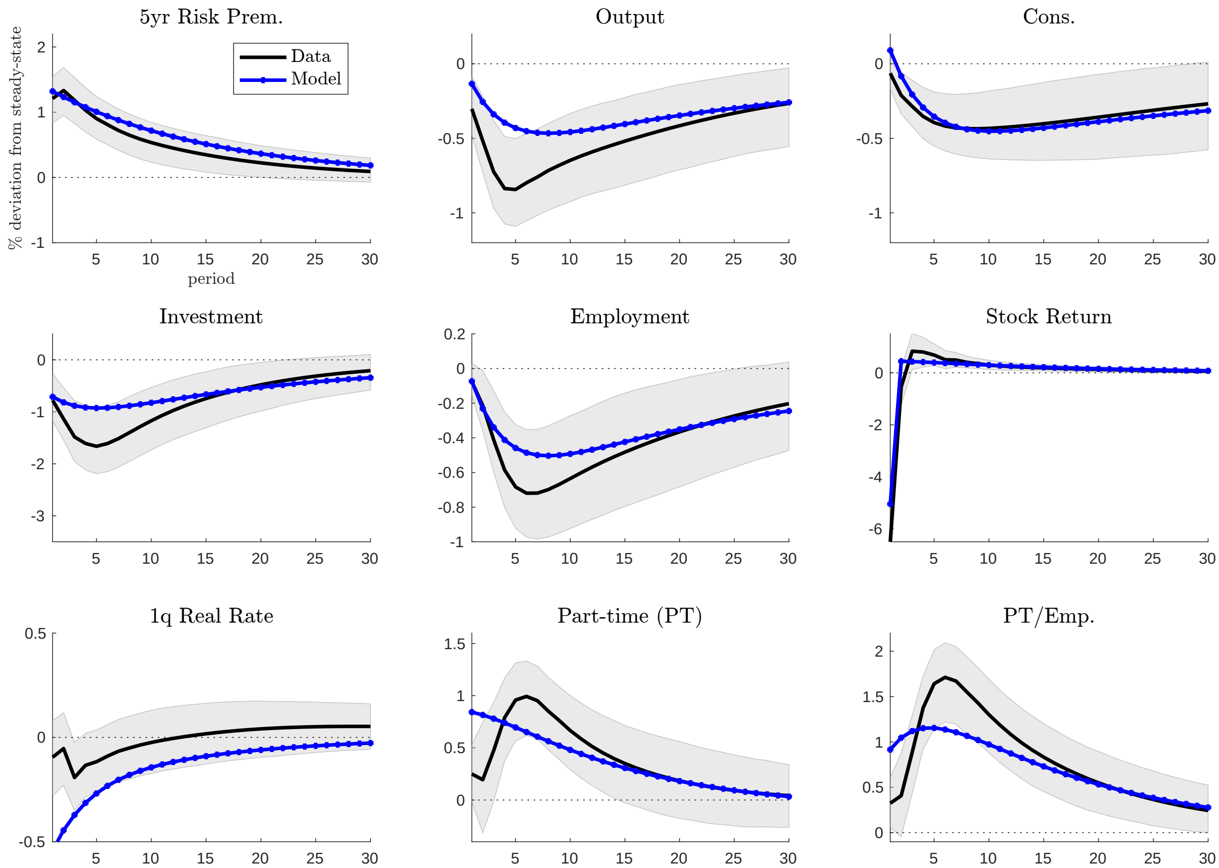
The estimation procedure searches for a global optimum, and Table 3 reports the estimated parameters $\widehat{\Pi}$ along with their corresponding standard errors.[9]

Our estimate of $\gamma \approx 34.7$ is 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). That this estimate remains "high" relative to microeconomic estimates of risk aversion is a manifestation of the well-known "equity premium" puzzle, the resolution of which remains debated.[10] Like the papers cited above, we seek to match the observed risk-premium without taking a strong stand on this debate.

The labor market parameters that can be compared to the literature are those of the full-time sector. Our estimates imply a replacement ratio, measured as unemployment

[9] We impose wide parameter bounds on the search space, and only ϵ_p obtains a (lower) bound.

[10] Potential solutions include habit formation (Campbell and Cochrane, 1999), long-run risk (Bansal and Yaron, 2004), rare disasters (Barro, 2006), or parameter/model uncertainty (Weitzman, 2007; Barillas et al., 2009).



Note: vertical axis in annualized percentage points for the risk premium, stock return, and 1-quarter real rate; all other numbers are in percentage deviations.

Figure 5: Impulse responses to VAR-identified risk premium shock along with model-implied responses.

surplus flow divided the by full-time wage, of 0.89. This value is somewhat higher than in calibrations intended to capture only the narrow monetary size of unemployment benefits but is lower than in Hagedorn and Manovskii (2008) who argue that this parameter should also reflect disutility of providing labor. The elasticities of full-time matches with respect to searchers is 0.41, close to Gertler and Trigari (2009) and near the midpoint of the values used in the literature.

Moving to the main results, Figure 5 shows that the impulse responses implied by the estimated model (blue-dotted lines) match the data quite well, including the aggregate comovement patterns that traditionally define the business cycle. On the macroeconomic side, the changes in output, consumption and employment track the data quite closely. Investment and output undershoot modestly, but the model-implied responses are substantial and remain for the most part within the standard error bands of the VAR.

The estimated model also captures two central conditional features of asset prices.

Table 4: Unconditional and Asset Pricing Moments

Real Variables			Asset Prices		
Moment	**Model**	**Data**	**Moment**	**Model**	**Data**
Std(Y)	1.53	1.49	$E[r_t^b]$	1.78	1.53
Std(C)	1.28	0.82	Std(r_t^b)	1.38	2.54
Std(I)	2.87	3.18	$E[rp_{t,t+1}^1]$	5.40	5.40
Std(N)	1.31	1.31	Std($rp_{t,t+1}^1$)	28.27	33.41
Std(N_1/N)	1.74	2.21	Ann. Sharpe Ratio	0.38	0.33

Note: Unconditional model moments based on a single simuluation of 5000 periods. Data moments based on data from our empirical sample period. All real variables are logged and then HP-filtered with a penalty parameter $\lambda = 1600$. Asset pricing moments are annualized percentages (i.e., quarterly percentages multiplied by 4) and are not filtered. Standard deviations are in percent. Sharpe ratio is for annualized equity returns.

First, the model closely matches the persistent increase in the 5-year equity risk premium. Second, it matches the steep fall in stock returns on impact and the subsequent long period of above-average returns. Thus, the model generates variation in asset prices primarily due to changes in expected excess returns, and not changes in cash-flows, as in the data.[11]

To further assess the external validity of our estimated model, we ask how well it reproduces some *untargeted* macroeconomic and asset pricing moments. The left panel of Table 4 shows that our model matches the unconditional volatility of output, investment, employment and the part-time employment share. The model slightly overpredicts the volatility of consumption but still implies that consumption is less volatile than output.

The right panel of the table shows that the model also succeeds in replicating several untargeted unconditional asset pricing moments. Our model predicts an unconditionally low and stable risk-free rate in line with the data. Besides reproducing the unconditional levels of risk premia that we targeted in estimation, our model also implies realistic unconditional variability of excess returns, which was not targeted. Indeed, the model's unconditional standard deviation of the (annualized) 1-quarter risk premium of 28.3% is quite close to the empirical counterpart of 33.4%. Moreover, the annualized Sharpe (1994) ratio, calculated using quarterly returns as $SR = \frac{E[log(R_{t+1}^E/R_t^b)]}{std\left[log(R_{t+1}^E/R_t^b)\right]}$, implied by our model is 0.38, which is quite close to the empirical value of 0.33 in our sample.

4.5 The Flight-to-Safety Channel in the Quantitative Model

Our analytical results in Section 3 show why reallocation between different savings vehicles with different average returns is central for achieving macroeconomic comovement.

[11]Moreover, Figure D.1 in Appendix D reports the IRF of the safe-discounted value of profits for the model and data together, and shows the model matches the very small effect on profits found in the data.

Table 5: Reallocation effects on C and Y

	Between N_f & N_p	**Between N & I**	**Total savings**	**Equilibrium**
Consumption	-0.75	-1.16	0.90	-1.00
Output	-0.33	-0.52	-0.15	-1.00

Note: Contribution of each channel, as share of equilibrium consumption/output change. Consumption responses cumulated over 12 quarters, without discounting. Negative numbers reflect decreasing cumulated consumption. Each column reflects the marginal contribution, beyond previous channels, so that the first three columns sum to minus one.

Meanwhile, our quantitative model features two potential types of reallocations: first, firms reallocate between hiring in the two different types of labor used in generating the aggregate labor input; second, firms reallocate between hiring labor as a whole and capital investment. The goal of this section is to provide a quantitative perspective on how important these different reallocation channels are in our estimated model.

Isolating the reallocation channels

To isolate the impact of reallocation, we use the model resource constraints to perform a counterfactual decomposition of the channels behind the equilibrium fluctuations in C_t and Y_t. We start by observing that we can write the total amount of investment or savings in the economy as

$$H_t \equiv I_t + \varphi_{f,t} V_{f,t} + \varphi_{p,t} V_{p,t} \equiv (\omega_{I,t} + \omega_{f,t} + \omega_{p,t}) H_t \tag{45}$$

where, for example, the variable $\omega_{I,t}$ captures the share of savings devoted to capital investment. In our first counterfactual experiment, we assume total savings H_t and capital investment I_t do not respond to shocks, allowing only the relative shares of investment in each type of labor to follow their equilibrium paths. We then trace the implications of this reallocation through the economy resource constraint (assuming that households allocate their labor search effort in the same proportions as they do in equilibrium). Consistent with our analytical model, this “labor reallocation only” experiment causes a substantial drop in both consumption and output. The first column of Table 5 summarizes this fall by cumulating the consumption response over three years following the shock; it shows that roughly 75% of the equilibrium consumption fall and about one-third of the fall in output over this time can be accounted for by the reallocation of labor.

In the next experiment, we also allow the share of capital investment relative to labor to follow its equilibrium path along with the adjustment between the investment in the two types of labor. (Hence, $\omega_{I,t}$, $\omega_{f,t}$, and $\omega_{p,t}$ follow their equilibrium paths, but total savings H_t does not move.) The table shows that allowing for both types of reallocation increases the consumption fall by an additional 116%, so that the two types of reallocation together, holding overall savings fixed, account for almost two times the aggregate fall in consumption. These two reallocations together also contribute substantially to the fall in output, totalling 85% of its equilibrium response.

Finally, the third column of the table shows that the adjustment of total savings, H_t, contributes an *increase* in consumption equal to 90% of the equilibrium consumption fall. At the same time, the fall in total savings reduces the inputs available for production, contributing about 15% to the total fall in output. This result emphasizes our analytical intuition: fluctuations in overall savings tend to push consumption and output in opposite directions, making comovement more difficult to achieve in the model. Without a reallocation between savings vehicles with different marginal products, our model would not be able to generate comovement and match the patterns in the data.

Risk Premia Decomposition

What is the quantitative importance of the different savings channels for risk premia in our model? To answer this question, we first compute the risky component of the return for each of the three savings vehicles in the economy. Beginning with physical capital:

$$R^K_{t+1} \equiv \frac{MPK_{t+1} + q_{t+1}\left(1 - \delta - adj.costs\right)}{q_t},$$

The return on investment in physical capital is entirely risky because capital becomes productive in the following period. Therefore, the risky return to capital reflects the net cash flow of a capital unit, equal to its marginal product (MPK_{t+1}) plus the change in the market price net of depreciation and adjustment costs.

By contrast, labor is productive immediately so its initial period payoffs are known to the firm. The risky component of the labor return to the firm is:

$$R^L_{i,t+1} = \frac{(1-\rho_{i,t+1})[MPL_{i,t+1} - W_{i,t+1} + \tilde{J}_{i,t+1}]}{\tilde{J}_{i,t}}.$$

In this expression, $MPL_{i,t+1} - W_{i,t+1}$ is tomorrow's cash flows, $\rho_{i,t+1}$ takes into account the worker's separation risk, and $\tilde{J}_{i,t} \equiv \frac{\varphi_{i,t}}{\Theta_{i,t}} - (MPL_{i,t} - W_{i,t})$ prices the value of the worker to the firm, $\frac{\varphi_{i,t}}{\Theta_{i,t}}$, net of the current-period cash flow, $MPL_{i,t} - W_{i,t}$. With these elements in place, Proposition 3 decomposes the firm value and the unlevered equity risk

Table 6: Disaggregated Risk Premia

	Risk Premium	**Firm Value Share**	**Equity Premium Share**
Full-time premium	15.51	0.03	0.47
Part-time premium	0.61	0.00	0.00
Capital premium	0.55	0.97	0.53

Note: Risk premium column based on unlevered equity premium, expressed as annualized percentages. Shares of firm value are based on the non-stochastic steady state of the model. Shares of equity premium $\left(\frac{\mathbb{E}[s_{k,t}RP^K_{t+1}]}{\mathbb{E}[RP^E_{t+1}]}, \frac{\mathbb{E}[s_{n1,t}RP^L_{1,t+1}]}{\mathbb{E}[RP^E_{t+1}]}, \text{ and } \frac{\mathbb{E}[s_{n2,t}RP^L_{2,t+1}]}{\mathbb{E}[RP^E_{t+1}]}\right)$ are based on unlevered equity value, for which the accounting decomposition in the proposition holds exactly. All moments involving risk-premia are computed using the stochastic steady state of the model.

premium into the sum of share-weighted risk premia to the three factors of production.

