Risky Business Cycles*

Susanto Basu† Boston College and NBER

Giacomo Candian‡ HEC Montréal

Ryan Chahrour§ Boston College

Rosen Valchev ¶ Boston College

October 29, 2021

Abstract

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

Keywords: Business Cycles; Risk Premia; Uncertainty.
JEL Classification: E32, E24.

*We thank George-Marios Angeletos, Larry Christiano, Cosmin Ilut, Nir Jaimovich, Ana Lariau, Stephen Terry, and seminar participants at The Ohio State University, the Federal Reserve Bank of Atlanta, Monash University, University of Padua, Aarhus University, William & Mary, and the participants to the NBER Summer Institute and to the AEA, CEA, NASMES, WEAI, SED, EEA, and Stanford SITE conferences.

†Department of Economics, Boston College, Chestnut Hill, MA 02467. Telephone: 617-552-2182. Email: susanto.basu@bc.edu.

‡Department of Applied Economics, 3000, Chemin de la Côte-Sainte-Catherine, Montréal QC, H3T 2A7 Canada. Telephone: 514-340-6810. Email: giacomo.candian@hec.ca.

§Department of Economics, Boston College, Chestnut Hill, MA 02467. Telephone: 617-552-0902. Email: ryan.chahrour@bc.edu.

¶Department of Economics, Boston College, Chestnut Hill, MA 02467. Telephone: 617-552-8704. Email: rosen.valchev@bc.edu.

1 Introduction

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

Related Literature

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

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

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

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

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

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

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

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

2 Risk Premium Shocks

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

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

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

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

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

which consists of the logs of real per-capita output, consumption, investment, employment, real ex-post stock returns (inclusive of dividends), real ex-post three-month treasury bill returns, and the level of the dividend-price ratio. Our data range from 1985Q1 through 2018Q4, starting in the mid-1980s to avoid the structural break of the start of the "Great Moderation".[10] The VAR is estimated in levels using ordinary least squares, including three lags in the polynomial $B(L)$.

We augment our baseline VAR with a set of auxiliary variables, S_t, that includes additional labor market and business cycle indicators. These auxiliary variables are related to current and past observations of Y_t according to

$$S_t = \Gamma(L)Y_t + v_t, \tag{3}$$

and the coefficient matrix $\Gamma(L)$, estimated via OLS, contains the same number of lags as the VAR in (1). Using the estimated values of $\Gamma(L)$, we can then compute the impulse responses for any auxiliary variable using the responses for Y_t implied by (1). Among the variables in S_t, we include total employment, part-time employment, the ex-post return on five-year US bonds, and two measures of market risk perceptions that have appeared recently in the literature, which we describe in more detail below.

2.1 Identification Approach

Following Uhlig (2003), we identify a "rotation" matrix A such that the first element of the shock vector ϵ_t is the orthogonal innovation that explains the largest portion of the variation in the *expected* equity excess return. Excess returns are not explicitly included in our data, but they can be computed using the variables in Y_t. Specifically, the *realized* j-period cumulative excess return is defined as

$$rp_{t,t+j} \equiv [r_{t+1}^s + r_{t+2}^s + ... + r_{t+j}^s] - [r_{t+1}^b + r_{t+2}^b + ... + r_{t+j}^b]. \tag{4}$$

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

Assuming the variables in Y_t span the information set of investors, we can use the expectations implied by the VAR to derive an expression for the expected excess return:

$$\mathbb{E}_t[rp_{t,t+j}] = (e_5 - e_6)\left[(I - B(L))^{-1}\sum_{i=1}^{j} L^{-j}\right]_+ A\epsilon_t \tag{5}$$

where $[\cdot]_+$ denotes the annihilator operator that eliminates terms with negative powers in L.[11]

Let $\phi(z) \equiv (e_5 - e_6)\left[(I - B(z))^{-1}\sum_{i=1}^{j} z^{-j}\right]_+ A$ be the z transfer-function associated with the MA(∞) representation in (5). The variance of $E_t[rp_{t,t+j}]$ associated with spectra of periodicity $p \equiv [p_1, p_2]$ is given by

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

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

$$\Omega_p^{rp} = \frac{1}{2\pi}\int_{2\pi/p_2}^{2\pi/p_1} \phi(e^{-i\lambda})'\phi(e^{-i\lambda}) d\lambda. \tag{7}$$

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

$$A = \hat{A}q_1, \tag{8}$$

where $\hat{A}$ is the Cholesky decomposition of the matrix $\Sigma_\mu \equiv cov(\mu_t)$. Effectively, then, the first element of the resulting vector ϵ_t is the orthogonal innovation that has the highest contribution to the overall variance of the expected excess equity return.

To implement the procedure, we need to specify the horizon at which excess returns are computed and the frequency band of variation we want our procedure to target. As a baseline case we choose $j = 20$, consistent with the common practice in the finance literature of emphasizing the predictability in the five-year excess equity return. Second we choose $p = [2, 500]$, corresponding to fluctuations of periodicity anywhere between 2 and 500 quarters. Practically, this corresponds to targeting unconditional variances, but

[11] For example, in the case of a VAR(1) so that $Y_t = BY_{t-1} + A\epsilon_t$, the expression in (5) reduces to

$$E_t[RP_{t+j}] = (e_5 - e_6)(B + B^2 + ... + B^j)(I - BL)^{-1}A\epsilon_t.$$

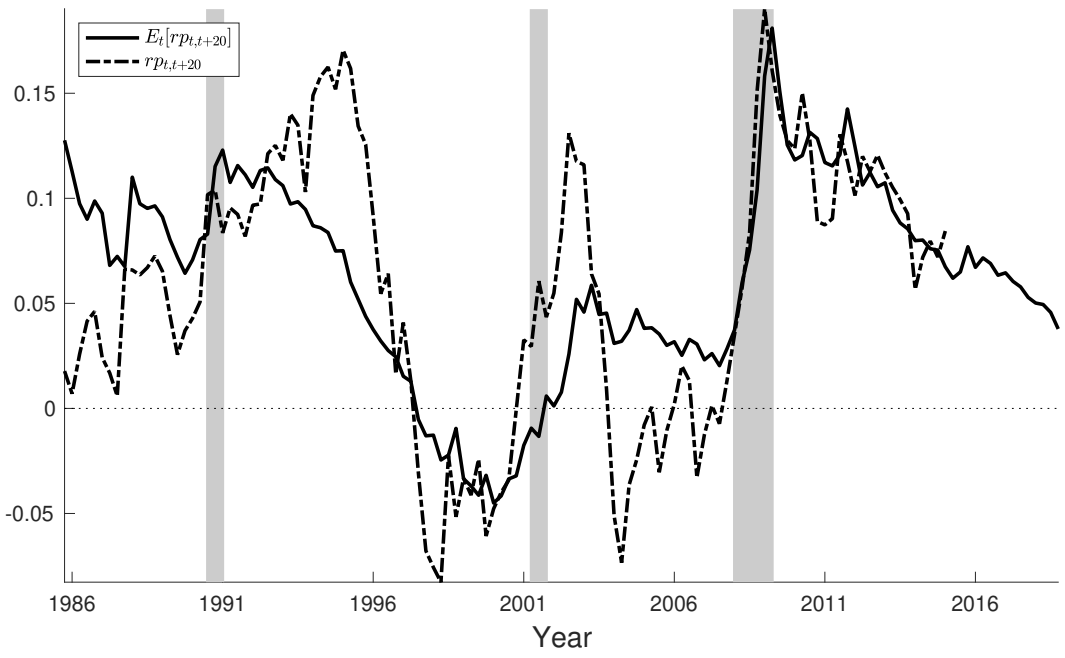


Figure 1: Ex-ante and ex-post excess stock returns.

allows us to perform robustness checks in which the VAR is estimated in VECM form and the lag polynomial $B(L)$ has a unit root. In robustness checks, we find our main qualitative and quantitative findings are robust to our choice of lag-length in the VAR as well as to estimating the VAR in VECM form so long as we allow for more than two independent trends in the data.

Before turning to the key empirical results, in Figure 1 we plot the expected excess stock return as estimated by our VAR, $E_t(rp_{t,t+20})$ against the realized excess return over that same forecasting horizon, $rp_{t,t+20}$. The Figure shows that both series exhibit substantial variation, though the ex-post series is not surprisingly somewhat more volatile. Moreover, the figure shows that VAR-implied excess return is, indeed, a remarkably good predictor of excess stock returns: it explains about 53% of the unconditional variation in actual realized returns. Overall, the figure showcases the common finding in the finance literature that there is a substantial predictable component in five-year excess stock returns (e.g. Cochrane (2011)) and that our VAR captures that predictability very well.

2.2 Empirical Results

Our identification procedure based on Uhlig (2003) extracts the structural shock (or combination of shocks) that accounts for the bulk of the fluctuations in the VAR-implied expected excess returns. While this procedure cannot label the deep origins of this shock

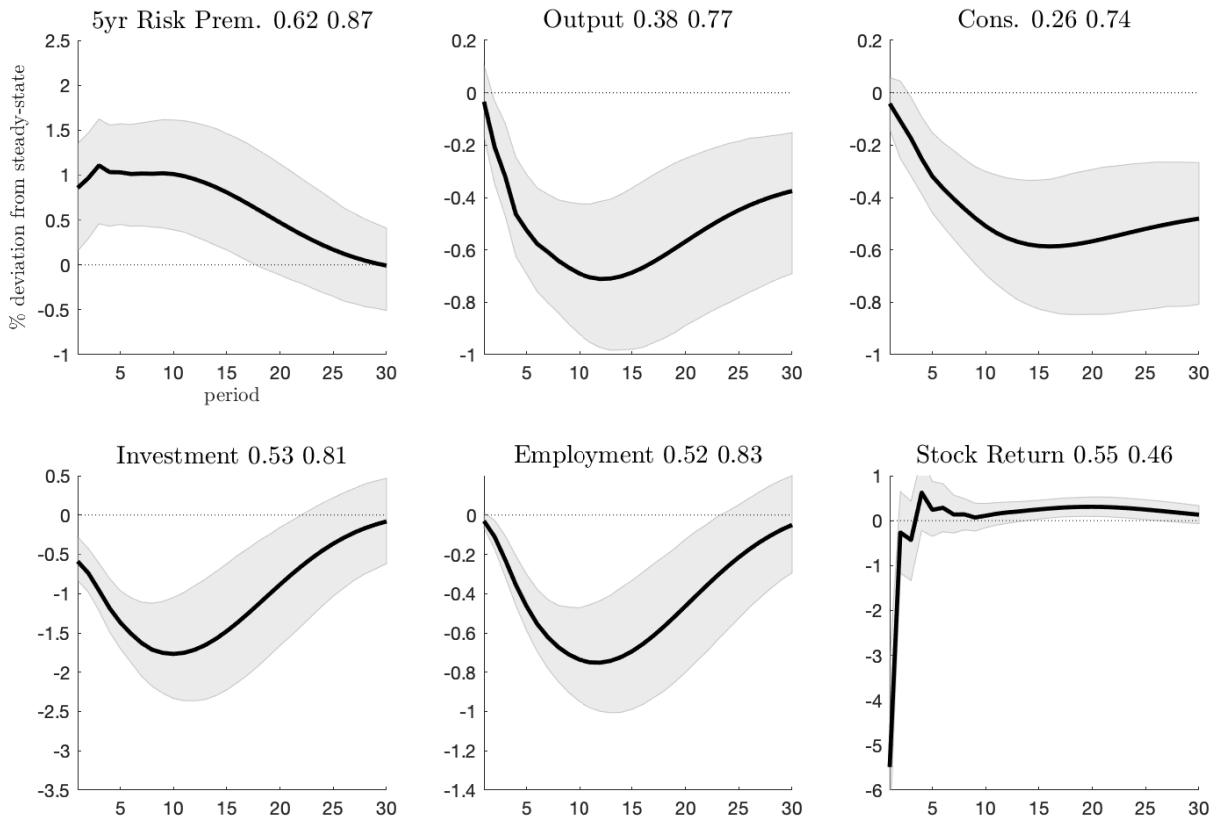


Figure 2: Impulse responses to VAR-identified risk premium shock. Numbers in subplot titles correspond to the percent of variance explained at the business cycle and unconditional frequencies, respectively.

uniquely, it is a powerful statistical tool for isolating the predominant driver of surprise changes in expected excess equity returns, which we can then further analyze.

