

Does Cross-Sectional Asset Pricing Matter for the Macroeconomy? [★]

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Abstract

Yes. The quantity of risk underlying cross-sectional return spreads is time-varying, yielding swings in factors' risk premia. We define “macro-relevant” factors as those whose risk premium variation induce consumption fluctuations, and more broadly, a business-cycle. While most factors documented in the literature are vetted in this manner, a handful of factors' risk matter for economic growth, above and beyond changes in market risk. We cluster macro-relevant factors based on their impact in frequency domains. Macro-relevant factors mostly relate to profitability, organization capital, financial conditions, or inventory. Interestingly, many factors' risk premia are associated with expansions, unlike the market risk premium.

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A growing macroeconomic literature increasingly emphasizes the importance of aggregate discount rate shocks for economic growth. Existing studies demonstrate, for instance, that short-term economic activity can be either amplified or curtailed by interest rate shocks emanating from monetary policy. Similarly, the risk premium component of discount rates, known to be dynamic, has been identified as a potent driver of business cycle fluctuations. Specifically, the quantity of aggregate risk, manifested as market uncertainty, shows time-variation and can catalyze recessionary periods. Additionally, the price of market risk, attributed in part to risk aversion, is not static and can instigate economic downturns.

Market shocks, however, are not the only innovations that command a risk premium. Financial literature has documented a diverse set of cross-sectional return spreads. These constitute a myriad of asset pricing factors, each potentially having its unique price per unit of risk. Prevailing thought suggests that these priced factors reflect other sources of systematic risk shocks, which inherently demand a premium from investors. These shocks, like those governing the market, exhibit heteroscedasticity, as evidenced by the stochastic nature of factors' expected returns and realized variances.

While macro-fundamentals frequently serve as the framework for interpreting cross-sectional risk premiums, the reciprocal relationship remains largely underexplored within macro-finance studies. This prompts a key question: Does cross-sectional asset pricing influence macroeconomic fundamentals? More specifically, do variations in factors' risk premia — which are orthogonal to the market's premium — also drive business cycle fluctuations?

The aforementioned questions have gained greater relevance recently, especially given the exponential growth of the factor-based literature, colloquially termed the 'factor zoo'. Most existing studies that tame this 'zoo' primarily focus on the statistical efficacy (or lack thereof) of factors in explaining cross-sectional stock return variation. However, an economic perspective posits that factors should be priced only if their governing shocks impact investors' marginal utility, which is intrinsically tied to consumption within prevailing models. Thus, identifying the set of factors whose risk premia influence macro oscillations is crucial, not only for understanding the full spectrum of business cycle determinants but

also for offering an economically-guided approach for evaluating and selecting factors.

In the context of this discourse, our paper presents two salient contributions. First, we introduce a novel methodology, building upon foundational research, that allows for the extraction of each factor’s risk premium shocks, independent of the market. Second, using these extracted shocks, we compute impulse response functions from factor risk premia to consumption, output, and investment aggregates. We define a Macro-Relevant Factor (MRF) as one whose risk premium shock has both statistically and economically significant impacts on consumption trajectories. Notably, MRFs might not always coincide with factors selected by traditional asset pricing metrics. Ex-ante, a factor might not possess significant explanatory power in the cross-sectional valuation domain but could still influence notable aggregate economic cycles, or vice versa.

Ex-post, we uncover several key findings. First, from a comprehensive list of factors, only a limited subset of about twenty qualify as MRFs. Intriguingly, from the prominent Fama-French and Q-factor models, only profitability – and to some degree, capital growth – are recognized as MRFs.

Second, we classify MRFs based on their ensuing economic impacts in the frequency domain. The risk premia of some MRFs affect purely the short-run, while others influence the long-run. Some MRFs exhibit a contractionary effect, consistent with the notion that higher discount rates restrain investment and expansions. Somewhat surprisingly, most MRFs’ risk premia result in increased consumption and investment, aligning with the idea of ‘good’ uncertainty and with phases of innovation across different sectors.