Proposition 3. *The ex-dividend firm value, $P^e_t \equiv \tilde{P}^e_t - D_t$, is given by:*

$$P^e_t = q_t K_{t+1} + \tilde{J}_{f,t} N_{f,t} + \tilde{J}_{p,t} N_{p,t}. \tag{46}$$

The unlevered return to equity $R^E_{t+1} \equiv \frac{P^e_{t+1} + D_{t+1}}{P^e_t}$ can be expressed as:

$$R^E_{t+1} = s_{k,t} R^K_{t+1} + s_{f,t} R^L_{f,t+1} + s_{p,t} R^L_{p,t+1}, \tag{47}$$

with $s_{k,t} = \frac{q_t K_{t+1}}{q_t K_{t+1} + \tilde{J}_{f,t} N_{f,t} + \tilde{J}_{p,t} N_{p,t}}$, $s_{f,t}$ and $s_{p,t}$ similarly defined, and $s_{k,t} + s_{f,t} + s_{p,t} = 1$.

Proof. See Appendix C.5. □

In Table 6 we report the risk premium, the share of firm value, and the share of the equity premium attributable to each input. Our estimation implies an average full-time labor premium of around 15.5% and a part-time premium of 0.61%. This reflects the features of part-time jobs that make them safer investments: flexible wages and shorter duration. Physical capital is the safest investment vehicle for firms, with an estimated risk premium of 0.55%.

The value decomposition shows that firms derive most of their *value* from capital: 97% of it in our estimated model. Despite this high share in firm value, the share of the unlevered equity *risk premium* attributable to capital is 53% while the share attributable to full-time labor is 47%.[12] This is a consequence of the fact that, in our estimated model, full-time labor is considerably more risky than capital despite its modest contribution to firm value. The contribution of part-time labor to firm value and the equity risk premium are negligible.

[12]Recall that our model matches the levered equity premium we observe in the data.

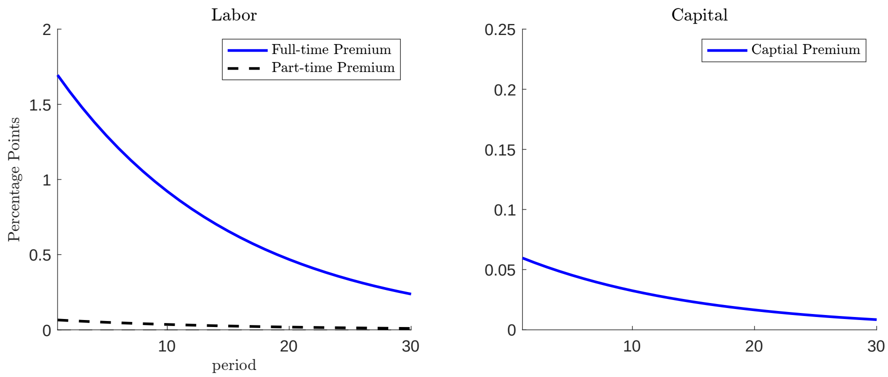


Figure 6: Impulse responses of risk premia in the model following a risk appetite shock.

While direct empirical counterparts of these objects do not exist, the recent literature has found that "installed" labor is an important priced component of the value of U.S. publicly traded firms (Belo et al., 2022). The literature also finds that cross-sectional risk premia are higher for firms with more rigid wages (Favilukis and Lin, 2016, Donangelo et al., 2019) and higher labor adjustment frictions (Belo et al., 2014, Kuehn et al., 2017). All of these observations are qualitatively consistent with our model.

The return differences in Table 6 also correspond to differences in marginal products per dollar invested, which are reflected in the real effects of the flight-to-safety reallocation mechanism. Upon an increase in risk aversion the full-time labor risk premium rises more than the risk premium on both physical capital and part-time labor (see Figure 6). The consequence is twofold and follows the logic illustrated by the analytical model. First, firms shift their labor demand (i.e. vacancy postings) away from the risky full-time labor and toward safer part-time labor. The higher average risk premium of full time labor also manifests in its higher marginal product, hence this reallocation lowers output and consumption. Second, the fall in full-time labor is greater than the rise in part-time labor demand, mirroring the bigger rise in the full-time risk premium, hence aggregate labor N_t falls. In turn, this lowers the marginal product of capital and through the complementarity in the production function also leads to lower equilibrium physical investment I_t. As a result, all four main macro aggregates fall (Figure 5), without a change in technology.

Implications for measured TFP

The reallocation from full-time to part-time labor also has implications for measured TFP because the empirical measurement of productivity may not properly capture the heterogeneity between these two types of labor.

As shown in Appendix G, there are different ways of measuring TFP depending on the

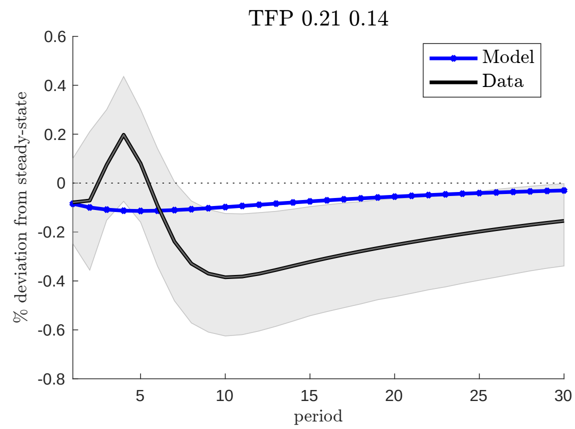


Figure 7: Model and data responses of measured TFP.

data available to the econometrician. The baseline case we analyze there is one where the econometrician does not separately observe full time and part-time labor and works with total employment.[13] In that case, our model implies the following change in *measured TFP* following a risk aversion shock

$$\Delta \log(\tilde{Z}_t^e) = (1-\alpha)\Delta \log(N_t) - \omega_N \Delta \log(N_{f,t} + N_{p,t}).$$

Above, ω_N is the labor share, N_t is the actual CES aggregate of full-time and part-time labor in the production function (eq. (30)), and $(N_{f,t} + N_{p,t})$ is total employment.

Figure 7 shows the impulse response of measured TFP in the model against the response of TFP in our baseline treatment of the data. In the model, TFP falls by about 0.1% at the trough, which corresponds to approximately 30% of the trough in output. Because measured TFP takes into account total employment but not how full-time and part-time workers affect output separately, shifting a worker from full-time to part-time changes output (and actual labor aggregate N_t), but not the total number of employed workers $(N_{f,t} + N_{p,t})$. Thus, the resulting change in output is interpreted as a shift in measured TFP.

The Figure also shows that empirical TFP falls by more than implied by our quantitative model, but still the model's response remains within the confidence bands of the data at almost all horizons. A possible reason for the discrepancy is that we model only one source of heterogeneity in input riskiness whereas also other dimensions of het-

[13]We consider TFP measurement based on total employment, and not hours, because our model abstracts from the intensive margin of labor and it is the number of employed agents (in full-time and part-time jobs) that enter the production function. In the Appendix, however, we also present the case of using total hours and results are unchanged.

erogeneity may underlie the empirical decline in TFP. For example, different types of capital (e.g., structures vs. software) have different depreciation rates and therefore will face different risk premia. Risk-driven changes in capital allocation shares from high-marginal-product to low-marginal-product capital types would lead to falling measured TFP for the same reasons that labor heterogeneity does in our model.

Role of Sticky Wages

In our model, sticky wages play a role that is complementary to, but distinct from, their role in most prior literature. To see this, consider the value of a type-i labor match for a firm:

$$J_{i,t} = MPL_{i,t} - W_{i,t} + (1-\rho_i)\mathbb{E}_t\left\{M_{t,t+1}J_{i,t+1}\right\}. \tag{48}$$

Equation (48) states that the value of a match is equal to the firm's cash flows, 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 equation forward, we can rewrite the value of a match as:

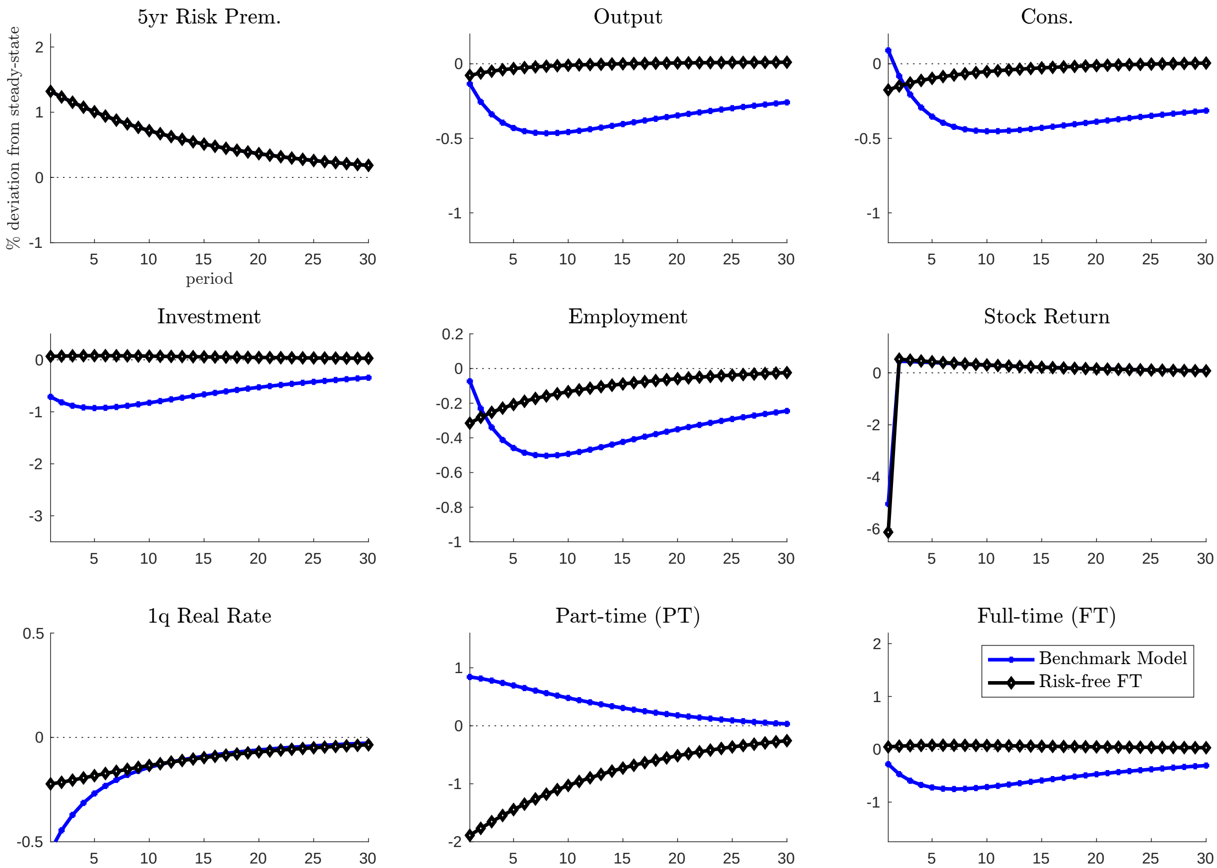
$$J_{i,t} = \underbrace{\sum_{j=0}^{\infty}\frac{(1-\rho_i)^j\mathbb{E}_t(MPL_{i,t+j}-W_{i,t+j})}{R_{t,t+j}}}_{\text{cash flows}} + \underbrace{\sum_{j=1}^{\infty}(1-\rho_i)^j Cov_t\left(M_{t,t+j}, MPL_{i,t+j}-W_{i,t+j}\right)}_{\text{risk premium}}, \tag{49}$$

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 (49) expresses the value of a match as the sum of two terms. The first is the present value of firms' cash flows, discounted with the risk-free rate $R_{t,t+j} = \mathbb{E}_t[M_{t,t+j}]^{-1}$. The second is a risk adjustment. Labor matches for which firms' cash flows covary more negatively with the stochastic discount factor carry higher risk premia.