More generally, a seminal finding of the asset pricing literature is that risk premia are excessively volatile and not clearly attributable to fundamentals. For example, recent work by Bekaert et al. (2019) finds that equity risk premia are in fact almost entirely driven by exogenous shocks to "risk-aversion" or "risk-appetite", emphasizing that this is a shock to the pricing of assets rather than a shock to the fundamental volatility of cash flows. Given these results, it is likely that we are recovering the same shock, hence, we will simply label the result of our identification procedure as a "risk premium" or "risk-aversion" shock, and study how the broader set of macro variables react to such shocks. Our results can then serve as a well-defined empirical target for *any* model in which risk premia vary over time, either exogenously or endogenously as a result of some other shocks.

Figure 2 plots the impulse responses of the major business cycle variables in response to the shock identified by our VAR procedure. The first panel plots the response of the equity risk premium itself, which rises significantly on impact and stays elevated for at least fours years. The numbers in the panel titles represent the percent of variance of the risk premium explained by our shock at the business cycle and unconditional frequencies, respectively. In the case of the risk-premium itself, the shock explains 87% of the unconditional variation in the predictable five-year excess return of equity, and 62% of its variance at business cycle frequencies. These numbers are very high, signifying that indeed surprise innovations to the equity risk premium predominantly follow a common dynamic pattern. It is interesting to consider how this pattern plays out in the rest of the economy.

The next four panels in the figure show the responses of the main macro aggregates. The figures shows that all of these variables are substantially affected by our shock as well, with output, consumption, investment and employment all falling substantially on impact, and remaining depressed for an extended period. The last panel shows that the shock is also associated with a sharp drop in stock prices on impact (fall in ex-post return), followed, after more than a year, by a persistent period of higher than average returns. These eventual higher than average returns underlie the elevated risk premium.

The titles of these five panels similarly report the percent of variance explained by the shock, and these values are also quite large: at business cycle frequencies the shock explains more than half of variables except consumption and output, and the shock generally explains substantially more than half of the unconditional variances. Moreover, we emphasize that this "risk premium" shock causes large fluctuations that specifically follow all of the standard patterns associated with the typical business cycle, exemplified with strong comovement across Y, C, I and N.

Table 1 presents an alternative perspective on how important the identified shock is for generating comovement in the data. Each entry in the table reports the unconditional covariance between the variables listed in the row/column, conditional on *only the risk premium shock* being active, relative to the covariance implied by the full estimated system in (1). Thus, the diagonal elements of the table correspond to the standard variance share decomposition, as reported in the panel titles of Figure 2. By contrast, the off-diagonal elements are not bounded between zero and one: They will take negative values if the covariance implied by our shock has the opposite sign as the corresponding unconditional covariance, and they will be larger than unity when the covariance conditional on our shock is larger than the unconditional covariance.

Table 1: Unconditional Covariance Explained - Baseline Procedure

	Output	**Cons.**	**Investment**	**Employment**	**Stock Return**
Output	0.77				
Cons.	0.77	0.74			
Investment	0.85	0.93	0.81		
Employment	0.88	0.88	0.88	0.83	
Stock Return	1.29	1.00	1.41	0.99	0.46

The Table shows that, as important as our shock is for the variances of each variable, it is an even more important driver of comovement among the variables. For example, the "share" of 1.29 for the covariance between output and stock returns implies that the unconditional output-stock return covariance is *smaller* than the covariance implied by our identified shock alone. Thus, all other shocks that affect output and stock prices must move them in *opposite* directions. More generally, all of the off-diagonal entries in the table are above 0.75, indicating that our identified shock explains the large majority of the unconditional comovement we find in the data.

Since our identification procedure is closely related to the "main business cycle shock" identification of Angeletos et al. (2020), it is natural to compare our findings here with theirs.[12] In particular, those authors identify the shock that explains the largest portion of the (business cycle) variance of a single quantity variable, such as a measure of employment, output or investment. To compare our results, we perform their procedure on our estimated VAR by targeting just employment over business cycle frequencies.

Table 2 reports the same covariance shares as we report for our shock. The table shows that the shock identified using their procedure captures a somewhat smaller share of unconditional fluctuations, as well as a smaller portion of the comovement across the variables, especially with regard to stock returns. Note that their procedure targets business cycle frequencies, in that frequency band their shock indeed explains more of the fluctuations in employment (as that is its target), however, again the differences are mild.

Backing out the point estimates of identified shocks, the two shock series are strongly correlated at 89.7%. Meanwhile, in unreported results we find that the corresponding impulse responses are qualitatively similar across both shocks. Hence we conclude that,

[12] Kurmann and Otrok (2013) have also followed a similar strategy, but identifying the shock which best explains the slope of the yield curve. However, the shock they recover is different than the one we find – for example it *does not* generate the full comovement pattern, as on impact of their shock investment rises. Moreover, inflation also is significantly lower for an extended period of time, while as we show further below, in our case if anything inflation rises.

Table 2: Uncondtional Covariance Explained - Angeletos et al. (2020) procedure

	Output	**Cons.**	**Investment**	**Employment**	**Stock Return**
Output	0.62				
Cons.	0.62	0.59			
Investment	0.67	0.74	0.59		
Employment	0.72	0.74	0.67	0.66	
Stock Return	0.59	0.67	-0.20	0.64	0.51

though we target very different portions of the data (excess returns vs employment, unconditional vs business cycles) the shock we identify is closely related to the "main business cycle" shock.

From this perspective, our empirical exercise showcases that the central features of business cycles and risk-premia are indeed intimately related. Whatever is responsible for business cycles is also responsible for the large counter-cyclical risk-premium fluctuations, and vice versa. The "main business cycle" shock and the "risk-aversion" shock appear to share the same structural origins.

Figure 3 and 4 report impulse responses to our identified shock for several additional variables of interest (most of which are included in the auxiliary vector S_t, except for interest rates which are part of the core VAR). The first panel in the top row of Figure 3 shows a somewhat surprising result – the employment of part-time workers actually *increases* in response to our shock. This response is significant after the impact period, and the fluctuations induced by our shock explain a very large portion of the fluctuations in this series as well – 74% of its unconditional variance. The second panel plots the share of part-time employment in total employment; since total employment is falling this share rises even more in percentage terms than the part-time employment itself. Finally, last panel of the first row shows that aggregate hours-per-worker fall substantially after the shock, which is another manifestation of the shift towards part-time employees.

The final row of Figure 3 shows that real interest rates, both short and longer term, are hardly affected by our shock at all. The fluctuations are small for both variables, never significant for the 5-year bond rate, and capture only relative small portions of the variance of either.

While safe rates are relatively unaffected by the shock, the final panel of the figure shows that excess bond returns — measured by the spread between Baa-rated corporate debt and the 10-year treasury yield — do rise in the period after the shock, though the

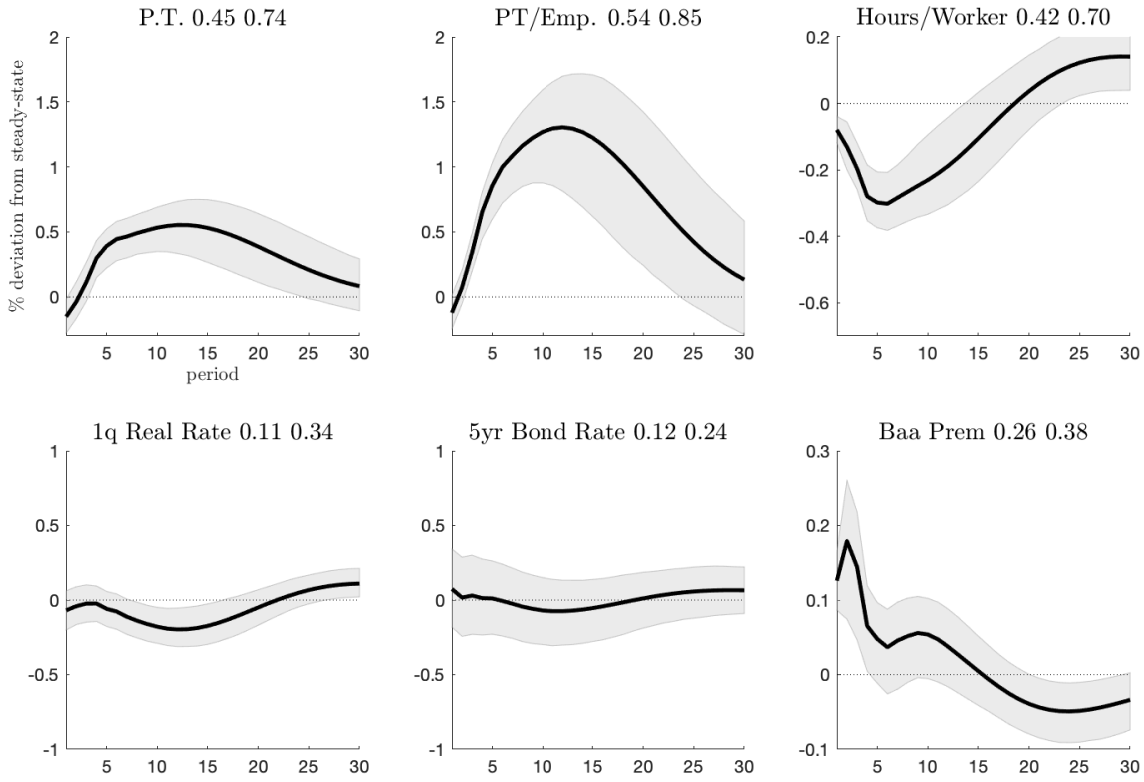


Figure 3: Impulse responses to VAR-identified risk premium shock for additional variables. Numbers in subplot titles correspond to the percent of variance explained at the business cycle and unconditional frequencies, respectively.

effect is quite transitory, unlike the large and persistent effects on equity risk premia. Lastly, while we do not report it, the equity-based perceived-risk measure of Pflueger et al. (2020) also increases strongly in response to our shock. Thus, while the risk premia rise across several asset classes, our shock seems to play a major role in equity markets specifically.

Finally, the left panel of Figure 4 shows that the aggregate profit rate in the non-financial sector shows no significant decline (and if anything even *rises*, though only four years after the shock, and briefly so). This is consistent with our view that it is changes in the required return (i.e. risk-premia), rather than expected future cash-flows, that are driving the fall in asset prices we document following our shock.

Moreover, in the right panel of the figure, we observe that our shock does not create any significant deflationary pressure, as would be implied by textbook Neo-Keynesian mechanism of a demand-driven recession. If anything, inflation even rises modestly after the shock. Overall, our shock explains less that 15% of the business cycle variance of both

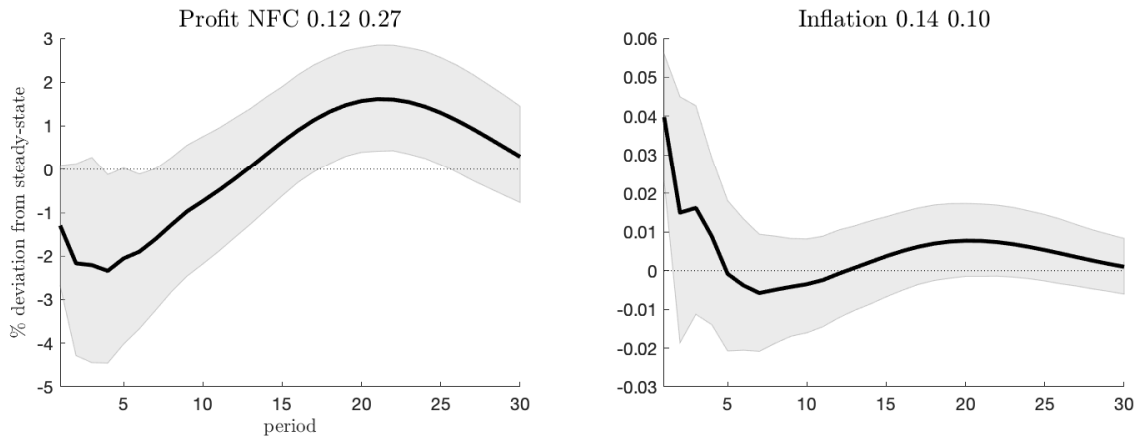


Figure 4: Impulse responses to VAR-identified risk premium shock for additional variables. Numbers in subplot titles correspond to the percent of variance explained at the business cycle and unconditional frequencies, respectively.

of these variables, indicating that aggregate profits and inflation are quite disconnected from risk premia and macroeconomic fluctuations.