Third, the grouping of MRFs based on their consumption trajectories reveals common themes within each cluster. Broadly speaking, MRFs are related to cross-sectional spreads based on either profitability, organization capital, financial conditions, or inventory changes.

Lastly, several factors do not command an unconditional risk premium in our sample. Traditional asset pricing metrics deem these factors non-robust in out-of-sample analyses. However, their *conditional* risk premia fluctuations still induce meaningful variation in output and consumption, making them macro-relevant, albeit in a weaker form.

Overall, the answer to the question posited in our title is - yes: risk fluctuations tied to a select group of factors can impact economic growth beyond oscillations in aggregate risk. This highlights the importance of integrating *cross-sectional* sources of uncertainty or risk fluctuations into business cycle models, as well as the importance of integrating macroeconomic measures into asset pricing evaluations.

Related Literature. Our study relates to two strands of literature. The first, focuses on the impact of aggregate risk premium fluctuations, including both changes in uncertainty — the quantity of risk — and in risk-attitudes — the price of risk, on economic outcomes.

Focusing on the quantity of risk, Bloom (2009) shows how sudden increases in economic uncertainty affect business conditions, presenting evidence that uncertainty shocks lead to a decline in business investment and output. Bloom, Floetotto, Jaimovich, Saporta-Eksten, and Terry (2018) extend the understanding of how uncertainty affects economic growth, emphasizing the variability of these impacts. Basu and Bundick (2017) and Fernández-Villaverde, Guerrón-Quintana, Kuester, and Rubio-Ramírez (2015) explore the impact of uncertainty shocks under sticky prices and recursive preferences, finding that increased uncertainty can lead to a significant decrease in consumption and investment, through their impact on firms' markups.

Other papers focus on the real economic impact of an elevated aggregate risk premium. The studies of Christiano, Motto, and Rostagno 2010; Gilchrist, Sim, and Zakrajšek 2014; Arellano, Bai, and Kehoe 2019 highlight that uncertainty increases firms' cost of capital through credit spreads, leading to significant reductions in investment activity. Di Tella and Hall (2021) rely on a model that features uninsurable risk. The covariance between firms' marginal product of labor and the households' SDF creates a risk premium wedge that suppresses investment and hiring. Borovicka and Borovicková (2018) examine the relationship between risk premia in financial markets and unemployment rates, finding that fluctuations in risk premia are closely linked to changes in unemployment. Related, Mitra and Xu (2020) analyze time-varying risk premium and unemployment risk across age groups, indicating significant variations, with younger and older workers experiencing different degrees of risk.

Caballero and Simsek (2020) propose a model focusing on the role of risk and speculation in demand recessions, suggesting that risk perception and speculative behavior are central to the dynamics of demand recessions. Basu, Candian, Chahrour, and Valchev (2021) investigate the role of risk fluctuations on business cycles, emphasizing that shocks to the market risk premium cause contractionary comovements, and explaining this finding in a model with time-variation in risk aversion. Endogenous growth models such as Kung and Schmid (2015) emphasize that lower valuations, induced for example by higher aggregate discount rates, can lead to lower firm entry and productivity growth.

While existing macroeconomic literature acknowledges the importance of changes in aggregate risk for business cycle fluctuations, macro models typically overlook cross-sectional risk premia. Indeed, in most models, macro fundamentals may explain expected return dispersion along several dimensions, but not vice versa. We contribute to the corpus of the aforementioned papers by emphasizing that changes in the market risk premium are not the only triggers of business cycles. Factor-specific risk premia can also impact economic growth, though intriguingly, this impact is predominantly expansionary.

The second strand of literature relevant to our paper discusses the profusion of factors in asset pricing models and the growing attempts to shrink the number of statistically relevant factors.

The rapidly increasing number of factors in the literature has attracted considerable scrutiny and criticism. Harvey, Liu, and Zhu (2016) investigate the predictive power of various asset pricing models, emphasizing the need for more robust theories. Bryzgalova (2015) addresses the issue of spurious factors in asset pricing models, showing that many factors identified may be statistical artifacts rather than true drivers of expected asset returns. Related, Hou, Xue, and Zhang (2020) attempt to replicate known anomalies in financial markets, questioning the consistency of these factors.