In the prior literature, (e.g., Hall, 2005) sticky wages serve to drive fluctuations in the expected cash flows associated with hiring (the first term above). In our model, the main role of sticky wages is rather to amplify the risk premium of full-time labor, by magnifying the negative covariance between the firm's cash flows and the stochastic discount factor (the second term above).

To demonstrate the quantitative importance of this channel, Figure 8 shows the responses to a risk aversion shock in a counterfactual economy in which we keep the full-time wage sticky as estimated, but eliminate the risk-premium term from the firm's full-time vacancy posting condition (49). Thus, we let sticky wages serve the same purpose as in the prior literature (amplified expected cashflows variation), but shut-down the novel risk



Note: vertical axis in annualized percentage points for the risk premium, stock return, and 1-quarter real rate; all other numbers are in percentage deviations.

Figure 8: Model responses without risk premia.

premium channel we propose there. The figure shows that this counterfactual fails to reproduce the empirical patterns (with very small real effects on quantities), and qualitatively fails to generate comovement as consumption and investment move in opposite directions. This happens even though full-time wages remain sticky, which highlights that the strong effects on labor we find in our baseline model are indeed due to sticky wages increasing the risk premia of labor matches, and not due to the standard real rigidity mechanisms. Thus, our model offers a distinct resolution to the Shimer (2005) puzzle, as arising from labor's sensitivity to risk aversion shocks.

Lastly, while full-time wages in our model adjust slowly to shocks, the *earnings per worker* (i.e. the aggregate) wage can adjust along two additional dimensions. First, the wages of existing part-time workers are flexible and they fall in response to the shock. Second, the share of part-time workers grows in the model as a share of total employment: since those workers have lower earnings, this also reduces earnings per worker. Together, these channels imply that aggregate wages fall in the model when risk aversion rises.

Appendix figure D.1 plots the impulse response of earnings per worker both in the model and the data, and provides some additional discussion. While our assumptions about wages are a simplification, the overall implications for the aggregate earnings per worker are not strongly counterfactual.

Relationship to the literature on labor risk and macroeconomic fluctuations

We conclude this section with a discussion of the relationship between our findings and Di Tella and Hall (2021) and Kehoe et al. (2022). Like our own model, the models in these papers rely on labor returns being uncertain and thus subject to risk considerations in order to generate fluctuations in labor demand.[14] The key difference across all three papers is in the way the different mechanisms can and cannot generate macroeconomic comovement in equilibrium – that is, to obtain not just a fall in labor demand and N_t, but also a contemporaneous fall in C_t, I_t and Y_t.

Di Tella and Hall (2021) have a model in which higher *idiosyncratic risk* can lead to recessions with comovement between C_t, N_t, and I_t. In their theory, risk-averse entrepreneurs reduce their demand for factors of production and increase their savings demand when faced with higher uninsurable idiosyncratic risk. The first effect reduces demand for both labor and capital services, while the second increases the demand for aggregate capital holdings (as capital is the only store of value in their economy).

The key to the Di Tella and Hall (2021) mechanism is that idiosyncratic risk washes out in the aggregate: investing in the *aggregate* capital stock is safer for entrepreneurs than hiring capital for production. This distinction between aggregate and private capital means that demand for capital as a savings vehicle can increase even as demand for capital as a factor of production falls, generating offsetting effects on I_t in equilibrium. As such, calibrations exist where increases in idiosyncratic risk do not lead to a large fall in investment, even as the labor input falls by a large amount. Because investment does not fall by much, lower output is mirrored by lower consumption, avoiding the typical issue that falling investment pushes up consumption via the resource constraint (as described in our Proposition 1).

Our mechanism differs from that of Di Tella and Hall (2021) because it generates

[14] This is achieved via search frictions and durable employment relationships in our paper and in Kehoe et al. (2022), while Di Tella and Hall (2021) assume that labor is hired before shocks realize. In order to amplify the impact of risk on labor demand, both Di Tella and Hall (2021) and our paper consider wages that do not respond to the realization of productivity shocks (idiosyncratic productivity in their case, and aggregate productivity in ours). Kehoe et al. (2022) have flexible wages but amplify the effects of risk via human capital accumulation, which increases the effective duration of labor.

macroeconomic comovement via changes in the desired *composition* of firm investments, rather than fluctuations in the overall demand for savings. The key elements in our composition story are (i) treating hiring as a form of investment, like in Hall (2017), and (ii) assuming two different types of labor positions, one with flexible wages and one with rigid wages. These assumptions introduce multiple durable factors of production with varying risk characteristics. Consequently, an increase in risk alters the desired *composition* of investment. In contrast to Di Tella and Hall (2021), this mechanism works with fluctuations in *aggregate* risk or risk appetite and more generally can deliver macroeconomic comovement without requiring a particular response of desired savings.[15] Moreover, it can also explain additional facts, such as the patterns of higher aggregate risk premia and the shift toward part-time workers during recessions.

On the other hand, the goal of Kehoe et al. (2022) is to obtain large employment fluctuations and solve the Shimer puzzle rather than to generate macroeconomic comovement *conditional* on risk premia fluctuations. As such, they do not consider the characteristics of business cycles conditional on *only* fluctuations in risk and uncertainty. Rather, they have standard first-order productivity shocks that also generate risk premia fluctuations, and thus their results reflect a combination of first-moment and higher-moment shocks, like in Bloom et al. (2018). We conjecture that the Kehoe et al. (2022) model does not deliver comovement conditional on just fluctuations in risk aversion or uncertainty, because it is otherwise a standard model of fluctuations in the overall demand for savings and is thus subject to the intuition of Proposition 1.

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 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 puts risk premia and their effects on precautionary saving at the center of macroeconomic propagation. In this respect, our

[15] The Di Tella and Hall (2021) mechanism does not work with fluctuations in aggregate risk. The reason is that, in response to an increase in aggregate risk no wedge can emerge between the desire to save and the desire to employ risky capital as a factor of production. Without the offsetting increase in desired savings, investment unambiguously falls. This frees up additional resources for consumption, reintroducing the tension described in Proposition 1.

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, 2021), information frictions (Ilut and Saijo, 2021), and heterogeneous asset valuations (Caballero and Simsek, 2020). All of these features likely play a role in the world. 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 patterns likely 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 for which there is already intriguing empirical evidence (e.g., Eisfeldt and Rampini, 2006). Future research should continue to explore the business cycle consequences of these alternative applications of this mechanism.

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Online Appendix

A Empirical Appendix

A.1 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-

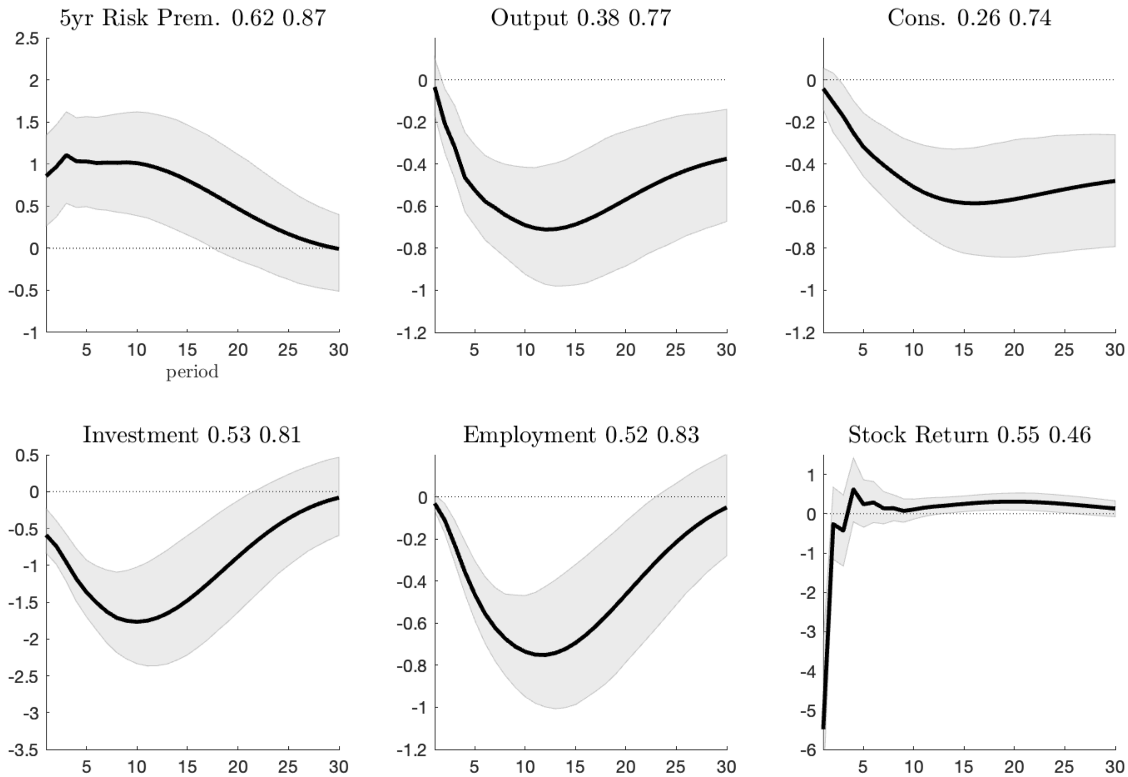

Figure A.1: VAR results based on the 1985 - 2018 sub-sample.

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 to 10-year treasury bonds (FRED code: BAA10YM). The short term rate is defined as the real log change in 3-month Treasury Bills index. The 5-year real bond yield is the real log change in 5-year Treasury Bond index.

A.2 Short-sample results

An earlier version of this paper was based on a shorter sample, starting in 1985Q1. Figure A.1 below shows our baseline VAR results, recomputed using that shorter sample. All results are qualitatively the same. The main difference is that the persistence of the increased risk premium is higher.

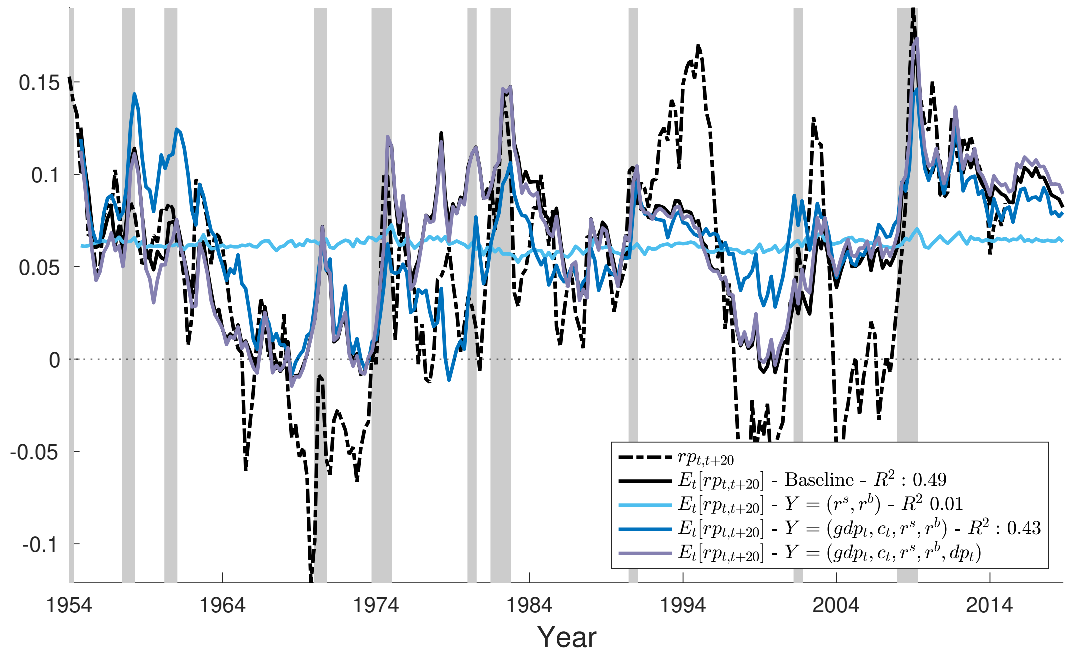

Figure A.2: Ex-post and Ex-ante excess stock returns from alternative VARs.

A.3 Excess Stock Return Predictability

In this section, we examine whether VAR-implied expected returns $\mathbb{E}_t(rp_{t+j})$ capture the underlying risk premium effectively, and examine the sources of this predictability. All of the following forecasting exercises are performed in-sample.