This disconnect, together with the largely insignificant and counterintuitive sign of these impulse responses, helps to motivate our search for a model of risk-driven business cycles that does not center around supply shocks or textbook inflationary demand shocks.

3 Model

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

The central modeling challenge in generating comovement via risk fluctuations is that an increase in risk leads to precautionary motives, which move consumption and investment in opposite directions ceteris paribus. However, since our model features frictions in forming or severing labor relationships, this effectively turns labor positions into an alternative real savings technology. As a result, in addition to an overall increase in desired savings upon a rise in risk, the agents are also facing the portfolio choice problem of *what* to save in, and ceteris paribus, shift savings and investments towards *safer* options.

The key to our mechanism is that long-term labor relationships are riskier than both

capital and part-time labor matches. Because of this, an increase in risk aversion leads to a reallocation of savings away from full-time vacancies and towards both capital and part-time labor. Both of these "investments" deliver less additional output in the short run: capital only becomes operational with a lag and part-time workers, according to our estimation, have a lower marginal product. In this way, the reallocation of savings towards capital and part-time workers lowers output and, through the general equilibrium effect of market clearing, ultimately decreases aggregate investment along with consumption and aggregate employment.

Households

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

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

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

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

In the above, Q^c_t is price of a multi-period corporate bond where a fraction $(1-d)$ of the principal is repaid each period, R^r_t is the one-period safe real interest rate, P^e_t is the price of a share of the representative firms that pays a real dividend D^e_t, and E^l_t is the household's total labor earnings (detailed below).

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

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

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

Households supply labor inelastically, but labor markets are subject to search and matching frictions in the spirit of Mortensen and Pissarides (1994). There are two types of labor contracts: the first, which we call "full-time", involves longer-term relationships and sticky wages, labeled $W_{1,t}$, while the second, which we call "part-time", involves shorter employment spells and flexible wages, $W_{2,t}$. We denote with $N_{1,t}$ and $N_{2,t}$ the masses of labor currently working under the full-time and part-time contracts, respectively. While employment status may vary across workers, their consumption is the same because the household provides perfect consumption insurance for its members.

Workers search sequentially. Specifically, all unemployed workers at the beginning of period t first try to find a full-time job. If the search is unsuccessful, a given worker searches for a part-time job.[13] Accordingly, the mass of searchers for the two types of contracts are:

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

$$S_{2,t} = 1 - N_{1,t} - (1 - \rho_2)N_{2,t-1}. \tag{13}$$

Equation (12) reflects the following timing assumptions. At the beginning of period t, a fraction ρ_1 and ρ_2 of employment relationships that were active in the full-time and part-time sector at time $t-1$ experience exogenous separation and the corresponding workers enter the pool of unemployed. All of these workers, $\rho_1 N_{1,t-1} + \rho_2 N_{2,t-1}$, and those who were unemployed in the previous period, $U_{t-1} \equiv 1 - N_{1,t-1} - N_{2,t-1}$, look for a full-time job at time t. Equation (13) then states that all agents who were unemployed at the beginning of the period and did not find a full-time job, then search in the part-time sector.

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

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

subject to any shocks themselves.

Because the representative household self-insures, aggregate household earnings each period are thus:

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

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

Firms

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

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

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

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

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

subject to the production function,

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

the labor aggregator,

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

the capital accumulation equation,

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

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

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

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

Depreciation depends on utilization via the following functional form:

$$\delta(u_t) = \delta + \delta_1(u_t(i) - u) + \frac{\delta_2}{2}(u_t(i) - u)^2. \tag{22}$$

In the above constraints, Z_t is an exogenous labor-augmenting technology, and $\Theta_{i,t}$ is the probability of filling a type-i vacancy.

We follow Jermann (1998) by assuming the representative firm finances a percentage of its capital stock each period through debt. Like in Gourio (2012), this financing occurs with multi-period riskless bonds. Firm debt evolves according to

$$B^c_{t+1} = dB^c_t + L_t, \tag{23}$$

where the parameter $d \in [0, 1)$ is the portion of outstanding debt that does not mature in the current period, and hence determines the effective duration of a bond as $\frac{1}{1-d}$. The net amount of new borrowing each period, $Q^c_t L_t = \xi K_{t+1}$, 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 $B^c/K \equiv \nu = \xi/(1-d)$. The price of the multi-period bond (Q^c_t) is determined by the pricing equation

$$Q^c_t = \mathbb{E}_t \left[M_{t,t+1}(dQ^c_{t+1} + 1) \right]. \tag{24}$$

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

$$D^E_t = D_t - B^c_t + \xi K_{t+1}. \tag{25}$$

Since the Modigliani and Miller (1958) theorem holds in our model, leverage does not affect firm value or optimal firm decisions. Leverage makes the price of equity more volatile, however, and allows us to map the model concept of equity returns to the data.

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

$$J_{i,t} = MPL_{i,t} - W_{i,t} + (1-\rho_i)\mathbb{E}_t \left\{ M_{t,t+1} J_{i,t+1} \right\}. \tag{26}$$

Equation (26) states that the value a of match is equal to the current surplus the firm extracts from it, given by the marginal product of the worker ($MPL_{i,t}$) net of the wage payment, plus the discounted continuation value if the worker does not separate from the firm. Solving this condition forward, we can rewrite the value of a match as:

$$J_{i,t} = \underbrace{\sum_{j=0}^{\infty} \frac{(1-\rho_i)^j \mathbb{E}_t(MPL_{i,t+j} - W_{i,t+j})}{R^R_{t,t+j}}}_{\text{cash flows}} + \underbrace{\sum_{j=1}^{\infty} (1-\rho_i)^j Cov_t\left(M_{t,t+j}, MPL_{i,t+j} - W_{i,t+j}\right)}_{\text{risk premium}}, \quad (27)$$

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

The asset-pricing equation (27) expresses the value of a match as the sum of two terms. The first term is the present value of cash-flows, in this case the surplus from the match from the view point of the firm, discounted with the relevant risk-free rate $R^R_{t,t+j} = \mathbb{E}_t[M_{t,t+j}]^{-1}$. The second term is a risk adjustment. Assets whose dividend streams covary negatively with the stochastic discount factor, and positively with consumption, have lower prices or higher risk premia, since holding those assets gives the investor a more volatile consumption stream. In this particular context, labor relationships whose future firm's surplus covary more negatively with the stochastic discount factor will carry a higher risk premium.

Wage-setting

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

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

$$W_1 = \eta_1 \left[(1-\Omega)(1-\alpha) \left(\frac{uK}{N}\right)^{\alpha} \left(\frac{N}{N_1}\right)^{\frac{1}{\theta}} + \gamma_1^l \theta_1 \right] + (1-\eta_1) b_1, \quad (28)$$

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

Given the sequential nature of the search in the two sectors, the steady-state outside

option for the full-time sector is

$$b_1 \equiv P_2^m(W_2 + \kappa) + (1 - P_2^m)b_2, \tag{29}$$

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

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

$$W_{2,t} = \eta_2 \left[\Omega(1-\alpha) Z_t \left(\frac{u_t K_t}{Z_t N_t} \right)^{\alpha} \left(\frac{N_t}{N_{2,t}} \right)^{\frac{1}{\theta}} + \gamma_{2,t}^{l} \theta_{2,t} \right] + (1 - \eta_2) b_{2,t}. \tag{30}$$

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

This wage setting setup conforms with the data, where the part-time positions indeed display more flexible wages than full-time positions, as documented by Lariau (2017). Moreover, the same paper also documents that part-time position feature significantly shorter spells of employment, hence at our benchmark calibration we set $\rho_2 > \rho_1$.

As can be seen explicitly in equation (27), these empirically relevant differences in the duration of employment spells and in the wage flexibility result in different risk profiles of the two labor contracts. On the one hand, the recursive preferences place a higher risk-premium on longer duration assets (i.e. there is a higher covariance between the long-horizon SDFs and far off uncertain cash flows). On the other hand, the stickier wages effectively act as leverage and amplify the volatility of the full-time labor match surplus that accrues to the firm. Both of these features, make the risk-premium on full-time labor positions higher.

Government

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

$$G = \bar{g} Y. \tag{31}$$

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

Market clearing

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

$$N_{1,t} = (1 - \rho_1)N_{1,t-1} + \mathcal{M}_{1,t}, \tag{32}$$

$$N_{2,t} = (1 - \rho_2)N_{2,t-1} + \mathcal{M}_{2,t}, \tag{33}$$

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

$$\mathcal{M}_{i,t} = \chi_i v_i^{\epsilon_i} S_i^{1-\epsilon_i}, \tag{34}$$

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

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

$$Y_t = C_t + I_t + \gamma_{1,t}^l v_{1,t} + \gamma_{2,t}^l v_{2,t} + G_t. \tag{35}$$

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

Exogenous Processes

The economy is perturbed by two exogenous disturbances. The first is technology, Z_t, which we assume is integrated of order one and follows an AR(1) in log-growth rates:

$$\log(\Delta Z_t) = \rho_z \log(\Delta Z_{t-1}) + \sigma_z \epsilon_t^z, \tag{36}$$

where $\Delta Z_t \equiv Z_t / Z_{t-1}$. The second is risk aversion, γ_t, with dynamics governed by an AR(2) processes in logs:

$$\log(\gamma_t / \gamma_{ss}) = \rho_{1,\gamma} \log(\gamma_{t-1} / \gamma_{ss}) + \rho_{2,\gamma} \log(\gamma_{t-2} / \gamma_{ss}) + \sigma_\gamma \epsilon_t^\gamma. \tag{37}$$

Although the model generates the *qualitative* comovement patterns of the data when estimated with an AR(1) process, allowing for the richer dynamics in (37) helps the model to better match the hump-shaped patterns exhibited by our empirical impulse responses.

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 outside options, the sticky full-time wage, and government expenditure are all cointegrated with technology, with a common error-correction rate of ω. Specifically, for each variable $X \in \{\gamma_{1,t}, \gamma_{2,t}, b_{1,t}, b_{2,t}, W_{1,t}, G_t\}$, we assume that $X_t = \Gamma_t \bar{X}$ where $\bar{X}$ is the deterministic steady-state value, and

$$\Gamma_{t+1} = \Gamma_t^{\omega} Z_t^{1-\omega}. \tag{38}$$

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

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

$$W_{1,t} = \left(\frac{Z_{t-1}}{\Gamma_{t-1}}\right)^{1-\omega} W_{1,t-1}. \tag{39}$$

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

4 Quantifying the Mechanism

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

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

Table 3: Calibrated Parameters

Name	Description	Value
β	Discount rate	0.994
ψ	Intertemporal elasticity of substitution	2.500
α	Capital share	0.300
δ	Capital depreciation rate	0.025
δ_2	Cap. util. cost $\times$ 100	0.030
$\bar{g}$	Steady-state G/Y	0.200
d	Corporate bond duration	0.975
	Labor Markets	
ρ_1	Separation Rate - FT	0.044
ρ_2	Separation Rate - PT	0.354
η_1	HH's bargaining power - FT	0.500
η_2	HH's bargaining power - PT	0.200
	Exogenous Processes	
σ_z	Std. dev. of tech shock	0.006

4.1 Calibrated Parameters and Steady-State Targets

To begin, we calibrate a set of standard parameters to values that are consistent with the literature, as summarized in Table 3. Namely, we set $\beta = 0.994$ to be consistent with a non-stochastic steady-state annual real interest rate around 2.4%. The capital share is set to a standard value of 0.3 in the production function. Because the estimated model includes risk, this will imply an unconditional capital income share that is slightly less than 0.3. We use a standard long-run depreciation rate of $\delta = 0.025$. The relatively low curvature parameter of the capital depreciation function, $\delta_2 = 0.0003$, implies that adjustments in utilization are relatively inexpensive, consistent with the values used by Christiano, Eichenbaum, and Evans (2005). Finally, we assume that on average government expenditures are 20% of GDP and fix the bond duration parameter $d = 0.975$, so as to imply corporate debt has a 10-year maturity, as in Gourio (2012).