Historically, many factors were deemed as priced through the methodology of Fama and MacBeth (1973). In recent developments, novel methodologies have been introduced to scrutinize and eliminate redundant factors. Feng, Giglio, and Xiu (2020) undertake a critical

evaluation of the proliferation of factors used in asset pricing models, proposing a statistical methodology to test the validity of these factors. Kozak, Nagel, and Santosh (2020) argue for simplification in multifactor models, given their limited effectiveness in explaining stock returns. Kelly, Pruitt, and Su (2019) propose a model treating stock characteristics as covariances, offering a new perspective on risk and return. Giglio and Xiu (2021) highlight the consequences of omitting key factors, while identifying weak factors.

One conclusion of the aforementioned studies is that most robust factors are materially encapsulated within the Fama and French (2015) factor model or the augmented Hou, Mo, Xue, and Zhang (2021) q-factor model.

We contribute to this line of research by offering a novel methodology to extract variation in factors' risk premia. We argue that, while certain factors may have low explanatory power for the cross-section of equities, their expected return variation can lead to sizable business cycle fluctuations. This renders them macro-relevant, a concept that bridges the efforts to tame the factor zoo with structural asset pricing literature.

1 Methodology

We outline the methodology for identifying factor risk premia shocks. Given a vector autoregression estimated on a set of macroeconomic variables, the market excess return, $r_{m,t}^e$, and a cross-sectional factor of interest, f_t , we seek to sequentially identify two shocks: the first, which accounts for the maximal share of forecast error variances in the realized equity risk premium, and a second shock, which is orthogonal to the first, that maximally captures forecast error variances in the factor f_t 's realized risk premium, both for some horizon $\bar{k} \geq 1$. Our approach for the extraction of the first shock draws largely from Uhlig (2004), while the extraction of the second shock follows a novel approach.

1.1 Step 1: VAR Estimation

Let $Y_t = [\Gamma_t^\top, r_{m,t}^e, f_t]^\top_{N \times 1}$, where Γ_t is a vector of predictive variables. Assume that the vector Y_t is centered and evolves in an auto-regressive manner:

$$Y_t = B(L)Y_{t-1} + \eta_t, \quad (1)$$

where $B(L)$ are coefficients on the lagged realizations of Y_t . Using ML we can estimate $B(L)$ and η_t . Let ε_t be an $N \times 1$ vector of the underlying standardized orthogonal structural shocks, such that $\eta_t \equiv A\varepsilon_t$, where A is the structural loadings matrix.

Let $C(L)$ be the corresponding MA- ∞ representation for the VAR coefficients $B(L)$, and $\Sigma^{1/2}$ as the lower Cholesky factorization of the covariance matrix Σ of η_t . The MA- ∞ representation of equation (1) is:

$$\begin{aligned} Y_t &= \sum_{\ell=0}^{\infty} C_\ell L^\ell \eta_t \\ &= \sum_{\ell=0}^{\infty} C_\ell \Sigma^{1/2} L^\ell \hat{\varepsilon}_t, \end{aligned} \quad (2)$$

where L^ℓ denotes the lag operator, L , applied ℓ times, C_ℓ is the corresponding MA- ∞ coefficients to the same lag, and $\hat{\varepsilon}_t = \Sigma^{-1/2}\eta_t$ are the shocks implied by the loadings $\Sigma^{1/2}$.

Without further restrictions, A and ε_t cannot be uniquely identified: For any orthonormal rotation matrix $Q_{N \times N}$ such that $QQ^\top = \mathbb{I}$, it is possible to decompose the residuals η_t as:

$$\eta_t = \underbrace{AQ}_{:=\tilde{A}} \underbrace{Q^\top \varepsilon_t}_{:=\tilde{\varepsilon}_t}, \quad (3)$$

which yields $\tilde{A}\tilde{\varepsilon}_t$, an equally valid orthogonal decomposition of η_t .