The dashed black line in Figure A.2 plots the expected excess stock return as estimated by our VAR, $\mathbb{E}_t(rp_{t,t+20})$, against the realized excess returns over that same forecasting horizon, $rp_{t,t+20}$. The Figure shows that both series exhibit substantial variation. While the ex-post series is more volatile, the VAR-based expectation of the excess returns tracks it reasonably well. The R^2 of regressing ex-post returns on our VAR forecast is 0.49, which is both significant and in line with the previous literature, which has found very similar levels of predictability in 5-year returns (e.g., Cochrane, 2011).

To understand which specific variables in Y_t are the main predictors our VAR relies on, we investigate 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 the smallest VAR that allows us to compute expected excess stock return: the VAR that contains only stock and T-bill returns, that is $Y_t = [r_t^s, r_t^b]$. In Figure A.2, we plot the forecasted excess return as estimated by this smaller 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 that explains only about one percent of the realized excess return.

We then sequentially expand the number of variables in the restricted VARs to include more variables from our original set. Doing this exercise in different permutations, we find that consumption and GDP are particularly important. While including GDP or consumption alone only marginally improves the prediction, the dark blue line in Figure A.2 shows that adding them jointly delivers a substantial improvement and raises the R^2 to 0.43, a result in the spirit of Campbell (1987), Cochrane (1994), Lettau and Ludvigson (2001), and Melone (2021). In this case, the VAR-implied expected return 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 also find that the third most important variable is the dividend-price ratio. Adding dp_t to the four-variable VAR with r_t^s, r_t^b, c_t and gdp_t further improves predictability and brings the R^2 to 0.46. While this bump in R^2 looks relatively modest, the actual VAR-forecast $\mathbb{E}_t(rp_{t+j})$ changes in important ways once we add dp_t. In Figure A.2, we can see that this 5-variable VAR's estimate of the conditional risk premium (purple line) is essentially identical to that of our baseline 7-variable VAR (black line). Adding dp_t is particularly helpful in offering a better return forecast in the late 90s and in the 60s-70s period, as we can see by comparing the dark blue and the purple lines in Figure A.2.

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 in the 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).[16]

A.4 Controlling for Supply Shocks

The goal of this appendix is to address the concern that the *risk premium shock* we identify in Section 2 of the paper might actually constitute a linear combination of supply and demand shocks. If supply and demand have opposite effects on inflation, then this could potentially account for our finding that the risk premium shock has a small impact on inflation.

[16] While we do not include cay_t directly in Y_t, our VAR nevertheless flexibly captures the same information by implicitly estimating the cointegration relationship between consumption and GDP.

Our general approach is to include TFP in our set of auxiliary variables, and then use information about TFP to identify supply shocks using one of several different procedures. In each case, we first identify a set of TFP-related supply shocks and then identify our risk premium shock using our maximum-share approach, after controlling for the identified supply disturbances. Controlling for these supply shocks, we find the same patterns in the data, which suggests to us that our shock is not conflating supply and demand in an important way.

In the first case, labeled "Method 1", we identify a single supply shock as that which explains the largest possible share of the contemporaneous surprise in productivity. This approach amounts to using a Choleski identification scheme with TFP ordered first, albeit with TFP an auxiliary variable.

For concreteness, we show the connection assuming only one lag in the VAR. Let

$$\tilde{Y}_t = \Gamma_{tfp} Y_t \tag{A.1}$$

where Γ_{tfp} is an invertible $n_y \times n_y$ matrix whose first row corresponds to the weights from the regression of TFP on the core VAR variables. (The remaining rows can be anything so long as they result in Γ_{tfp} being full rank.) Then, premultiplying by Γ_{tfp}, the VAR in equation (1) can be transformed into

$$\tilde{Y}_t = \Gamma_{tfp} B \Gamma_{tfp}^{-1} \Gamma_{tfp} Y_{t-1} + \Gamma_{tfp} A \varepsilon_t \equiv \tilde{B} \tilde{Y}_{t-1} + \tilde{A} \varepsilon_t. \tag{A.2}$$

We can then identify $\tilde{A}$ by setting

$$\tilde{A} = chol(\Gamma_{tfp} cov(u_t) \Gamma_{tfp}'), \tag{A.3}$$

and find $A = \Gamma_{tfp}^{-1} \tilde{A}$. Since the first row of $\tilde{A}$ has zeros outside of the first entry, this implies that 100% of the surprise in the (fitted) value of TFP is explained by the identified shock.

In the second case, labeled "Method 2" in Figure 4 below, we identify both an anticipated and a surprise supply shock using the approach of Chahrour et al. (2023), which itself is an extension of the Kurmann and Sims (2020) approach to identifying news shocks. The first stage of this procedure identifies the "news" shock that explains the largest share of *anticipated* fluctuations in TFP at horizons between 20 and 80 quarters into the future. The second stage identifies surprise TFP shocks as those which explain the largest share of the remaining surprises in TFP; this is again equivalent to using a Choleski identification with TFP ordered first, after having controlled for anticipated productivity shocks.

Our final approach to identifying supply shocks, labeled "Method 3" in Figure 4, is motivated by the concern of Bouakez and Kemoe (2023) that the unconditional correlation between measured TFP and inflation is rather weak, which they argue suggests the possibility for measurement error. We therefore identify as a supply shock the contemporaneous surprise that explains the strongest negative covariance between inflation and TFP. Since this negative relationship is the prototypical signature of supply shocks in most theories, then isolating the shock driving this moment before performing our risk premium identification should be particularly effective at reducing the confounding of supply and demand channels in our risk premium shock.

B Analytical Model: Proofs of Propositions

Preliminaries. The firm chooses labor N_f and N_p to maximize (8) subject to (9) - (10). We ignore the non-negativity constraints for both labor inputs because the Inada conditions of the Cobb-Douglas matching function imply they cannot bind in equilibrium. For a general wage process, the labor first-order conditions are

$$\frac{\varphi}{P_i} = \left(N_f^{\frac{\theta-1}{\theta}} + N_p^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}} N_i^{-\frac{1}{\theta}} \left(1 + E[M_{0,1}Z_1]\right) - \widetilde{W}_i, \tag{B.1}$$

where $\widetilde{W}_i \equiv W_{0,i} + E_0[M_{0,1}W_{1,i}]$ is the discounted value of total wage payments and $P_i = N_i^{\frac{1-\varepsilon}{\varepsilon}}$ is the equilibrium matching probability. Using the definition of covariance, we compute

$$E[M_{0,1}Z_1] = Cov(M_{0,1}, Z_1) + E_0[M_{0,1}]E[Z_1] = Cov(M_{0,1}, Z_1) + \frac{1}{R} \tag{B.2}$$

where the second equality follows from $E[Z_1] = 1$ and the standard definition of the risk-free interest rate. Hence, the general labor first-order condition is given by

$$\varphi N_i^{\frac{1-\varepsilon}{\varepsilon}} = \left(N_f^{\frac{\theta-1}{\theta}} + N_p^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}} N_i^{-\frac{1}{\theta}} \left[1 + \frac{1}{R} + Cov(M_{0,1}, Z_1)\right] - \widetilde{W}_i, \tag{B.3}$$

The factor $\left[1 + \frac{1}{R} + Cov(M_{0,1}, Z_1)\right]$ on the right-hand side of (B.3) captures the current and discounted future marginal product of the worker.

To derive results for consumption, we use the period-zero resource constraint. Time-zero consumption is given by production less hiring costs:

$$C_0 = \left(N_f^{\frac{\theta-1}{\theta}} + N_p^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} - \varphi N_f^{\frac{1}{\varepsilon}} - \varphi N_p^{\frac{1}{\varepsilon}}. \tag{B.4}$$

Proof of Proposition 1. Since the proposition assumes identical wages, equation (B.3) implies that both $N_f = N_p \equiv \tilde{N}$. Using this result, the period-0 marginal product of labor simplifies to

$$\left(\tilde{N}^{\frac{\theta-1}{\theta}} + \tilde{N}^{\frac{\theta-1}{\theta}}\right)^{\frac{1}{\theta-1}} \tilde{N}^{-\frac{1}{\theta}} = 2^{\frac{1}{\theta-1}} \equiv MPN_0, \tag{B.5}$$

with $MPN_1 \equiv Z_1 MPN_0$. Because the same intertemporal condition describes optimality for both types of labor, the risk-premium (measured by the price-dividend ratio, for example) will be identical between the two savings vehicles. Equation (B.1) becomes

$$\varphi \tilde{N}^{\frac{1-\varepsilon}{\varepsilon}} = MPN_0(1 + E[M_{0,1}Z_1]) - \tilde{W}. \tag{B.6}$$

Next, we explicitly compute the covariance term $E[M_{0,1}Z_1]$. Use the resource constraints, $C_0 = \left(\tilde{N}^{\frac{\theta-1}{\theta}} + \tilde{N}^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}} - 2\varphi\tilde{N}^{\frac{1}{\varepsilon}} = 2^{\frac{\theta}{\theta-1}}\tilde{N} - 2\varphi\tilde{N}^{\frac{1}{\varepsilon}}$ and $C_1 = Z2^{\frac{\theta}{\theta-1}}\tilde{N}$.

$$E[M_{0,1}Z_1] = \beta\left(\frac{2^{\frac{\theta}{\theta-1}}\tilde{N}}{2^{\frac{\theta}{\theta-1}}\tilde{N} - 2\varphi\tilde{N}^{\frac{1}{\varepsilon}}}\right)^{-\frac{1}{\psi}} \exp\left((1/\psi - 1)\gamma\frac{\sigma^2}{2}\right) \tag{B.7}$$

$$= \beta\left(1 - \frac{\varphi}{MPN_0}\tilde{N}^{\frac{1-\varepsilon}{\varepsilon}}\right)^{\frac{1}{\psi}} \exp\left((1/\psi - 1)\gamma\frac{\sigma^2}{2}\right) \tag{B.8}$$

Finally, differentiate the period-zero resource constraint (B.4) with respect to γ and impose symmetry to get

$$\frac{\partial C_0}{\partial\gamma} = 2\left(MPN_0 - \frac{\varphi}{\varepsilon}\tilde{N}^{\frac{1-\varepsilon}{\varepsilon}}\right)\frac{\partial\tilde{N}}{\partial\gamma} \tag{B.9}$$

From here, we take cases (i) and (ii) separately.

Case (i): flexible wages: Using the assumed wage process, equation (B.6) reduces to

$$\varphi\tilde{N}^{\frac{1-\varepsilon}{\varepsilon}} = \varepsilon MPN_0\left[1 + \beta\left(1 - \frac{\varphi}{MPN_0}\tilde{N}^{\frac{1-\varepsilon}{\varepsilon}}\right)^{\frac{1}{\psi}} \exp\left((1/\psi - 1)\gamma\frac{\sigma^2}{2}\right)\right]. \tag{B.10}$$

Rearrange to find

$$\frac{\frac{\varphi}{\varepsilon}\tilde{N}^{\frac{1-\varepsilon}{\varepsilon}}}{MPN_0} = \left[1 + \beta\left(1 - \frac{\varphi}{MPN_0}\tilde{N}^{\frac{1-\varepsilon}{\varepsilon}}\right)^{\frac{1}{\psi}} \exp\left((1/\psi - 1)\gamma\frac{\sigma^2}{2}\right)\right] \tag{B.11}$$

Non-negativity of C_0 implies that $1 - \frac{\varphi}{MPN_0}\tilde{N}^{\frac{1-\varepsilon}{\varepsilon}} > 0$. Thus, the right-hand-side of (B.11) is strictly greater than one, and we have $MPN_0 - \frac{\varphi}{\varepsilon}\tilde{N}^{\frac{1-\varepsilon}{\varepsilon}} < 0$. Equation (B.9) then implies that $\tilde{N}$ and C_0 must move in opposite directions in response to changes in γ.

To establish Corollary 1, notice that if $\psi = 1$, then (B.11) implies that N does not respond to γ, which means the same is true of C_0. If $\psi \neq 1$, we can bring all terms to the left hand side and use the implicit function theorem. Defining G in this way, differentiate (B.11) with respect to $\hat{N} \equiv \frac{\varphi}{MPN_0}\tilde{N}^{\frac{1-\varepsilon}{\varepsilon}}$:

$$\frac{\partial G}{\partial \hat{N}} = \frac{1}{\varepsilon} + \beta\frac{1}{\psi}\left(1 - \hat{N}\right)^{\frac{1-\psi}{\psi}} \exp\left((1/\psi - 1)\gamma\frac{\sigma^2}{2}\right) > 0 \tag{B.12}$$

On the other hand $\frac{\partial G}{\partial \gamma} > 0$ if and only if $\psi > 1$. By the implicit function theorem, $\frac{\partial \tilde{N}}{\partial \gamma} = -\frac{\partial \tilde{N}}{\partial \hat{N}}\frac{\partial G}{\partial \gamma}/\frac{\partial G}{\partial \hat{N}}$. Since $\frac{\partial \tilde{N}}{\partial \hat{N}}$ is positive, $\frac{\partial \tilde{N}}{\partial \gamma}$ is negative if $\psi > 1$ and positive if $\psi < 1$.