The elasticity of intertemporal substitution plays an important role in models that target asset pricing facts, and we set this parameter to $\psi = 2.5$. This value is relatively high compared to the standard macro literature that focuses on quantities only, but is in-line with values used by macro-finance papers that target asset pricing moments (Schorfheide et al., 2018). Nevertheless, the overall qualitative patterns we estimate do not rely on any restriction on ψ and can still emerge, for example, even when $\psi < 1$. Our primary motivation for choosing a high elasticity is that this choice allows our

model to match fairly large responses of consumption to our shock without generating counterfactually-large changes in safe interest rates.

In terms of labor markets, the key calibrated parameters are the separation rates, ρ_1 and ρ_2. We pick these values to satisfy two features of the data. First, we fix $\rho_2/\rho_1 = 8$, matching recent estimates of the relative difference in separation rates of part-timers to full-timers from the longitudinal dimension of the U.S. Current Population Survey (Lariau, 2017). Second, we then fix the level of separations in the full-time sector (ρ_1) to match the aggregate quarterly separation rate in the US economy of 10% (Yashiv (2008)). We also choose standard values for the Nash bargaining parameters (and generally find that alternative choices for these parameters play a small role in our results).

Finally, we use the Basu et al. (2006); Fernald (2014) data on utilization-adjusted U.S. TFP to calibrate the process for productivity. Over our sample period, we find that productivity is an almost perfect random walk and it has standard deviation in growth rates of 0.6%, implying $\rho_z = 0$ and $\sigma_z = 0.006$.

The remaining parameters are estimated by matching the impulse-responses to a risk-aversion shock, and also eight additional unconditional moments, which we report in Table 4. Our approach is to place extremely high weight on the unconditional moment targets in the estimation procedure (described below), with the idea being to get as good of a match as possible in terms of unconditional moments, and then see how the model does in terms of conditional dynamics. As we can see from the third column in Table 4, the model can indeed match the unconditional targets virtually perfectly.

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

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

Finally, we also target the standard-deviations of (HP-filtered) employment and vacancies (using the series created by Barnichon, 2010), in order to ensure that the model delivers a Beveridge curve in line with the data. We also note that since the model is indeed successful at matching both of these moments, this implies it also does not suffer

Table 4: Unconditional Target Moments

Description	**Data**	**Model**
Equity risk premium	0.064	0.063
Share of part-time	0.180	0.182
LR unemployment	0.060	0.061
Vacancy Rate	0.035	0.035
Hiring cost/GDP	0.010	0.010
PT earn./FT earn.	0.500	0.497
Std. Dev. HP log(Emp/Pop)	0.011	0.011
Std. Dev. HP log(vacan.)	0.117	0.117

from the Shimer puzzle.

4.2 Estimation Procedure

Aside from the additional long-run target moments in Table 4, our impulse response matching exercise is standard. The estimation targets are the impulse responses of output, consumption, investment, total employment, part-time employment, equity returns, and the real interest rate. We denote the set of parameters we estimate with Π, and those includes the steady-state risk aversion parameter γ, the capital adjustment cost parameter, ϕ_K, the aggregate leverage ratio ν, the vacancy posting costs, γ_1^l and γ_2^l, the value of outside options b_1 and b_2, the production share of part-time labor Ω, the four parameters governing the aggregate matching technologies, the cointegration parameter ω, and the parameters of the risk aversion shock, $\rho_{1,\gamma}, \rho_{2,\gamma}$ and σ_γ.

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

$$\mathcal{L}(\Pi) \equiv (\hat{\psi} - \psi(\Pi))' W (\hat{\psi} - \psi(\Pi)). \tag{40}$$

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

Table 5: Estimated Parameters

Name	Description	Point Est.	Std Err.
γ_{ss}	Steady-state risk aversion	79.123	11.508
ϕ_k	Capital Adj. Cost	12.478	2.210
ν	Leverage Ratio	0.822	0.024
	Labor Markets		
γ_1^l	Vacancy posting cost - FT	4.092	0.442
γ_2^l	Vacancy posting cost - PT	0.144	0.020
b_1	Value if no perm posit.	1.108	0.045
b_2	Value if unemployed	0.645	0.006
Ω	Labor contrib. of PT	0.172	0.008
θ	Elas. between FT & PT	1.715	0.108
ϵ_1	Matching elasticity - FT	0.329	0.023
ϵ_2	Matching elasticity - PT	0.514	0.016
χ_1	Matching technology - FT	0.794	0.051
χ_2	Matching technology - PT	0.959	0.020
ω	Cointegration parameter (i.e. wage adj.)	0.968	0.009
	Risk Aversion Process		
$\rho_{1,\gamma}$	AR(1) risk av. shock	1.960	0.026
$\rho_{2,\gamma}$	AR(2) risk av. shock	-0.966	0.025
σ_γ	Std. dev. of risk av. shock	0.025	0.010

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

4.3 Estimation Results

Table 5 reports the estimated values $\widehat{\Pi}$ along with standard errors for the estimates. The estimation procedure finds a global interior optimum, and the corresponding parameters value are quite plausible. For one example, the estimated value for the average level of risk aversion, $\gamma = 79.9$, is high but remains similar to or lower than the values found/used by several quantitive 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). For another example, the estimated elasticity between full- and part-time work of $\theta = 1.72$ is also reasonable. Though direct evidence on this elasticity is rare in the literature, Montgomery (1988) estimates a value of 1.5.[14]

Figure 5 shows that the impulse responses implied by the estimated model (blue-dot

[14]There is a much longer literature concerning the elasticity of substitution between skilled and unskilled workers. The numbers found in this literature are typically between 1.5 and 2, though Havranek et al. (2020) argue these estimates are likely to be biased upwards.

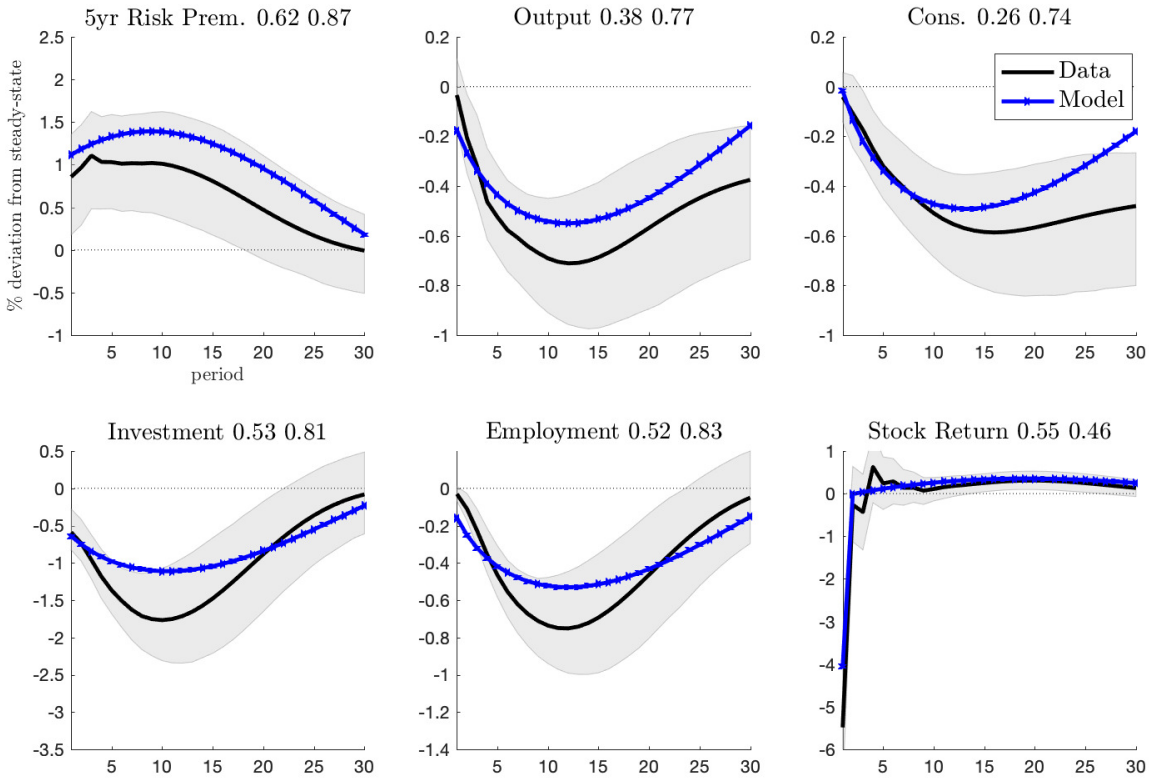


Figure 5: Impulse responses to VAR-identified risk premium shock along with model-implied responses.

lines) do an excellent job of matching the data, and in particular generate the familiar aggregate comovement pattern that traditionally defines the standard business cycle. On the macroeconomic side, the changes in output, consumption and employment track the data quite closely. The change in investment on impact exactly matches the sharp fall we observe in the data, and although the model then undershoots modestly for several subsequent periods it remains within the standard error bands of the data.

In addition to the macro variables, the model does an excellent job at capturing two central features of asset prices. First, the model closely matches the persistent increase in the 5-year equity risk premium, which was central to our identification of the empirical shock and is similarly central for disciplining the risk-aversion shock in the model. Second, the model also matches the pattern of realized equity returns very well, with a steep fall in stock returns on impact, followed by a long period of above-average returns. Thus, the model indeed generates variation in asset prices primarily due to changes in expected excess returns, and not changes in cash-flows, as is also true in the data. Overall, the model is successful at capturing both the business cycle comovements and the counter-

cyclical risk premium that we found in the data.

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

The answer is that, in our model, agents have several ways to invest: they can channel their increased desire to save either into physical capital or into one of two-types of labor relationships. Thus, in addition to increasing savings demand overall, the increased precautionary motive also induces agents to shift their savings towards *safer assets*, which generally have lower equilibrium marginal products. Intuitively, the latter is the natural counterpart to risky assets having lower equilibrium returns, but in the case of real assets.

There are two types of reallocation that happen in our model: one between labor and capital, another within labor markets. Consider first how an increase in risk aversion affects the firms' choice of posting full-time vs part-time vacancies. Since our calibration choices imply that short-term labor relationships are less risky, due to both a flexible wage and shorter duration, an increase in risk aversion induces firms to shift their vacancy postings towards the safer, part-time sector. However, it turns out that in our benchmark estimation part-time positions have a lower marginal product. This is not because of a difference in the fundamental productivity of the two types of labor — both are subject to the same total factor productivity disturbances — but because risk-averse firms consistently invest more in part-time labor for its safety, pushing down the marginal product even at the stochastic steady state.

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

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

[15] Recall from eq. (35) that investment in our model includes both investment in capital and in vacancy posting. Each contributes roughly half of the fall in measured investment, with the fall in vacancies contributing more early on and the fall in capital investment contributing more after the first year.