Case (ii): sticky wages: Using the assumed wage process, (B.6) can be written as

$$\varphi\tilde{N}^{\frac{1-\varepsilon}{\varepsilon}} - MPN_0 = E[M_{0,1}(Z_1 MPN_0 - W_0)] > 0, \tag{B.13}$$

where the inequality comes from Assumption 1. Intuitively, this says that the social cost of investing exceeds the current marginal product of labor. Using this inequality, equation (B.9) implies that $\tilde{N}$ and C_0 must move in opposite directions in response to changes in γ.

□

Proof of Proposition 2. After imposing $\psi = 1$ and $\theta = \infty$ and simplifying, the key equations are

$$\varphi N_f^{\frac{1-\varepsilon}{\varepsilon}} = \varepsilon + \beta\Phi\left(1 - (1-\varepsilon)\exp(\gamma\sigma^2)\right) \tag{B.14}$$

$$\varphi N_p^{\frac{1-\varepsilon}{\varepsilon}} = \varepsilon(1 + \beta\Phi) \tag{B.15}$$

$$C_0 = N_f + N_p - \varphi N_f^{\frac{1}{\varepsilon}} - \varphi N_p^{\frac{1}{\varepsilon}} \tag{B.16}$$

where $\Phi \equiv \frac{N_f + N_p - \varphi N_f^{\frac{1}{\varepsilon}} - \varphi N_p^{\frac{1}{\varepsilon}}}{N_f + N_p} = 1 - \frac{\varphi N_f^{\frac{1}{\varepsilon}} + \varphi N_p^{\frac{1}{\varepsilon}}}{N_f + N_p}$ lies strictly between 0 and 1.

Comparing (B.14) and (B.15), it is immediately clear that for any $\gamma > 0$, N_p must be greater than N_f. We proceed in four steps.

Step 1: Define $\hat{\gamma}$.

We define $\hat{\gamma}$ as the value of γ that is consistent with an equilibrium in which $\frac{\varphi}{\varepsilon}N_f^{\frac{1-\varepsilon}{\varepsilon}} - 1 = 0$. If such an equilibrium exists, then it will have $\hat{N}_f = \left(\frac{\varepsilon}{\varphi}\right)^{\frac{\varepsilon}{1-\varepsilon}} > 0$. Since $\Phi > 0$, equation (B.14) tells us that any equilibrium of this type will also have

$$\left(1 - (1-\varepsilon)\exp(\gamma\sigma^2)\right) = 0. \tag{B.17}$$

The value of $\hat{\gamma}$ is given by the solution to equation (B.17). Moreover, using ($B.17$) and (B.14) it follows that for $\gamma > \hat{\gamma}$ we violate Assumption 1. Thus, $\hat{\gamma}$ is the upper bound of γ values that we consider.

To prove that the equilibrium at $\hat{\gamma}$ exists, however, we still need to show that (B.15) implies that there is a valid (non-negative) value for N_p, and a corresponding positive C_0. We will show there exists such a solution in the interval $(\underline{N}, \overline{N})$, where $\underline{N} \equiv \hat{N}_f = \left(\frac{\varepsilon}{\varphi}\right)^{\frac{\varepsilon}{1-\varepsilon}}$ and $\overline{N} =$ is the solution to

$$N_p + \hat{N}_f - \varphi\hat{N}_f^{\frac{1}{\varepsilon}} - \varphi\hat{N}_p^{\frac{1}{\varepsilon}} = C_0 = 0. \tag{B.18}$$

Notice that for any $N_p > \underline{N}$, the derivative of the left-hand side of (B.18) is negative, which implies that in $(\underline{N}, \overline{N})$, C_0 approaches zero from above.

Both the left-hand side and the right hand side of (B.15) are continuous functions of N_p. The left-hand side is monotonically increasing in N_p, while the right-hand side is monotonically decreasing for $N_p > \underline{N}$. At $N_p = \underline{N}$ the right hand side of (B.15) clearly exceeds the left hand side, so an equilibrium requires N_p greater than $\hat{N}_f$. At $N_p = \overline{N}$, the left-hand side of (B.15) is strictly greater than the right-hand side. By the continuous value theorem, we know there exists a unique value $\hat{N}_p \in (\underline{N}, \overline{N})$ that satisfies (B.15) and $\hat{C}_0 > 0$.

We denote the equilibrium point at $\hat{\gamma}$ as $(\hat{N}_p, \hat{N}_f, \hat{C}_0)$.

Step 2: Use the implicit function theorem to differentiate around $(\hat{N}_f, \hat{N}_p)$ and sign the derivative $\frac{\partial N_f}{\partial \gamma}$ and $\frac{\partial N_p}{\partial \gamma}$.

Bringing all terms to the left-hand sides of (B.14) and (B.15), and define the notation

$$F_1 \equiv \varphi N_f^{\frac{1-\varepsilon}{\varepsilon}} - \varepsilon - \beta\Phi\left(1 - (1-\varepsilon)\exp(\gamma\sigma^2)\right)$$

$$F_2 \equiv \varphi N_p^{\frac{1-\varepsilon}{\varepsilon}} - \varepsilon(1+\beta\Phi)$$

Using the implicit function theorem on the system of equations $F_1 = 0$ and $F_2 = 0$, around the point $(\hat{N}_f, \hat{N}_p)$ we obtain

$$\begin{aligned} \left.\begin{bmatrix} \frac{\partial N_f}{\partial \gamma} \\ \frac{\partial N_p}{\partial \gamma} \end{bmatrix}\right|_{\hat{\gamma}} &= -\begin{bmatrix} \frac{\partial F_1}{\partial N_f} & 0 \\ \frac{\partial F_2}{\partial N_f} & \frac{\partial F_2}{\partial N_p} \end{bmatrix}^{-1} \begin{bmatrix} \beta\Phi(1-\varepsilon)\exp(\hat{\gamma}\sigma^2)\sigma^2 \\ 0 \end{bmatrix} \\ &= -\begin{bmatrix} w & x \\ y & z \end{bmatrix} \begin{bmatrix} \beta\Phi(1-\varepsilon)\exp(\hat{\gamma}\sigma^2)\sigma^2 \\ 0 \end{bmatrix} \end{aligned}$$

where we have defined the elements of the 2x2 matrix inverse above as w, x, y and z. Using the matrix inverse formula,

$$w = \frac{\frac{\partial F_2}{\partial N_p}}{\frac{\partial F_1}{\partial N_f}\frac{\partial F_2}{\partial N_p}} = \frac{1}{\varphi\frac{1-\varepsilon}{\varepsilon}\hat{N}_f^{\frac{1-2\varepsilon}{\varepsilon}}} > 0. \tag{B.19}$$

It follows that at $\gamma = \hat{\gamma}$ we have $\frac{\partial N_f}{\partial \gamma} = w\beta\Phi(1-\varepsilon)\exp(\hat{\gamma}\sigma^2)\sigma^2 < 0$.

Next, we need to show that $\frac{\partial N_p}{\partial \gamma} > 0$. For this, we need to compute

$$y = -\frac{\frac{\partial F_2}{\partial N_f}}{\frac{\partial F_1}{\partial N_f}\frac{\partial F_2}{\partial N_p}} \tag{B.20}$$

It is quick to show that $\frac{\partial F_2}{\partial N_f} > 0$. Since the numerator of $\Phi = \frac{N_f + N_p - \varphi N_f^{\frac{1}{\varepsilon}} - \varphi N_p^{\frac{1}{\varepsilon}}}{N_f + N_p}$ does not change with N_f at the point $(\hat{N}_f, \hat{N}_p)$, it follows that

$$\frac{\partial F_2}{\partial N_f} = \varepsilon\beta\Phi(\hat{N}_f + \hat{N}_p)^{-1}. \tag{B.21}$$

We have already shown that $\frac{\partial F_1}{\partial N_f} > 0$ above, hence now we just need to also show that $\frac{\partial F_2}{\partial N_p} > 0$, and then we will have $y < 0$ and thus $\frac{\partial N_p}{\partial \gamma} > 0$.

Computing the partial of F_2 with respect to N_p, we have

$$\frac{\partial F_2}{\partial N_p} > 0 = \varphi\frac{1-\varepsilon}{\varepsilon}\hat{N}_p^{\frac{1-2\varepsilon}{\varepsilon}} - \varepsilon\beta\frac{1 - \frac{\varphi}{\varepsilon}\hat{N}_p^{\frac{1-\varepsilon}{\varepsilon}}}{\hat{N}_f + \hat{N}_p} + \varepsilon\beta\Phi(\hat{N}_f + \hat{N}_p)^{-1}. \tag{B.22}$$

The first and last terms above are evidently positive. Since $(1 - \frac{\varphi}{\varepsilon}\hat{N}_f^{\frac{1-\varepsilon}{\varepsilon}}) = 0$ and $\hat{N}_p > \hat{N}_f$, we also know that $(1 - \frac{\varphi}{\varepsilon}\hat{N}_p^{\frac{1-\varepsilon}{\varepsilon}}) < 0$. This implies that the second term above is also positive, and so $\frac{\partial F_2}{\partial N_p} > 0$ and $y < 0$. Hence, $\frac{\partial N_f}{\partial \gamma} = -y\beta\Phi(1-\varepsilon)\exp(\hat{\gamma}\sigma^2)\sigma^2 > 0$.

Finally, from the above derivations we can also see that $\frac{\partial F_2}{\partial N_f} < \frac{\partial F_2}{\partial N_p}$, and hence $w > y$ and thus we conclude that $\left|\frac{\partial N_f}{\partial \gamma}\right| > \left|\frac{\partial N_p}{\partial \gamma}\right|$. This implies that $\frac{\partial Y}{\partial \gamma} = \frac{\partial N}{\partial \gamma} = \frac{\partial(N_f+N_p)}{\partial \gamma} < 0$.

Step 3: Totally differentiate (B.16) at the point $(\hat{N}_f, \hat{N}_p)$ to derive the implication for consumption.

We find

$$\frac{\partial C_0}{\partial \gamma} = \left(1 - \frac{\varphi}{\varepsilon}N_f^{\frac{1-\varepsilon}{\varepsilon}}\right)\frac{\partial N_f}{\partial \gamma} + \left(1 - \frac{\varphi}{\varepsilon}N_p^{\frac{1-\varepsilon}{\varepsilon}}\right)\frac{\partial N_p}{\partial \gamma}. \tag{B.23}$$

And since $\left(1 - \frac{\varphi}{\varepsilon}\hat{N}_f^{\frac{1-\varepsilon}{\varepsilon}}\right) = 0$, $\left(1 - \frac{\varphi}{\varepsilon}\hat{N}_p^{\frac{1-\varepsilon}{\varepsilon}}\right) < 0$ (since $\hat{N}_p > \hat{N}_f$) and $\left.\frac{\partial N_p}{\partial \gamma}\right|_{\hat{\gamma}} > 0$, we thus have that $\left.\frac{\partial C_0}{\partial \gamma}\right|_{\hat{\gamma}} < 0$.

Step 4: Draw implications for γ near $\hat{\gamma}$.

Since $\left.\frac{\partial N_f}{\partial \gamma}\right|_{\hat{\gamma}} < 0$, $\left.\frac{\partial N_p}{\partial \gamma}\right|_{\hat{\gamma}} > 0$, $\left.\frac{\partial N}{\partial \gamma}\right|_{\hat{\gamma}} < 0$, and $\left.\frac{\partial C_0}{\partial \gamma}\right|_{\hat{\gamma}} < 0$, by continuity we know that there exists a neighborhood of values for γ – which we label $(\tilde{\gamma}, \hat{\gamma})$ – for which these equilibrium relationships remain the same hence for all $\gamma \in (\tilde{\gamma}, \hat{\gamma}]$ we continue to have the full comovement – that is $\frac{\partial N_f}{\partial \gamma} < 0$, $\frac{\partial N_p}{\partial \gamma} > 0$, $\frac{\partial N}{\partial \gamma} < 0$, and $\frac{\partial C_0}{\partial \gamma} < 0$.

□

C Model

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

C.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

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

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

$$C_t + P_t^e X_{t+1} + Q_t^c(B_{t+1}^c - dB_t^c) + \frac{1}{R_t^r} B_{t+1} \leq (D_t^e + P_t^e) X_t + B_t^c + B_t + E_t^l. \tag{C.2}$$

In the above, Q_t^c is the price of a multi-period corporate bond with average duration $(1-d)^{-1}$, R_t is the one-period safe real interest rate, P_t^e is the price of a share of the representative firms that pays a real dividend D_t^e, and E_t^l 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:

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

The first-order conditions for the households yield

$$\begin{aligned}
1 &= R_t \mathbb{E}_t M_{t,t+1}, \\
P_t^E &= \mathbb{E}_t \left[M_{t,t+1} \left(D_{t+1}^E + P_{t+1}^E \right) \right], \\
Q_t^c &= \mathbb{E}_t \left[M_{t,t+1} (d Q_{t+1}^c + 1) \right].
\end{aligned}$$

C.2 Firms

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

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

subject to the production function:

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

and the labor aggregator:

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

The capital accumulation equation is

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

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

$$N_{f,t} = (1 - \rho_f) N_{f,t-1} + \Theta_{f,t} V_{f,t}, \tag{C.8}$$

$$N_{p,t} = (1 - \rho_{p,t}) N_{p,t-1} + \Theta_{p,t} V_{p,t}. \tag{C.9}$$

where ρ_f and ρ_p are the exogenous components of separation rates and $\rho_{p,t} \equiv \rho_p + (1 - \rho_p) P_{f,t}$ takes into account part-timers that endogenously switch to a full-time job. The cash flows of of the firm are given by

$$D_t = Y_t - W_{f,t} N_{f,t} - W_{p,t} N_{p,t} - I_t - \varphi_{f,t} V_{f,t} - \varphi_{p,t} V_{p,t}. \tag{C.10}$$

The problem of the firms yields the following equilibrium conditions:

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

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

$$\tilde{R}^K_t K_t = \alpha (K_t)^\alpha (Z_t N_t)^{1-\alpha}, \tag{C.13}$$

and finally

$$\frac{\varphi_{f,t}}{\Theta_{f,t}} = (1 - \Omega)(1 - \alpha) Z_t \left(\frac{K_t}{Z_t N_t}\right)^\alpha \left(\frac{N_t}{N_{f,t}}\right)^{\frac{1}{\theta}} - W_{f,t} + \mathbb{E}_t \left\{ M_{t,t+1} \frac{(1 - \rho_f)\varphi_{f,t+1}}{\Theta_{f,t+1}} \right\}, \tag{C.14}$$

$$\frac{\varphi_{p,t}}{\Theta_{p,t}} = \Omega (1 - \alpha) Z_t \left(\frac{K_t}{Z_t N_t}\right)^\alpha \left(\frac{N_t}{N_{p,t}}\right)^{\frac{1}{\theta}} - W_{p,t} + \mathbb{E}_t \left\{ M_{t,t+1} \frac{(1 - \rho_{p,t+1})\varphi_{p,t+1}}{\Theta_{p,t+1}} \right\}. \tag{C.15}$$

In equilibrium, $\Theta_{i,t} = \frac{\mathcal{M}_i(S_{i,t}, v_{i,t})}{v_{i,t}}$, where $\mathcal{M}_i$ is the Cobb-Douglas matching function for sector i given by (39).

C.3 Labor Market Search and Nash Bargaining

Our analysis of the labor market assumes that the household reallocate ssearch effort across markets until it is indifferent between searching in the two markets. The value of search in a given market depends on the likelihood of finding a job in each market, the wages offered conditional on employment and the continuation value in each sector.

From the household perspective, the stock of workers evolves according to

$$N_{f,t} = (1-\rho_f)N_{f,t-1} + P_{f,t}S_{f,t} \tag{C.16}$$

$$N_{p,t} = (1-\rho_{p,t})N_{p,t-1} + P_{p,t}S_{p,t} \tag{C.17}$$

where $(1-\rho_{p,t}) \equiv (1-\rho_p)(1-P_{f,t})$ is the part-time separation rate, and $P_{f,t}$ and $P_{p,t}$ capture the employment returns to search effort in each market, which the household takes as given.

Define $\mathbb{W}_{f,t}$ as the value of being a matched worker in the full-time sector, $\mathbb{W}_{p,t}$ as the value of being a matched worker in the part-time sector, $\mathbb{S}_{f,t}$ as the value of search effort in the full-time market, $\mathbb{S}_{p,t}$ as the value search effort in the part-time market, and $\mathbb{U}_t$ as the value of being currently unemployed. The surplus terms are determined by the following equations

$$\mathbb{W}_{f,t} = W_{f,t} + \mathbb{E}_t\left\{M_{t,t+1}\left[(1-\rho_f)\mathbb{W}_{f,t+1} + \rho_f\mathbb{S}_{f,t+1}\right]\right\}, \tag{C.18}$$

$$\mathbb{W}_{p,t} = (W_{p,t}+\kappa_t) + \mathbb{E}_t\{M_{t,t+1}[(1-\rho_p)[(1-P_{f,t+1})\mathbb{W}_{p,t+1} + P_{f,t+1}\mathbb{W}_{f,t+1}] + \rho_p\mathbb{S}_{f,t+1}]\} \tag{C.19}$$

$$\mathbb{S}_{f,t} = P_{f,t}\mathbb{W}_{f,t} + (1-P_{f,t})\mathbb{U}_t \tag{C.20}$$

$$\mathbb{S}_{p,t} = P_{p,t}\mathbb{W}_{p,t} + (1-P_{p,t})\mathbb{U}_t \tag{C.21}$$

$$\mathbb{U}_t = b_t + \mathbb{E}_t\left\{M_{t,t+1}\mathbb{S}_{f,t+1}\right\}. \tag{C.22}$$

In equation (C.19) above, the term $P_{f,t+1}\mathbb{W}_{f,t+1}$ reflects the possibility that a worker with an ongoing part-time jobs finds a full-time job in the following period. As noted in the main text, in equilibrium $\mathbb{S}_{f,t} = \mathbb{S}_{p,t}$.

To implement Nash bargaining, we need to compute firm surpluses as well. The value of a matched worker is given by:

$$J_{i,t} = MPL_{i,t} - W_{i,t} + \mathbb{E}_t\left\{(1-\rho_{i,t+1})M_{t,t+1}J_{i,t+1}\right\} \tag{C.23}$$

Under free-entry, $J_{i,t} = \frac{\varphi_{i,t}}{\Theta_{i,t}}$. We assume that if workers walk away from a match at the bargaining stage, then they remain unemployed for the period. Using the above surplus definitions, Nash-bargaining surplus-sharing rules are given by:

$$\mathbb{W}_{f,t} - \mathbb{U}_t = \frac{\eta_f}{1-\eta_f}\frac{\varphi_{f,t}}{\Theta_{f,t}} \tag{C.24}$$

$$\mathbb{W}_{p,t} - \mathbb{U}_t = \frac{\eta_p}{1-\eta_p}\frac{\varphi_{p,t}}{\Theta_{p,t}}. \tag{C.25}$$

We use (C.24) only to determine the steady-state wage of full-time workers, but impose (C.25) period-by-period to model flexible part-time wages.

C.4 Stationary Equilibrium

The model economy follows a balanced-growth path driven by the technology process, Z_t, which we assume is a random walk:

$$\log(Z_t) = \log(Z_{t-1}) + \sigma_z \epsilon_t^z, \tag{C.26}$$

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 $\{\hat{Y}_t, \hat{C}_t, \hat{I}_t, \hat{G}_t, \hat{K}_t, V_{f,t}, V_{p,t}, N_t, N_{f,t}, N_{p,t}, S_{f,t}, S_{p,t}, U_t, \tilde{R}_t^K, q_t, R_t, M_t, \hat{\mathbb{V}}_t, \hat{W}_{f,t}, \hat{W}_{p,t}, \hat{\mathbb{W}}_{f,t}, \hat{\mathbb{W}}_{p,t}, \hat{\mathbb{S}}_{f,t}, \hat{\mathbb{S}}_{p,t}, \hat{\mathbb{U}}_t, \hat{P}_t^E, \hat{D}_t^E, \hat{B}_t^c, Q_t^c, \hat{\Gamma}_t\}$ that satisfies the following conditions:

$$\hat{Y}_t = (\hat{K}_t)^\alpha (\Delta Z_t N_t)^{1-\alpha}, \tag{C.27}$$

$$N_t = \left((1-\Omega) N_{f,t}^{\frac{\theta-1}{\theta}} + \Omega N_{p,t}^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}}, \tag{C.28}$$

$$N_{f,t} = (1-\rho_f) N_{f,t-1} + \mathcal{M}_1(S_{f,t}, V_{f,t}), \tag{C.29}$$

$$N_{p,t} = (1-\rho_{p,t}) N_{p,t-1} + \mathcal{M}_2(S_{p,t}, V_{p,t}), \tag{C.30}$$

$$S_{f,t} + S_{p,t} = 1 - (1-\rho_f) N_{f,t-1}, \tag{C.31}$$

$$\hat{\mathbb{S}}_{f,t} = \hat{\mathbb{S}}_{p,t} \tag{C.32}$$

$$U_t = 1 - N_{f,t} - N_{p,t}, \tag{C.33}$$

$$\begin{aligned}\frac{\hat{\Gamma}_t \varphi_1 V_{f,t}}{\mathcal{M}_1(S_{f,t}, V_{f,t})} =& (1-\Omega)(1-\alpha)\Delta Z_t \left(\frac{\hat{K}_t}{\Delta Z_t N_t}\right)^\alpha \left(\frac{N_t}{N_{f,t}}\right)^{\frac{1}{\theta}} - \hat{W}_{f,t} + \\ &+ \mathbb{E}_t\left\{M_{t,t+1}\Delta Z_t \frac{(1-\rho_f)\hat{\Gamma}_{t+1}\varphi_1 V_{f,t+1}}{\mathcal{M}_1(S_{f,t+1}, V_{f,t+1})}\right\},\end{aligned} \tag{C.34}$$

$$\frac{\hat{\Gamma}_t \varphi_{p,t} V_{p,t}}{\mathcal{M}_2(S_{p,t}, V_{p,t})} = \Omega(1-\alpha)\Delta Z_t \left(\frac{\hat{K}_t}{\Delta Z_t N_t}\right)^{\alpha} \left(\frac{N_t}{N_{p,t}}\right)^{\frac{1}{\theta}} - \hat{W}_{p,t} + \tag{C.35}$$

$$+ \mathbb{E}_t \left\{ M_{t,t+1} \Delta Z_t \frac{(1-\rho_{p,t+1})\hat{\Gamma}_{t+1}\varphi_2 V_{p,t+1}}{\mathcal{M}_2(S_{p,t+1}, V_{p,t+1})} \right\},$$

$$\hat{\mathbb{W}}_{f,t} = W_{f,t} + \mathbb{E}_t \left\{ M_{t,t+1} \Delta Z_t \left[(1-\rho_f)\hat{\mathbb{W}}_{f,t+1} + \rho_f \hat{\mathbb{S}}_{f,t+1} \right] \right\}, \tag{C.36}$$

$$\hat{\mathbb{W}}_{p,t} = (\hat{W}_{p,t} + \hat{\Gamma}_t \kappa) \tag{C.37}$$

$$+ \mathbb{E}_t \{ M_{t,t+1} \Delta Z_t [(1-\rho_p)[(1-P_{f,t+1})\hat{\mathbb{W}}_{p,t+1} + P_{f,t+1}\hat{\mathbb{W}}_{f,t+1}] + \rho_p \hat{\mathbb{S}}_{f,t+1}] \}$$

$$\hat{\mathbb{S}}_{f,t} = P_{f,t}\hat{\mathbb{W}}_{f,t} + (1-P_{f,t})\hat{\mathbb{U}}_t, \tag{C.38}$$

$$\hat{\mathbb{S}}_{p,t} = P_{p,t}\hat{\mathbb{W}}_{p,t} + (1-P_{p,t})\hat{\mathbb{U}}_t, \tag{C.39}$$

$$\hat{\mathbb{U}}_t = \hat{\Gamma}_t b + \mathbb{E}_t \left\{ M_{t,t+1} \Delta Z_t \hat{\mathbb{S}}_{f,t+1} \right\}, \tag{C.40}$$

$$\hat{\mathbb{W}}_{p,t} - \hat{\mathbb{U}}_t = \frac{\eta_p}{1-\eta_p} \frac{\hat{\Gamma}_t \varphi_2}{\Theta_{p,t}}, \tag{C.41}$$