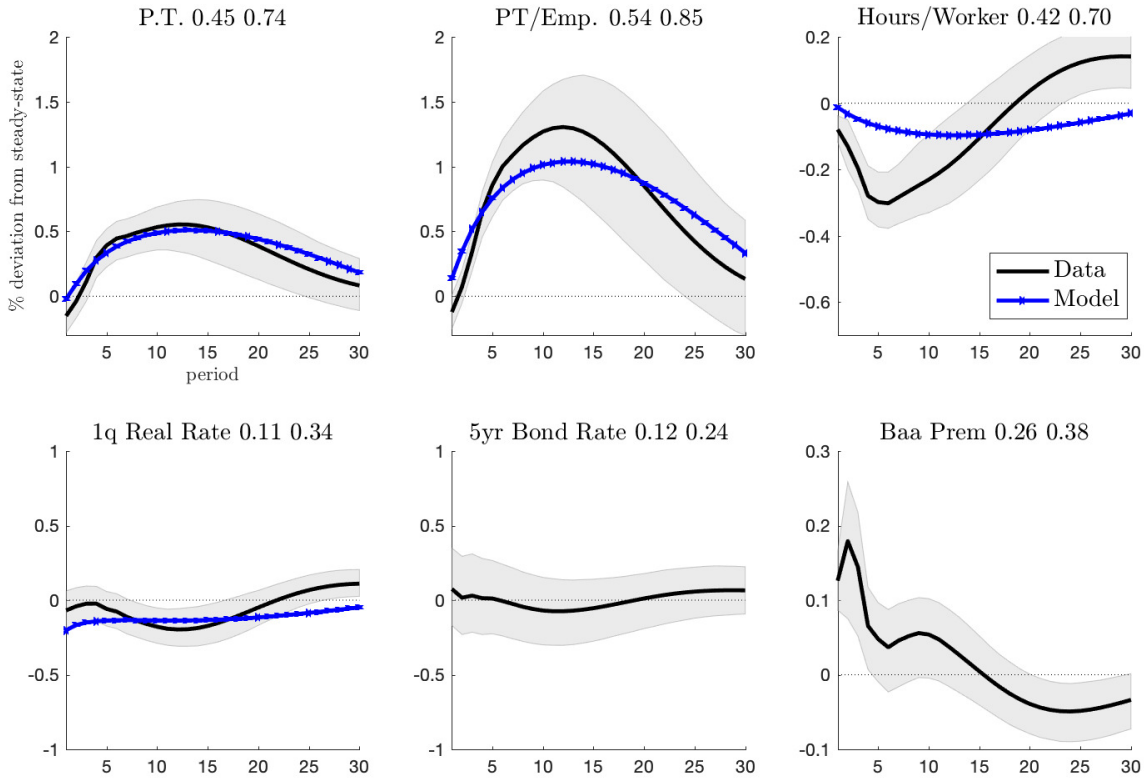


Figure 6: Impulse responses to VAR-identified risk premium shock along with model-implied responses.

an even larger fall in output.

The result of these reallocations across savings vehicles is a real version of the Paradox of Thrift. Risk-averse firms reallocate towards less productive inputs, reducing the resources available for investment and consumption and, by lowering the future marginal product of physical capital, ultimately reduce the incentive to invest in capital goods themselves. When the reallocation forces described above are strong enough, as is the case in our benchmark estimation, the risk aversion shock thus leads to an overall fall in output, investment, labor, and consumption, generating the hallmark business cycle comovement.

The first row of Figure 6 captures the model's implications for the reallocation within labor types. In the first panel, we show the model's implications for part-time employment, and the second panel shows the response of the (logged) ratio of part-time to full-time employment. These figures show that the model not only captures the patterns of total employment, but also captures very well the concurrent reallocation between the full-time and part-time sectors that is also a significant feature of the data. This is direct evidence

of the crucial reallocation forces behind our model. This reallocation towards the part-time workers with flexible wages also allows the model to be consistent with recent, though still controversial, evidence that aggregate wages are fairly cyclical, despite the fact that wages in our full-time sector are relatively rigid. Indeed, the unconditional correlation of HP-filtered wages and output in our model is 0.40 at our estimated parameter values.

The third panel of the first row plots the impulse response of hours-per-worker in the data and model. Since our model does not include an intensive margin within jobs, we construct this response by assuming that hours of a part-time worker are exactly half the hours of full-time workers. This panel shows that the (extensive margin) reallocation of workers across worker types can account for a portion, but not all, of the fall in hours-per-worker seen in the data.

The bottom left panel of the figure reports the model implied dynamics of the real interest rate. While the model implies a somewhat larger fall in real interest rates in response to the shock, the economic significance of the difference is modest. The limited response of the real interest rate in the model highlights that in our framework recessions are driven by varying *risk premia*, and the associated reallocation of savings towards safer assets rather than by intertemporal substitution of present for future consumption. This business-cycle narrative is consistent with the central lesson of the macro-finance literature summarized in Cochrane (2017). Overall, we conclude, the model does a remarkably good job of matching the quantitative patterns in the data.

4.4 Risk Premia

Above, we discussed the basic intuition that underlies our model's ability to deliver realistic macroeconomic comovements based on differences in the relative risk profiles of the available real investment vehicles. Our argument essentially requires full-time labor, the dominant component of aggregate labor, to be sufficiently risky. We now verify these patterns hold in our estimation by measuring in the model the risk premia associated with the the three types of available investment assets: capital, full-time and part-time vacancies.

We begin by defining the excess return on physical capital as

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

where

$$\tilde{R}^K_{t+1} \equiv \frac{\alpha u_{t+1}\left(\frac{u_{t+1}K_{t+1}}{Z_{t+1}N_{t+1}}\right)^{\alpha-1} + q_{t+1}\left(1-\delta(u_{t+1}) - adj.costs\right)}{q_t}, \tag{41}$$

can be derived by rearranging the capital Euler equation. In (41) the return on capital reflects the net cash flow of a unit of capital, equal to its marginal product plus the change in the market price net of depreciation and adjustment costs.

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

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

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

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

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

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

Table 6 reports the (annualized) stochastic steady state premia implied by our model. Our baseline estimation implies a part-time labor premium of 4.1%, and a full-time labor premium of 18.7%, which is several times higher. This reflects the characteristic differen-

Table 6: Steady-state Annualized Risk Premia

Description	**Value (%)**
Capital premium	0.5
Full-time labor premium	18.7
Part-time labor premium	4.1

tial features of the part-time sector as having (i) flexible wages and (ii) a shorter duration – both of which make the part-time labor relatively less risky, and thus makes it an attractive alternative to full-time positions during periods of heightened risk aversion. It turns out that that the average capital premium of the model is also fairly low, at just 0.5%, thus full-time labor vacancies are indeed the riskiest investment vehicle in our model.

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

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

$$SR = \frac{E[log(R^E_{t+1}/R^b_t)]}{std\left[log(R^E_{t+1}/R^b_t)\right]}. \tag{42}$$

where R^E_{t+1} is the return on equity. The annualized Sharpe ration implied by our model is 0.45, which is quite close to the empirical value of 0.41 in our sample. Similarly, the model-implied standard-deviation of the (annualized) 5-year risk premium is $100 \times std(rp_{t,t+20}) = 6.68\%$, which is very similar to the corresponding realized standard-deviation in our data sample of 6.41%. These results provide additional confirmation that our model provides a quantitatively realistic match to the data, not only in terms of average premia, but also

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

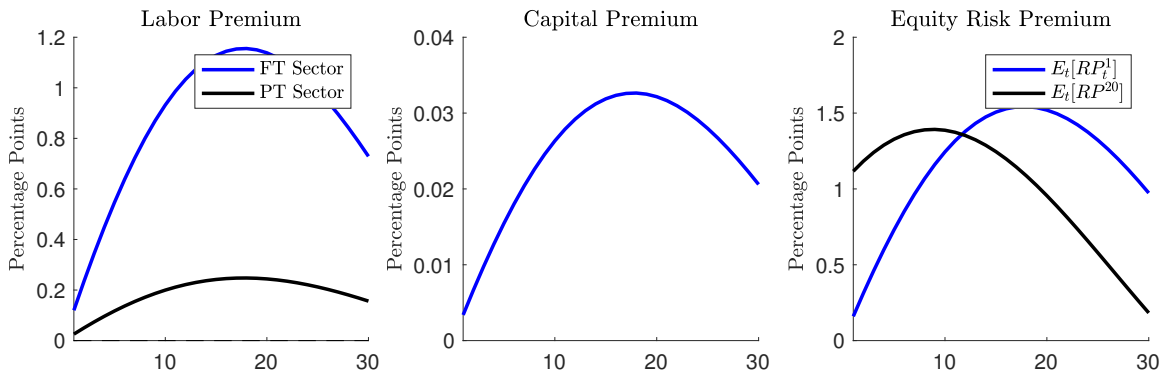


Figure 7: Impulse responses of risk premia in the model following a risk appetite shock.

in terms of their volatility.

Lastly, Figure 7 reports the responses of the labor and capital risk premia to the risk aversion shock in our estimated model. The figure shows that, as suggested by our discussion above, the risk premia for the full-time sector rises substantially more than that of the part-time sector and capital, conditional on an aggregate increase in risk-aversion. The last panel of the figure shows the patterns of the one-quarter and the five-year expected equity risk premia. The figure emphasizes that the bulk of the increase in the longer-term risk premia occurs because of expected excess returns that occur a year or more after the arrival of the shock. This feature is also consistent with our reduced-form evidence that shows statistically significant excess stock returns beginning a year after the identified shock.

4.5 Inspecting the Mechanism

To examine what features of the model are crucial for our results, and why, we perform a set of counter-factual experiments changing one parameter or one feature at a time, otherwise using the estimated values for the other parameters of the model.

In Figure 8 we plot the counterfactual responses when all wages are flexible and set according to Nash bargaining period by period. The figure shows that wage stickiness is crucial for the strength of our mechanism.

However, the way wage stickiness operates in our model is novel – the key is that it helps generate a high *risk premium* on full-time labor relationships, and not a high volatility of the expected cash flows to full time labor. The sticky wages effectively act as leverage on the surplus accruing to firms, increasing the surplus volatility (and thus its pro-cyclicality). In turn, under fully flexible wages, full-time labor relationships are much

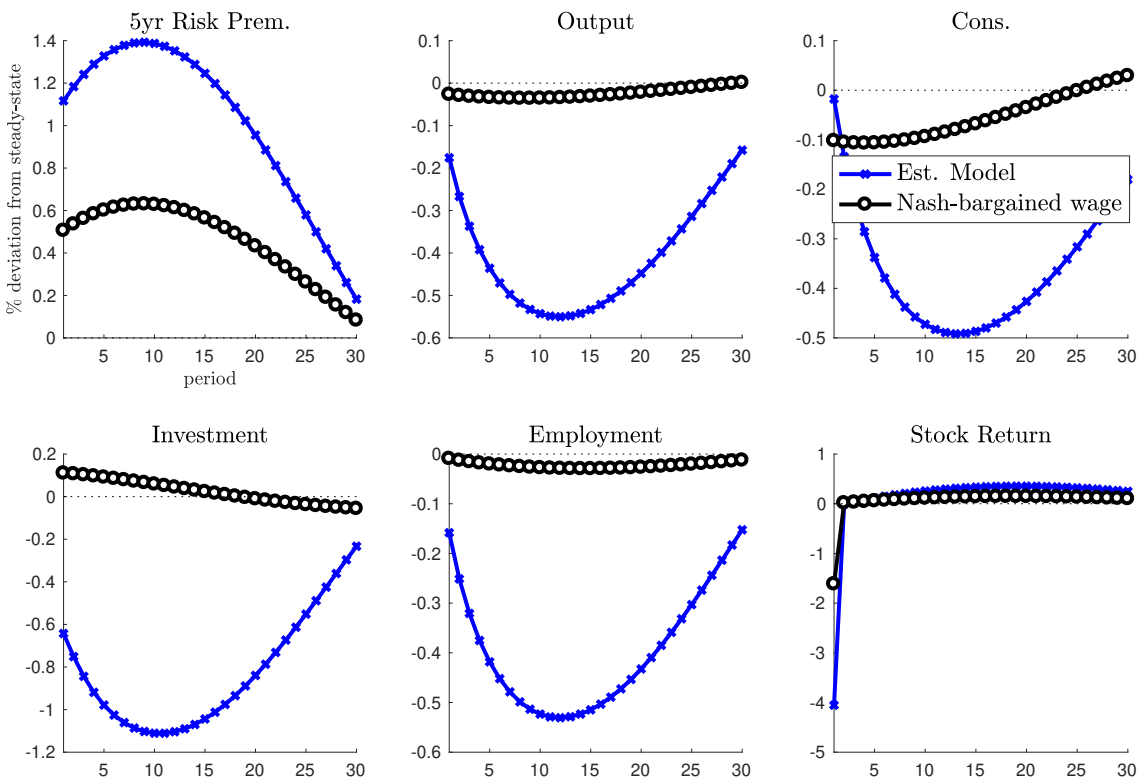


Figure 8: Model responses with Nash-bargained wages.

safer, hence the reallocation of investment conditional on risk-aversion shocks, which drive the fall in labor and output in our benchmark model, is largely absent. As a result, the risk-aversion shocks are no longer able to generate meaningful fluctuations in aggregate quantities, a finding that effectively shows the Shimer (2005) puzzle extends beyond shocks to productivity to other potential sources of aggregate fluctuations, including second-moment shocks.