$$\hat{W}_{f,t} = \hat{\Gamma}_t \hat{W}_1^{ss}, \tag{C.42}$$

$$M_{t,t+1} = \beta \left(\frac{\hat{C}_{t+1}\Delta Z_t}{\hat{C}_t}\right)^{1-1/\psi} \left(\frac{\hat{C}_t}{\hat{C}_{t+1}\Delta Z_t}\right) \left(\frac{\hat{\mathbb{V}}_{t+1}}{(\mathbb{E}_t \hat{\mathbb{V}}_{t+1}^{1-\gamma_t})^{\frac{1}{1-\gamma_t}}}\right)^{1/\psi - \gamma_t}, \tag{C.43}$$

$$\hat{P}_t^E = \mathbb{E}_t \left[M_{t,t+1} \Delta Z_t \left(\hat{D}_{t+1}^E + \hat{P}_{t+1}^E \right) \right], \tag{C.44}$$

$$Q_t^c = \mathbb{E}_t \left[M_{t,t+1}(dQ_{t+1}^c + 1) \right], \tag{C.45}$$

$$1 = R_t \mathbb{E}_t M_{t,t+1}, \tag{C.46}$$

$$\tilde{R}_t^K = \alpha \left(\frac{\hat{K}_t}{\Delta Z_t N_t}\right)^{\alpha-1}, \tag{C.47}$$

$$q_t = \mathbb{E}_t \Big[M_{t,t+1} \Big(\tilde{R}_{t+1}^K + \tag{C.48}$$

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

$$\hat{K}_{t+1} = \left(1 - \delta - \frac{\phi_K}{2}\left(\frac{\hat{I}_t}{\hat{K}_t} - \delta\right)^2 \right) \frac{\hat{K}_t}{\Delta Z_t} + \frac{\hat{I}_t}{\Delta Z_t}, \tag{C.49}$$

$$\frac{1}{q_t} = 1 - \phi_K \left(\frac{\hat{I}_t}{\hat{K}_t} - \delta\right), \tag{C.50}$$

$$\hat{Y}_t = \hat{C}_t + \hat{I}_t + \hat{\Gamma}_t \gamma_1 V_{f,t} + \hat{\Gamma}_t \gamma_2 V_{p,t} + \Delta Z_t \bar{g} Y, \tag{C.51}$$

$$\hat{G}_t = \Delta Z_t \bar{g} Y, \tag{C.52}$$

$$\hat{D}^E_t = \hat{Y}_t - \hat{W}_{f,t}N_{f,t} - \hat{W}_{p,t}N_{p,t} - \hat{I}_t - \Gamma_t(\varphi_1 V_{f,t} + \varphi_2 V_{p,t}) - \hat{B}^c_t + \xi\frac{\hat{K}_{t+1}}{\Delta Z_t}, \tag{C.53}$$

$$\hat{B}^c_{t+1} = d\hat{B}^c_t/\Delta Z_t + \xi\hat{K}_{t+1}/Q^c_t, \tag{C.54}$$

$$\hat{\mathbb{V}}_t = \max\left[(1-\beta)(\hat{C}_t)^{1-1/\psi} + \Delta Z_t^{1-1/\psi}\beta(\mathbb{E}_t\hat{\mathbb{V}}_{t+1}^{1-\gamma_t})^{\frac{1-1/\psi}{1-\gamma_t}}\right]^{\frac{1}{1-1/\psi}}, \tag{C.55}$$

$$\hat{\Gamma}_{t+1} = \hat{\Gamma}^\omega_t(\Delta Z_t)^{-\omega}. \tag{C.56}$$

C.5 Risk Premia Decomposition

Proof of Proposition 3. The optimality conditions for $V_{f,t}, V_{p,t}, N_{f,t}, N_{p,t}$ can be expressed compactly as:

$$J_{f,t}\Theta_t = \varphi_{p,t} \tag{C.57}$$

$$J_{p,t}\Theta_t = \varphi_{f,t} \tag{C.58}$$

$$J_{f,t} = MPL_{f,t} - W_{f,t} + \mathbb{E}_t\left\{M_{t,t+1}(1-\rho_f)J_{f,t+1}\right\} \tag{C.59}$$

$$J_{p,t} = MPL_{p,t} - W_{p,t} + \mathbb{E}_t\left\{M_{t,t+1}(1-\rho_{p,t+1})J_{p,t+1}\right\} \tag{C.60}$$

Combining the optimality conditions for capital (C.11) and investment (C.12) one can write:

$$q_tK_{t+1} = \mathbb{E}_t\Big[M_{t,t+1}\Big(\alpha Y_{t+1} - I_{t+1} + q_{t+1}K_{t+2}\Big)\Big] \tag{C.61}$$

Substituting these relationships in the cum-dividend value of the firm $\tilde{P}^e_t$ in (28) we get:

$$\begin{aligned}
\tilde{P}^e_t = {} & Y_t - I_t - \sum_{i\in\{f,p\}}\left[W_{i,t}N_{i,t} + \varphi_{i,t}v_{i,t} + J_{i,t}(N_{i,t} - (1-\rho_{i,t})N_{i,t-1} - \Theta_{i,t}v_{i,t})\right] + \\
& \mathbb{E}_tM_{t,t+1}\left\{Y_{t+1} - I_{t+1} - \sum_{i\in\{f,p\}}\left[W_{i,t+1}N_{i,t+1} + \varphi_{i,t+1}v_{i,t+1} + J_{i,t+1}(N_{i,t+1} - (1-\rho_{i,t+1})N_{i,t} - \Theta_{i,t+1}v_{i,t+1})\right]\right\} \\
& + \ldots
\end{aligned}$$

The $J_{i,t}\Theta_{i,t}v_{i,t}$ terms cancel with $\varphi_i v_{i,t}$ and the term $J_{i,t}N_{i,t}$ cancels with $(1-\alpha)Y_t - W_{i,t}N_{i,t}$ and $\mathbb{E}_tM_{t,t+1}(1-\rho_i)N_{i,t}J_{i,t+1}$ in the first and second line respectively. The sequence $\alpha Y_{t+s} - I_{t+s}$ for $s \geq 1$ sums to q_tK_{t+1} per (C.61). We are left with:

$$\tilde{P}_t = \alpha Y_t - I_t + J_{f,t}(1-\rho_f)N_{f,t-1} + J_{p,t}(1-\rho_{p,t})N_{p,t-1} + q_tK_{t+1} \tag{C.62}$$

Since the total number of shares is normalized to 1, $\tilde{P}_t^e$ corresponds to the cum-dividend price of the firm. The ex-dividend value of the firm, $P_t^e = \tilde{P}_t^e - D_t$ is:

$$P_t^e = \alpha Y_t - I_t + J_{f,t}(1-\rho_f)N_{f,t-1} + J_{p,t}(1-\rho_{p,t})N_{p,t-1} + q_t K_{t+1} - (Y_t - W_t N_t - I_t - \varphi_{f,t}V_{f,t} - \varphi_{p,t}V_{p,t})$$

which simplifies to

$$P_t^e = q_t K_{t+1} + J_{f,t}N_{f,t} + J_{p,t}N_{p,t} - ((1-\alpha)Y_t - W_{f,t}N_{f,t} - W_{p,t}N_{p,t}).$$

The above can also be expressed as:

$$P_t^e = q_t K_{t+1} + \tilde{J}_{f,t}N_{f,t} + \tilde{J}_{p,t}N_{p,t}, \tag{C.63}$$

with $\tilde{J}_{i,t}$ being the continuation value of the workers:

$$\tilde{J}_{i,t} = \mathbb{E}_t \left\{ M_{t+1} \left[MPL_{i,t+1} - W_{i,t+1} + (1-\rho_{i,t+1})\tilde{J}_{i,t+1} \right] \right\} = J_{i,t} - (MPL_{i,t} - W_{i,t}). \tag{C.64}$$

The unlevered return to equity is defined as:

$$R_{t+1}^E = \frac{D_{t+1} + P_{t+1}^e}{P_t^e} = \frac{\alpha Y_{t+1} - I_{t+1} + q_{t+1}K_{t+2} + J_{f,t+1}(1-\rho_f)N_{f,t} + J_{p,t+1}(1-\rho_{p,t+1})N_{p,t}}{q_t K_{t+1} + \tilde{J}_{f,t}N_{f,t} + \tilde{J}_{p,t}N_{p,t}}.$$

Using (C.64) and (C.61) we can thus express the return to equity as a weighted sum of the return to capital and to the two labor types:

$$R_{t+1}^E = s_{k,t}R_{t+1}^K + s_{f,t}R_{f,t+1}^L + s_{p,t}R_{p,t+1}^L, \tag{C.65}$$

where $s_{K,t} = \frac{q_t K_{t+1}}{q_t K_{t+1} + \tilde{J}_{f,t}N_{f,t} + \tilde{J}_{p,t}N_{p,t}}$, $s_{f,t}$ and $s_{p,t}$ are analogously defined, and $s_{k,t} + s_{f,t} + s_{p,t} = 1$. The returns are defined as:

$$R_{t+1}^K = \frac{\alpha Y_{t+1} - I_{t+1} + q_{t+1}K_{t+2}}{q_t K_{t+1}} = \frac{MPK_{t+1} + q_{t+1}\,(1 - \delta - adj.costs)}{q_t} \tag{C.66}$$

$$R_{i,t+1}^L = \frac{(1-\rho_{i,t+1})[MPL_{i,t+1} - W_{i,t+1} + \tilde{J}_{i,t+1}]}{\tilde{J}_{i,t}}. \tag{C.67}$$

□

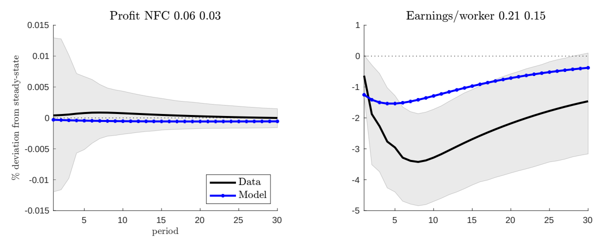

Figure D.1: Response of discounted profits and earnings per worker in model and data.

D Earnings per worker

Our assumptions about sticky wages in the full-time sector are stark for simplicity. Of course, the literature has come to contrasting and often opposed conclusions about the cyclicality of wages. One straightforward and common measure of wages is earnings per worker. The second panel of Figure D.1 plots the empirical and model-implied response of earnings per worker, under our baseline empirical and model estimates.

The figure shows that earnings per worker fall modestly in response to the shock both in the data and in the model. While the model fall is somewhat less than in the data, it falls in or near the empirical confidence band. In the model, there are two reasons this measure of wages shows non-trivial adjustment in response to risk shocks, even though the wages of full-time workers do not respond. First, the wages of existing part-time workers are flexible and they fall in response to the shock. Second, the share of part-time workers grows in the model as a share of total employment: since those workers have lower earnings, this also reduces earnings per worker. We conclude from this figure that, while our assumptions about wages are probably an oversimplification, the overall implications for earnings per worker are not strongly counterfactual.