Our next counterfactual exercise demonstrates, directly, the fundamental role played by risk premia in driving business cycle comovements in our estimated model. Equation (27) in Section 3 has shown that the value of a match to a firm is the sum of the expected discounted cash flows associated with the match plus a risk premium. Figure 9 shows the responses to a risk aversion shock in a counterfactual economy where the risk premium component in the valuation of either full-time or part-time labor is shut down, so that firms only take into account expected cash-flow in their vacancy posting decisions. The picture shows that when we eliminate the risk premium associated with full-time workers, our model fails to reproduce business cycle comovements and delivers only negligible changes in all aggregate variables, including employment. By contrast, shutting down the risk premium on part-time workers leaves the dynamic responses to the risk aversion

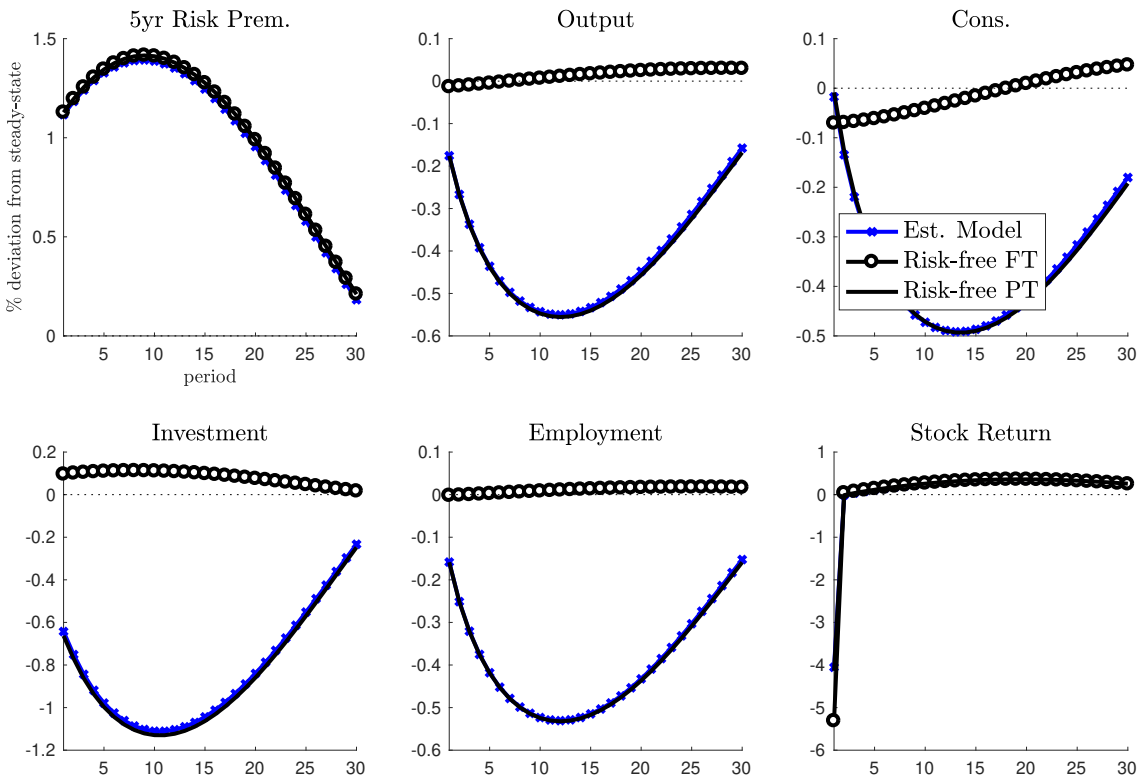


Figure 9: Model responses without risk premia.

shock virtually unchanged relative to our baseline.

We thus conclude that it is the high riskiness of the full-time workers that allows the model to match the aggregate responses to changes in risk premia. This is despite the fact that the usual effect of sticky wages amplifying the volatility of *expected* cash-flows, as in Hall (2005), is present in this counter-factual. That effect is simply small and negligible, in part because while sticky, the wage in our full-time sector is far from perfectly rigid.

By showing that the effect of the risk-aversion shock dissipates when full-time workers are safe, this exercise not only clarifies the role of wage stickiness in our model but also sets it apart from previous contributions. In Hall (2005), wage stickiness resolves the Shimer (2005) puzzle because it makes the value of matches more volatile. The volatility comes from the large movements in the expected cash flows associated with these matches following productivity shocks when wages are sticky.

By contrast, our last two counterfactuals demonstrate that in our model sticky wages generate volatility in the value of full-time matches by means of variation in the risk premia associated with these matches, not in the volatility of their expected cash flows. One important reason is the different type of shock we consider. Intuitively, a risk-aversion shock has only a muted impact on future labor productivity (only indirectly, through the

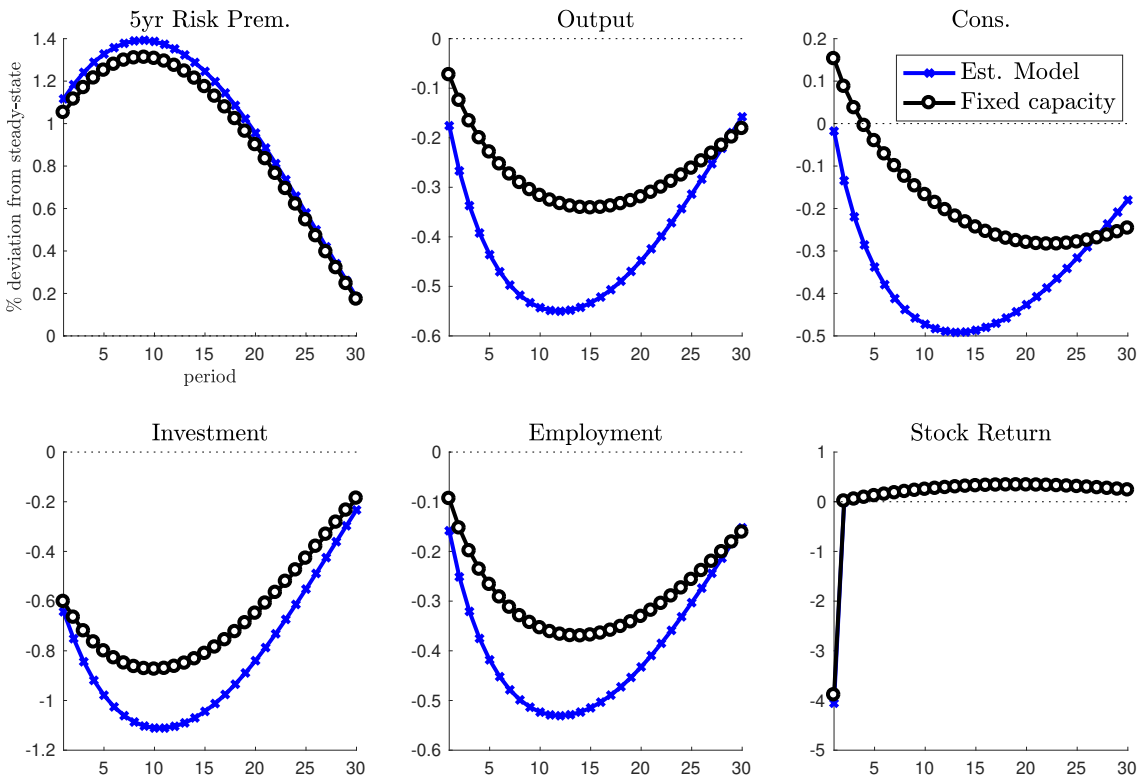


Figure 10: Model responses with fixed capacity utilization.

equilibrium fall in capital and utilization), unlike the standard direct shocks to the level of TFP. Hence, a risk premium shock, even with sticky wages, does not lead to meaningful variation in the expected cash flows of labor matches. It does, however, have a significant impact on the *pricing* of these cash flows, by making firms much more sensitive to the uncertainty involved with future surpluses from labor matches subject to sticky wages.

In this sense, we uncover a new way in which wage stickiness can help deliver large changes in the value of workers and thus resolve the Shimer (2005) puzzle: by driving large changes in the risk premia associated with employment.

In a different exercise, Figure 10 plots the resulting impulse responses when we counterfactually fix capacity utilization (circle lines), against the IRFs implied by the baseline estimation (blue lines). The key observation is that capital utilization plays an important amplification role, where without it the model does not generate a sufficient fall in output on impact to generate full comovement. In the benchmark model capacity utilization falls because the fall in aggregate labor N_t lowers the marginal product of capital. The fall in utilization amplifies the effect of the fall of aggregate labor on output, and enables a recession with full comovement. Without the fall in utilization, we still have a fall in both investment and employment, which showcases that our model's core reallocation forces

are sufficient to drop labor, and in turn MPK and investment on their own. However, the fall in investment is actually bigger than the fall in output in this case, and thus consumption rises for a few periods.

5 Conclusions

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

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

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

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

References

Angeletos, G.-M., F. Collard, and H. Dellas (2020, October). Business-cycle anatomy. *American Economic Review 110*(10), 3030–70.

Arellano, C., Y. Bai, and P. J. Kehoe (2019). Financial frictions and fluctuations in volatility. *Journal of Political Economy 127*(5), 2049–2103.

Bansal, R., M. M. M. Croce, W. Liao, and S. Rosen (2021). Uncertainty-induced reallocations and growth. *Available at SSRN 2872105*.

Barnichon, R. (2010). Building a composite help-wanted index. *Economics Letters 109*(3), 175 – 178.

Basu, S. and B. Bundick (2017). Uncertainty shocks in a model of effective demand. *Econometrica 85*(3), 937–958.

Basu, S., J. G. Fernald, and M. S. Kimball (2006). Are Technology Improvements Contractionary? *The American Economic Review 96*(5), pp. 1418–1448.

Bayer, C., R. Lütticke, L. Pham-Dao, and V. Tjaden (2019). Precautionary savings, illiquid assets, and the aggregate consequences of shocks to household income risk. *Econometrica 87*(1), 255–290.

Beaudry, P. and F. Portier (2006, September). Stock prices, news, and economic fluctuations. *American Economic Review 96*(4), 1293–1307.

Bekaert, G., E. C. Engstrom, and N. R. Xu (2019). The time variation in risk appetite and uncertainty. Technical report, National Bureau of Economic Research.

Belo, F., V. Gala, J. Salomao, and M. A. Vitorino (2019, July). Decomposing firm value. Working Paper 26112, National Bureau of Economic Research.

Blanchard, O. and J. Galí (2010, April). Labor markets and monetary policy: A new keynesian model with unemployment. *American Economic Journal: Macroeconomics 2*(2), 1–30.

Bloom, N. (2009). The impact of uncertainty shocks. *Econometrica 77*(3), 623–685.

Bloom, N., M. Floetotto, N. Jaimovich, I. Saporta-Eksten, and S. J. Terry (2018). Really uncertain business cycles. *Econometrica 86*(3), 1031–1065.

Borovicka, J. and K. Borovicková (2018). Risk premia and unemployment fluctuations. *Manuscript, New York University*.

Borowczyk-Martins, D. and E. Lalé (2019). Employment adjustment and part-time work: Lessons from the united states and the united kingdom. *American Economic Journal: Macroeconomics 11*(1), 389–435.

Caballero, R. J. and A. Simsek (2020, 03). A Risk-Centric Model of Demand Recessions and Speculation*. *The Quarterly Journal of Economics 135*(3), 1493–1566.

Cacciatore, M. and F. Ravenna (2020, October). Uncertainty, wages, and the business cycle. Working Paper 27951, National Bureau of Economic Research.

Caggiano, G., E. Castelnuovo, and G. Pellegrino (2021). Uncertainty shocks and the great recession: Nonlinearities matter. *Economics Letters 198*, 109669.

Challe, E., J. Matheron, X. Ragot, and J. F. Rubio-Ramirez (2017). Precautionary saving and aggregate demand. *Quantitative Economics 8*(2), 435–478.

Christiano, L., R. Motto, and M. Rostagno (2014). Risk shocks. *American Economic Review 104*(1), 27–65.

Christiano, L. J., M. Eichenbaum, and C. L. Evans (2005). Nominal Rigidities and the Dynamic Effects of a Shock to Monetary Policy. *Journal of Political Economy 113*(1), 1–45.

Cochrane, J. H. (2011). Presidential address: Discount rates. *The Journal of Finance 66*(4), 1047–1108.

Cochrane, J. H. (2017). Macro-finance. *Review of Finance 21*(3), 945–985.

den Haan, W. J. and G. Kaltenbrunner (2009). Anticipated growth and business cycles in matching models. *Journal of Monetary Economics*.

Dew-Becker, I. (2014). Bond pricing with a time-varying price of risk in an estimated medium-scale bayesian dsge model. *Journal of Money, Credit and Banking 46*(5), 837–888.

Di Tella, S. and R. E. Hall (2020, January). Risk premium shocks can create inefficient recessions. Working Paper 26721, National Bureau of Economic Research.

Edge, R. M. and R. S. Gürkaynak (2010). How useful are estimated dsge model forecasts for central bankers? [with comments and discussion]. *Brookings Papers on Economic Activity*, 209–259.

Eisfeldt, A. L. and A. A. Rampini (2006). Capital reallocation and liquidity. *Journal of monetary Economics 53*(3), 369–399.

Faia, E. and V. Pezone (2018). Monetary policy and the cost of heterogeneous wage rigidity: Evidence from the stock market.

Fernald, J. (2014). A quarterly, utilization-adjusted series on total factor productivity. Federal Reserve Bank of San Francisco.

Fernández-Villaverde, J., P. Guerrón-Quintana, K. Kuester, and J. Rubio-Ramírez (2015, November). Fiscal volatility shocks and economic activity. *American Economic Review 105*(11), 3352–84.

Freund, L. and P. Rendahl (2020). Unexpected effects: uncertainty, unemployment, and inflation.

Gilchrist, S., J. W. Sim, and E. Zakrajšek (2014). Uncertainty, financial frictions, and investment dynamics. Technical report, National Bureau of Economic Research.

Gourio, F. (2012). Disaster risk and business cycles. *American Economic Review 102*(6), 2734–66.

Hall, R. E. (2005, March). Employment fluctuations with equilibrium wage stickiness. *American Economic Review 95*(1), 50–65.

Hall, R. E. (2017, February). High discounts and high unemployment. *American Economic Review 107*(2), 305–30.

Havranek, T., Z. Irsova, L. Laslopova, and O. Zeynalova (2020). Skilled and unskilled labor are less substitutable than commonly thought. Technical report, Kiel, Hamburg.

Ilut, C. and H. Saijo (2021). Learning, confidence, and business cycles. *Journal of Monetary Economics 117*, 354–376.

Ilut, C. L. and M. Schneider (2014, August). Ambiguous business cycles. *American Economic Review 104*(8), 2368–99.

Jermann, U. J. (1998). Asset pricing in production economies. *Journal of Monetary Economics 41*(2), 257 – 275.

Kehoe, P. J., P. Lopez, V. Midrigan, and E. Pastorino (2019, December). Asset prices and unemployment fluctuations. Working Paper 26580, National Bureau of Economic Research.

Kilic, M. and J. A. Wachter (2018, 01). Risk, Unemployment, and the Stock Market: A Rare-Event-Based Explanation of Labor Market Volatility. *The Review of Financial Studies 31*(12), 4762–4814.

Kurmann, A. and C. Otrok (2013, October). News shocks and the slope of the term structure of interest rates. *American Economic Review 103*(6), 2612–32.

Lariau, A. (2017). Underemployment and the business cycle. *Unpublished manuscript, Boston College*.

Leduc, S. and Z. Liu (2016). Uncertainty shocks are aggregate demand shocks. *Journal of Monetary Economics 82*, 20–35.

López-Salido, D., J. C. Stein, and E. Zakrajšek (2017, 05). Credit-Market Sentiment and the Business Cycle*. *The Quarterly Journal of Economics 132*(3), 1373–1426.

Mitra, I. and Y. Xu (2019, 10). Time-Varying Risk Premium and Unemployment Risk across Age Groups. *The Review of Financial Studies 33*(8), 3624–3673.

Modigliani, F. and M. H. Miller (1958). The cost of capital, corporation finance and the theory of investment. *The American Economic Review 48*(3), 261–297.

Montgomery, M. (1988). On the determinants of employer demand for part-time workers. *The Review of Economics and Statistics*, 112–117.

Mortensen, D. T. and C. A. Pissarides (1994). Job creation and job destruction in the theory of unemployment. *The Review of Economic Studies 61*(3), 397–415.

Mukoyama, T., M. Shintani, K. Teramoto, et al. (2018). Cyclical part-time employment in an estimated new keynesian model with search frictions. Technical report.

Nekarda, C. J. and V. A. Ramey (2013). The cyclical behavior of the price-cost markup. Working Paper 19099, National Bureau of Economic Research.

Pflueger, C., E. Siriwardane, and A. Sunderam (2020, 03). Financial Market Risk Perceptions and the Macroeconomy*. *The Quarterly Journal of Economics 135*(3), 1443–1491.

Piazzesi, M. and M. Schneider (2006). Equilibrium yield curves. *NBER Macroeconomics Annual 21*, 389–472.

Rotemberg, J. J. and M. Woodford (1999). The cyclical behavior of prices and costs. Volume 1 of *Handbook of Macroeconomics*, Chapter 16, pp. 1051 – 1135. Elsevier.

Rudebusch, G. D. and E. T. Swanson (2012, January). The bond premium in a dsge model with long-run real and nominal risks. *American Economic Journal: Macroeconomics 4*(1), 105–43.

Schorfheide, F., D. Song, and A. Yaron (2018). Identifying long-run risks: A bayesian mixed-frequency approach. *Econometrica 86*(2), 617–654.

Segal, G. and I. Shaliastovich (2021). Uncertainty, risk, and capital growth. Technical report.

Sharpe, W. F. (1994). The sharpe ratio. *The Journal of Portfolio Management 21*(1), 49–58.

Shimer, R. (2005, March). The cyclical behavior of equilibrium unemployment and vacancies. *American Economic Review 95*(1), 25–49.

Uhlig, H. (2003). What moves real GNP? *Unpublished manuscript*.

Yashiv, E. (2008). U.S. Labor Market Dynamics Revisited. *Scandinavian Journal of Economics 109*(4).

Online Appendix

A Model

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

A.1 Households

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

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

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

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

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

Epstein-Zin preferences imply the following stochastic discount factor:

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

The first order conditions for the households yield

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

A.2 Firms

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

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

subject to the production function:

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

and the labor aggregator:

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

The capital accumulation equation is

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

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

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

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

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

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

The problem of the firms yields the following equilibrium conditions:

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

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

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

$$q_t \delta'(u_t) = R_t^K, \tag{A.14}$$

and finally

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

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

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

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

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

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

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

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

where the total labor force has been normalized to unity.

A.3 Equilibrium

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

ditions:

$$Y_t = (u_t K_t)^{\alpha} (Z_t N_t)^{1-\alpha}, \tag{A.21}$$

$$N_t = \left((1-\Omega) N_{1,t}^{\frac{\theta-1}{\theta}} + \Omega N_{2,t}^{\frac{\theta-1}{\theta}} \right)^{\frac{\theta}{\theta-1}}, \tag{A.22}$$

$$N_{2,t} = (1-\rho_1) N_{2,t-1} + m_2(S_{2,t}, v_{2,t}), \tag{A.23}$$

$$N_{1,t} = (1-\rho_2) N_{2,t-1} + m_1(S_{1,t}, v_{1,t}), \tag{A.24}$$

$$S_{1,t} = 1 - (1-\rho_1) N_{1,t-1} - (1-\rho_2) N_{2,t-1}, \tag{A.25}$$

$$S_{2,t} = 1 - N_{1,t} - (1-\rho_2) N_{2,t-1}, \tag{A.26}$$

$$\begin{aligned} \frac{\gamma_{1,t}^l v_{1,t}}{m_1(S_{1,t}, v_{1,t})} =& (1-\Omega)(1-\alpha) Z_t \left(\frac{u_t K_t}{Z_t N_t} \right)^{\alpha} \left(\frac{N_t}{N_{1,t}} \right)^{\frac{1}{\theta}} - W_{1,t} + \\ &+ \mathbb{E}_t \left\{ M_{t,t+1} \frac{(1-\rho_1) \gamma_{1,t+1}^l v_{1,t+1}}{m_1(S_{1,t+1}, v_{1,t+1})} \right\}, \end{aligned} \tag{A.27}$$

$$\begin{aligned} \frac{\gamma_{2,t}^l v_{2,t}}{m_2(S_{2,t}, v_{2,t})} =& \Omega(1-\alpha) Z_t \left(\frac{u_t K_t}{Z_t N_t} \right)^{\alpha} \left(\frac{N_t}{N_{2,t}} \right)^{\frac{1}{\theta}} - W_{2,t} + \\ &+ \mathbb{E}_t \left\{ M_{t,t+1} \frac{(1-\rho_2) \gamma_{2,t+1}^l v_{2,t+1}}{m_2(S_{2,t+1}, v_{2,t+1})} \right\}, \end{aligned} \tag{A.28}$$

$$W_{1,t} = \Gamma_t \eta \left[(1-\Omega)(1-\alpha) \left(\frac{uK}{N} \right)^{\alpha} \left(\frac{N}{N_1} \right)^{\frac{1}{\theta}} + \gamma_1^l \frac{v_1}{S_1} \right] + (1-\eta) \Gamma_t b_1, \tag{A.29}$$

$$W_{2,t} = \eta \left[\Omega(1-\alpha) Z_t \left(\frac{u_t K_t}{Z_t N_t} \right)^{\alpha} \left(\frac{N_t}{N_{2,t}} \right)^{\frac{1}{\theta}} + \gamma_{2,t}^l \frac{v_{2,t}}{S_{2,t}} \right] + (1-\eta) b_{2,t}, \tag{A.30}$$

$$M_{t,t+1} = \beta \left(\frac{C_{t+1}}{C_t} \right)^{1-1/\psi} \left(\frac{C_t}{C_{t+1}} \right) \left(\frac{V_{t+1}}{(\mathbb{E}_t V_{t+1}^{1-\gamma_t})^{\frac{1}{1-\gamma_t}}} \right)^{1/\psi - \gamma_t}, \tag{A.31}$$

$$P_t^E = \mathbb{E}_t \left[M_{t,t+1} \left(D_{t+1}^E + P_{t+1}^E \right) \right], \tag{A.32}$$