E Alternative Estimation Procedure

Our baseline estimation procedure compares theoretical impulse responses to those estimated from a particular empirical procedure on real data. In general, however, applying our empirical procedure to data generated by the model only imperfectly identifies the theoretical response to risk aversion disturbances. To alleviate concern that our results could be driven by potential misspecification of the identification procedure, we reestimated the model using an alternative procedure that aligns analogous objects in the model and data. In particular, define $\hat{\Psi}^m(\Pi)$ to be the vector of impulse responses generated by applying our "method 1" empirical procedure to a sample of 5,000 periods of data generated by the

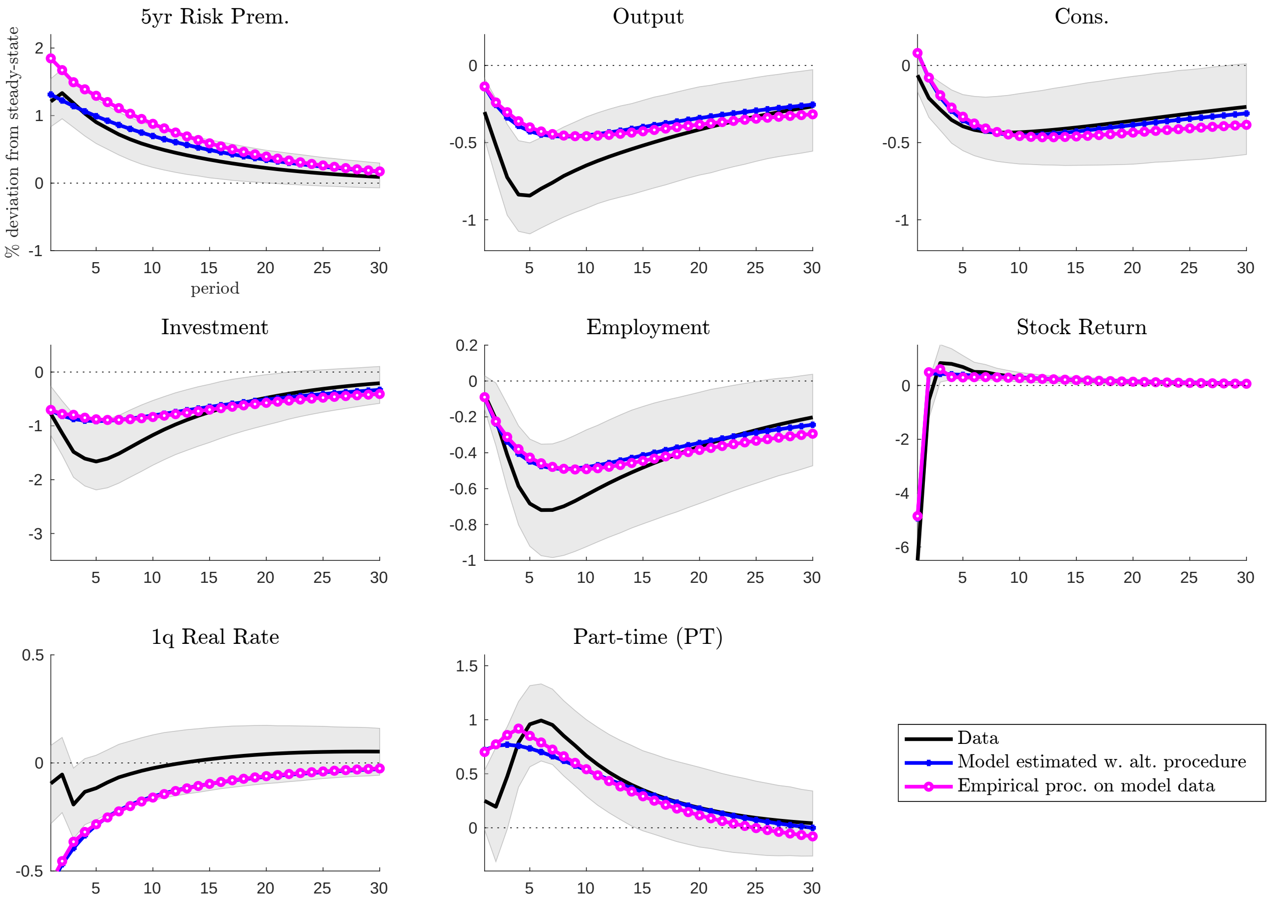

Figure E.1: Model responses when estimated using alternative procedure.

model under parameter vector Π (stacked along with the same unconditional moments as $\Psi(\Pi)$). Then, the parameter vector is estimated to minimize the loss function

$$\mathcal{L}^m(\Pi) \equiv (\hat{\Psi} - \hat{\Psi}^m(\Pi))' W (\hat{\Psi} - \hat{\Psi}^m(\Pi)). \tag{E.1}$$

The blue line in Figure E.1 presents the impulse responses for the model when reestimated in this way. The figure shows that the model impulse responses are very similar to our baseline procedure. The cyan line depicts the impulse responses that are generated by applying the empirical procedure on the model data. The close alignment of the blue and cyan lines demonstrates that our empirical procedure does a very good job of identifying the true effects of risk shocks on model-simulated data. The second column of Table E.1 shows the parameters of the reestimated model. Most parameters remain close to our baseline estimates.

Table E.1: Estimated Parameters - Robustness

Name	Description	Base Est.	Alt. Procedure	Low IES
γ_{ss}	Steady-state risk aversion	34.726	38.661	104.343
ν	Leverage Ratio	0.748	0.742	0.519
	Labor Markets			
φ_f	Vacancy posting cost - full-time	1.145	1.294	2.254
φ_p	Vacancy posting cost - part-time	0.155	0.109	0.293
κ	Value if no perm posit.	1.189	1.183	1.240
b	Value if unemployed	0.709	0.696	0.784
Ω	Labor contrib. of part-time	0.230	0.232	0.187
θ	Elas. between full- & part-time	5.943	6.582	2.698
ϵ_f	Matching elasticity - full-time	0.411	0.423	0.141
ϵ_p	Matching elasticity - part-time	0.025	0.025	0.025
χ_f	Matching technology - full-time	0.454	0.470	0.293
χ_p	Matching technology - part-time	2.462	3.521	0.993
ω	Gradual wage adj.	0.977	0.973	0.986
	Risk Aversion Process			
ρ_γ	AR(1) risk av. shock	0.935	0.932	0.954
σ_γ	Std. dev. of risk av. shock	0.424	0.429	0.299

F Low IES results

To emphasize that a high intertemporal elasticity is not essential for our results, Figure E.2 plots the implied impulse response for the model, estimated with $\psi = 0.5$. The model matches the data nearly as well as our baseline, but with a somewhat larger miss on the interest rate response. The third column of Table E.1 presents the parameters estimated in this case.

G TFP calculation

Taking log changes of the production function (29), we can write the change in output following a risk aversion shock as:

$$\Delta \log(Y_t) = (1-\alpha)\Delta \log N_t + \alpha \Delta \log(K_t), \tag{G.1}$$

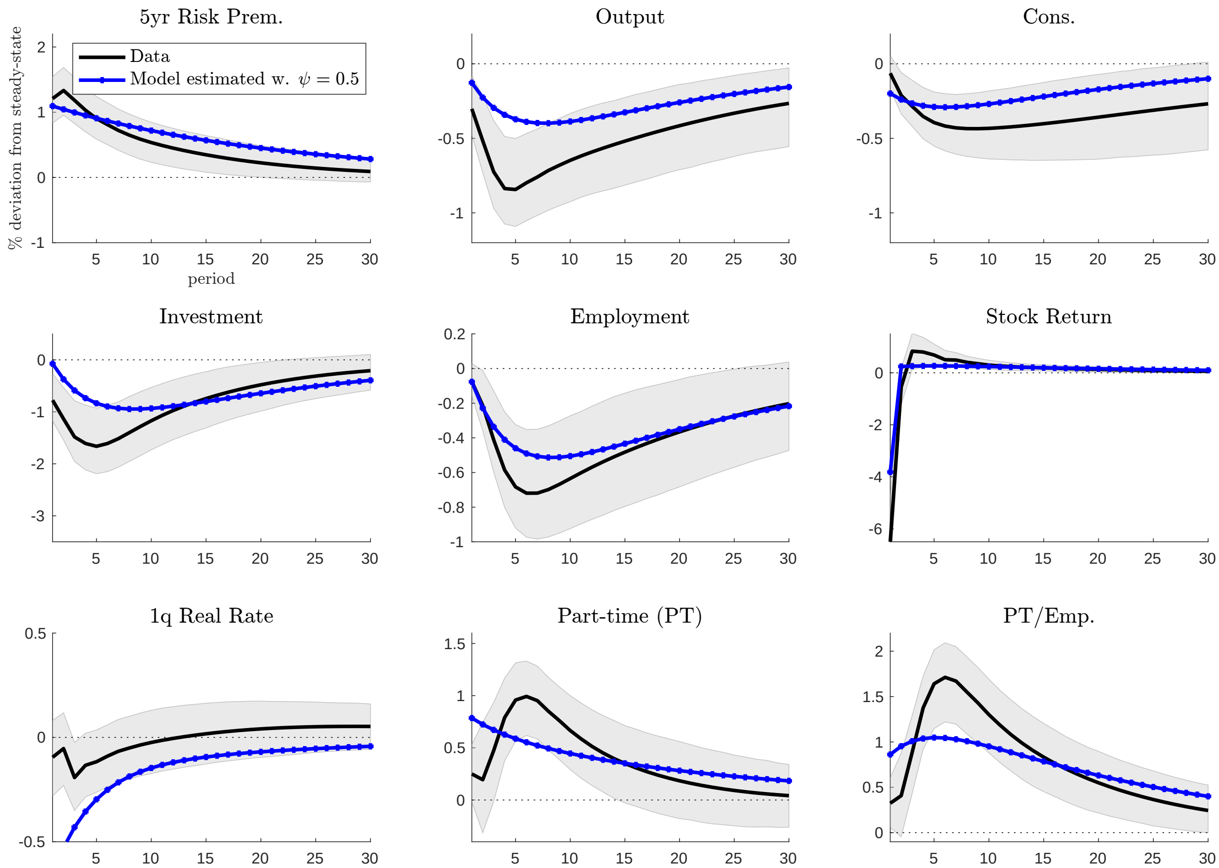

Figure E.2: Model responses with low intertemporal elasticity of substitution.

$\Delta \log Z_t$ does not appear in (G.1) since changes in true TFP are zero in response to the risk aversion shock.

To define measured TFP we need to specify what data the econometrician observes and what he knows about the model that generated the data. The quarterly measure of TFP typically used for business cycle analysis, and the one we confront our model with, builds on Basu, Fernald, and Kimball (2006) and is implemented in quarterly data by Fernald (2014). Aggregate TFP is constructed using data on output and production input such as capital and labor. The methodology takes into account certain dimensions of input heterogeneity by using actual or estimated relative factor prices to control for differences in implied marginal products. The dimensions of labor heterogeneity considered are education, age, sex, race/ethnicity, industry, and occupation, but do not include part-time status. Thus, the effect of part-time status on wages is controlled for only to the extent that it is explained by these six included variables.

It follows that in our model, where there is no such heterogeneity along those six

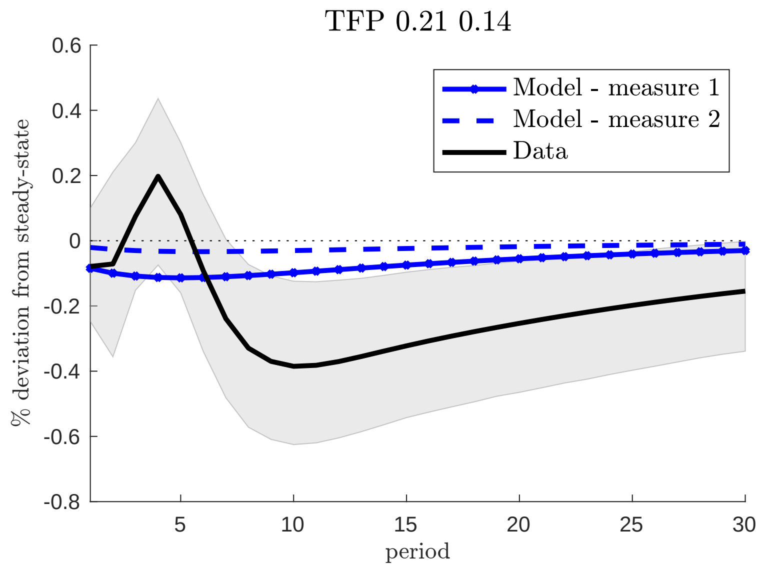

Figure G.1: Empirical and alternative model responses of measured TFP.

dimensions, the "naive" TFP econometrician would not distinguish between N_p and N_f, and, given data on output, capital and employment, would construct the change in measured TFP, $\Delta \log \tilde{Z}_t^e$, as:

$$\Delta \log \tilde{Z}_t^e = \Delta \log(Y_t) - \omega_N \Delta \log(N_{f,t} + N_{p,t}) - (1 - \omega_N)\Delta \log(K_t), \tag{G.2}$$

where $\omega_N = \frac{W_f N_f + W_p N_p}{Y}$ is the labor share. Since there are no distortions in physical capital investment, capital gets paid its true output elasticity, which implies $\alpha = 1 - \omega_N$. Thus, plugging (G.1) in (G.2), we can rewrite the baseline measured TPF in response to a risk aversion shock as:

$$\Delta \log \tilde{Z}_t^e \equiv (1 - \alpha)\Delta \log(N_t) - \omega_N \Delta \log(N_{f,t} + N_{p,t}). \tag{G.3}$$

Figure G.1 shows the response of such TFP measure in our model alongside the empirical response of Fernald's TFP. We discuss the finding in the main text.

In some applications, the TFP econometrician may have data on hours in addition to employment. In this case, the measure of TFP would be:

$$\Delta \log \tilde{Z}_t^h \equiv (1 - \alpha)\Delta \log(N_t) - \omega_N \Delta \log(N_{f,t} + x N_{p,t}). \tag{G.4}$$

Above, x represents the ratio of hours worked by a part-time worker relative to the hours of a full-time worker, which in section 4.2 we calibrated to be 0.5. The labor share ω_N

remains unchanged because it depends on the total labor income of each group.