$$Q_t^c = \mathbb{E}_t \left[M_{t,t+1} (d Q_{t+1}^c + 1) \right], \tag{A.33}$$

$$1 = R_t^r \mathbb{E}_t M_{t,t+1}, \tag{A.34}$$

$$R_t^K = \alpha \left(\frac{u_t K_t}{Z_t N_t} \right)^{\alpha - 1}, \tag{A.35}$$

$$R_t^K = q_t \delta'(u_t), \tag{A.36}$$

$$\begin{aligned} q_t =& \mathbb{E}_t \Big[M_{t+1} \Big(u_{t+1} R_{t+1}^K + \\ &+ q_{t+1} \left(1 - \delta(u_{t+1}) - \frac{\phi_K}{2} \left(\frac{I_{t+1}}{K_{t+1}} - \delta \right)^2 + \phi_K \left(\frac{I_{t+1}}{K_{t+1}} - \delta \right) \frac{I_{t+1}}{K_{t+1}} \right) \Big) \Big], \end{aligned} \tag{A.37}$$

$$K_{t+1} = \left(1 - \delta(u_t) - \frac{\phi_K}{2}\left(\frac{I_t}{K_t} - \delta\right)^2\right) K_t + I_t, \tag{A.38}$$

$$\frac{1}{q_t} = 1 - \phi_K\left(\frac{I_t}{K_t} - \delta\right), \tag{A.39}$$

$$Y_t = C_t + I_t + \gamma_1 v_{1,t} + \gamma_2 v_{2,t} + G_t, \tag{A.40}$$

$$G_t = \bar{g} Y_t, \tag{A.41}$$

$$D_t^E = Y_t - W_{1,t}N_{1,t} - W_{2,t}N_{2,t} - I_t - \gamma_{1,t}^l v_{1,t} - \gamma_{2,t}^l v_{2,t} - B_t^c + \xi K_{t+1}, \tag{A.42}$$

$$B_{t+1}^c = dB_t^c + \xi K_{t+1}/Q_t^c, \tag{A.43}$$

$$V_t = \max\left[(1-\beta)(C_t)^{1-1/\psi} + \beta(\mathbb{E}_t V_{t+1}^{1-\gamma_t})^{\frac{1-1/\psi}{1-\gamma_t}}\right]^{\frac{1}{1-1/\psi}}, \tag{A.44}$$

$$\Gamma_{t+1} = \Gamma_t^{\omega} Z_t^{1-\omega}. \tag{A.45}$$

A.4 Stationary Equilibrium

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

$$\log(\Delta Z_t) = \rho_z \log(\Delta Z_{t-1}) + \sigma_z \epsilon_t^z, \tag{A.46}$$

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

$$\hat{Y}_t = (u_t \hat{K}_t)^{\alpha} (\Delta Z_t N_t)^{1-\alpha}, \tag{A.47}$$

$$N_t = \left((1-\Omega) N_{1,t}^{\frac{\theta-1}{\theta}} + \Omega N_{2,t}^{\frac{\theta-1}{\theta}}\right)^{\frac{\theta}{\theta-1}}, \tag{A.48}$$

$$N_{2,t} = (1-\rho_1) N_{2,t-1} + m_2(S_{2,t}, v_{2,t}), \tag{A.49}$$

$$N_{1,t} = (1-\rho_2) N_{2,t-1} + m_1(S_{1,t}, v_{1,t}), \tag{A.50}$$

$$S_{1,t} = 1 - (1-\rho_1) N_{1,t-1} - (1-\rho_2) N_{2,t-1}, \tag{A.51}$$

$$S_{2,t} = 1 - N_{1,t} - (1-\rho_2) N_{2,t-1}, \tag{A.52}$$

$$\frac{\hat{\Gamma}_t \gamma_1^l v_{1,t}}{m_1(S_{1,t}, v_{1,t})} = (1-\Omega)(1-\alpha)\Delta Z_t \left(\frac{u_t \hat{K}_t}{\Delta Z_t N_t}\right)^{\alpha} \left(\frac{N_t}{N_{1,t}}\right)^{\frac{1}{\theta}} - \hat{W}_{1,t} + \tag{A.53}$$

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

$$\frac{\hat{\Gamma}_t\gamma_{2,t}^l v_{2,t}}{m_2(S_{2,t},v_{2,t})}=\Omega(1-\alpha)\Delta Z_t\left(\frac{u_t\hat{K}_t}{\Delta Z_t N_t}\right)^{\alpha}\left(\frac{N_t}{N_{2,t}}\right)^{\frac{1}{\theta}}-\hat{W}_{2,t}+ \tag{A.54}$$

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

$$\hat{W}_{1,t}=\hat{\Gamma}_t\eta\left[(1-\Omega)(1-\alpha)\left(\frac{u\hat{K}}{N}\right)^{\alpha}\left(\frac{N}{N_1}\right)^{\frac{1}{\theta}}+\gamma_1^l\frac{v_1}{S_1}\right]+(1-\eta)\hat{\Gamma}_t b_1, \tag{A.55}$$

$$\hat{W}_{2,t}=\eta\left[\Omega(1-\alpha)\Delta Z_t\left(\frac{u_t\hat{K}_t}{\Delta Z_t N_t}\right)^{\alpha}\left(\frac{N_t}{N_{2,t}}\right)^{\frac{1}{\theta}}+\hat{\Gamma}_t\gamma_2^l\frac{v_{2,t}}{S_{2,t}}\right]+(1-\eta)\hat{\Gamma}_t b_2, \tag{A.56}$$

$$M_{t,t+1}=\beta\left(\frac{\hat{C}_{t+1}\Delta Z_t}{\hat{C}_t}\right)^{1-1/\psi}\left(\frac{\hat{C}_t}{\hat{C}_{t+1}\Delta Z_t}\right)\left(\frac{\hat{V}_{t+1}}{(\mathbb{E}_t\hat{V}_{t+1}^{1-\gamma_t})^{\frac{1}{1-\gamma_t}}}\right)^{1/\psi-\gamma_t}, \tag{A.57}$$

$$\hat{P}_t^E=\mathbb{E}_t\left[M_{t,t+1}\Delta Z_t\left(\hat{D}_{t+1}^E+\hat{P}_{t+1}^E\right)\right], \tag{A.58}$$

$$Q_t^c=\mathbb{E}_t\left[M_{t,t+1}(dQ_{t+1}^c+1)\right], \tag{A.59}$$

$$1=R_t^r\mathbb{E}_t M_{t,t+1}, \tag{A.60}$$

$$R_t^K=\alpha\left(\frac{u_t\hat{K}_t}{\Delta Z_t N_t}\right)^{\alpha-1}, \tag{A.61}$$

$$R_t^K=q_t\delta'(u_t), \tag{A.62}$$

$$q_t=\mathbb{E}_t\Big[M_{t,t+1}\Big(u_{t+1}R_{t+1}^K+ \tag{A.63}$$

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

$$\hat{K}_{t+1}=\left(1-\delta(u_t)-\frac{\phi_K}{2}\left(\frac{\hat{I}_t}{\hat{K}_t}-\delta\right)^2\right)\frac{\hat{K}_t}{\Delta Z_t}+\frac{\hat{I}_t}{\Delta Z_t}, \tag{A.64}$$

$$\frac{1}{q_t}=1-\phi_K\left(\frac{\hat{I}_t}{\hat{K}_t}-\delta\right), \tag{A.65}$$

$$\hat{Y}_t=\hat{C}_t+\hat{I}_t+\hat{\Gamma}_t\gamma_1 v_{1,t}+\hat{\Gamma}_t\gamma_2 v_{2,t}+\Delta Z_t\bar{g}Y, \tag{A.66}$$

$$\hat{G}_t=\Delta Z_t\bar{g}Y, \tag{A.67}$$

$$\hat{D}_t^E=\hat{Y}_t-\hat{W}_{1,t}N_{1,t}-\hat{W}_{2,t}N_{2,t}-\hat{I}_t-\Gamma_t(\gamma_1^l v_{1,t}+\gamma_2^l v_{2,t})-\hat{B}_t^c+\xi\frac{\hat{K}_{t+1}}{\Delta Z_t}, \tag{A.68}$$

$$\hat{B}_{t+1}^c=d\hat{B}_t^c/\Delta Z_t+\xi\hat{K}_{t+1}/Q_t^c, \tag{A.69}$$

$$\hat{V}_t = \max\left[(1-\beta)(\hat{C}_t)^{1-1/\psi} + \Delta Z_t^{1-1/\psi}\beta(\mathbb{E}_t\hat{V}_{t+1}^{1-\gamma_t})^{\frac{1-1/\psi}{1-\gamma_t}}\right]^{\frac{1}{1-1/\psi}}, \tag{A.70}$$

$$\hat{\Gamma}_{t+1} = \hat{\Gamma}_t^{\omega}(\Delta Z_t)^{-\omega}. \tag{A.71}$$

A.5 Labor Market Search

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

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

$$\mathbb{W}_t^1 = W_{1,t} + \mathbb{E}_t\left\{M_{t,t+1}\left[(1-\rho_1)\mathbb{W}_{t+1}^1 + \rho_1\max\{\mathbb{S}_{t+1}^1, \mathbb{S}_{t+1}^2, \mathbb{U}_{t+1}\}\right]\right\}, \tag{A.72}$$

$$\mathbb{W}_t^2 = (W_{2,t} + \kappa_t) + \mathbb{E}_t\left\{M_{t,t+1}\left[(1-\rho_2)\mathbb{W}_{t+1}^2 + \rho_2\max\{\mathbb{S}_{t+1}^1, \mathbb{S}_{t+1}^2, \mathbb{U}_{t+1}\}\right]\right\}, \tag{A.73}$$

$$\mathbb{U}_t = b_2 + \mathbb{E}_t\left\{M_{t,t+1}\max\{\mathbb{S}_{t+1}^1, \mathbb{S}_{t+1}^2, \mathbb{U}_{t+1}\}\right\}, \tag{A.74}$$

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

$$\mathbb{S}_t^1 = P_{1,t}^m\mathbb{W}_t^1 + (1-P_{1,t}^m)\mathbb{S}_t^2. \tag{A.75}$$

$$\mathbb{S}_t^2 = P_{2,t}^m\mathbb{W}_t^2 + (1-P_{2,t}^m)\mathbb{U}_t. \tag{A.76}$$

Equations (A.72)-(A.74) reflect the assumption that as soon as workers separate from their employers, they can immediately begin to search. A worker will always prefer to search at least in the part time sector instead of foregoing search if

$$\mathbb{S}_t^2 \geq \mathbb{U}_t. \tag{A.77}$$

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

$$\mathbb{S}_t^1 \geq \mathbb{S}_t^2. \tag{A.78}$$

Inspection of the above equations reveals that a necessary condition for this to hold is

that κ_t be not too large. That is, the non-wage compensation from working only part-time should not be too high. If both these conditions are satisfied, we can replace the definitions in (A.72)-(A.74) with

$$\mathbb{W}_t^1 = W_{1,t} + \mathbb{E}_t \left\{ M_{t,t+1} \left[(1-\rho_1)\mathbb{W}_{t+1}^1 + \rho_1 \mathbb{S}_{t+1}^1 \right] \right\}, \tag{A.79}$$

$$\mathbb{W}_t^2 = (W_{2,t} + \kappa_t) + \mathbb{E}_t \left\{ M_{t,t+1} \left[(1-\rho_2)\mathbb{W}_{t+1}^2 + \rho_2 \mathbb{S}_{t+1}^1 \right] \right\}, \tag{A.80}$$

$$\mathbb{U}_t = b_2 + \mathbb{E}_t \left\{ M_{t,t+1} \mathbb{S}_{t+1}^1 \right\}, \tag{A.81}$$

Equations (A.79)-(A.81) together with (A.75)-(A.76) define the variables $\{\mathbb{W}_t^1, \mathbb{W}_t^2, \mathbb{S}_t^1, \mathbb{S}_t^2, \mathbb{U}_t\}$ under the assumption that conditions (A.77)-(A.78) hold.

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

B Data Construction

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

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

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

on non-durables and services.

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

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