We therefore assume, without loss of generality that:

$$\begin{aligned} A &= \Sigma^{1/2}Q, \\ \varepsilon_t &= Q^\top \hat{\varepsilon}_t, \end{aligned} \quad (4)$$

It follows that identifying the true rotation matrix Q is equivalent to identifying the true A and ε_t , and that identifying the column $i \in [1, N]$ of Q is sufficient to identify the i -th shock in the vector ε_t .

In the following steps, we will identify two columns of Q : the first, q_{MRP} , which accounts for the maximal share of forecast errors in the equity risk premium, and the second, q_{FRP} ,

which accounts for the maximal share of forecast errors in a given factor's risk premium. From the orthonormal properties of Q , it must be that $q_{MRP} \perp q_{FRP}$. Since mutually orthogonal combinations of orthogonal variables are also orthogonal, the extracted factor risk premium shock will be uncorrelated with the equity risk premium shock.

1.2 Step 2: Identifying Market Risk Premium Shocks

We follow an approach similar to Uhlig (2004) for the identification of q_{MRP} . Define g_j as an $N \times 1$ selection vector for variable j (i.e., takes the value 1 on the row which corresponds to j , and 0 elsewhere). The contribution of $\hat{\varepsilon}_t$ to the forecast error of variable j at time $t + \ell$ is given by:

$$g_j^\top C_\ell \Sigma^{1/2} \hat{\varepsilon}_t.$$

It follows that the expected forecast error variance of j at time $t + \ell$ originating from time- t shocks is:

$$(g_j^\top C_\ell \Sigma^{1/2})^\top g_j^\top C_\ell \Sigma^{1/2}.$$

Thus, the contribution of time- t shocks to the *average* forecast error variance of a variable j up to $\bar{k}$ periods in the future, $S_j^{\bar{k}}$, is given by:

$$S_j^{\bar{k}} := \frac{1}{\bar{k}} \sum_{k=1}^{\bar{k}} (g_j^\top C_k \Sigma^{1/2})^\top g_j^\top C_k \Sigma^{1/2} \quad (5)$$

Let $\hat{q}_{N \times 1}$ be any vector of unit length, $\hat{q}^\top \hat{q} = 1$. Consider a linear combination of $\hat{\varepsilon}_t$ weighted by $\hat{q}$, $\hat{q}^\top \hat{\varepsilon}_t$. Its contribution to the expected forecast error variance of j , denoted by $\mathcal{V}_j(\hat{q})$, is given by:

$$\mathcal{V}_j(\hat{q}) := \hat{q}^\top S_j^{\bar{k}} \hat{q}. \quad (6)$$

The objective is to extract the unit-length vector q_j which maximizes a shock's contribution to the expected forecast error variance of j , that is:

$$q_j = \arg \max_{\hat{q}} \mathcal{V}_j(\hat{q}), \text{ s.t. } \hat{q}^\top \hat{q} = 1 \quad (7)$$

The associated Lagrangian is:

$$\mathcal{L}_j(\hat{q}) = \hat{q}^\top S_j^{\bar{k}} \hat{q} - \lambda(\hat{q}^\top \hat{q} - 1), \quad (8)$$

where λ is the (scalar) Lagrange multiplier on the constraint. The first differential with

respect to $\hat{q}$ is:

$$\frac{\partial \mathcal{L}_j}{\partial \hat{q}} = 2S_j^{\bar{k}}\hat{q} - 2\lambda\hat{q} \quad (9)$$

Therefore, the potential values of the optimal q_j must belong to the set of eigenvectors for $S_j^{\bar{k}}$. For any eigenvector $\hat{q}$ of $S_j^{\bar{k}}$ we have:

$$\mathcal{V}_j(\hat{q}) = \hat{q}'S_j^{\bar{k}}\hat{q} = \hat{q}'\lambda\hat{q} = \lambda, \quad (10)$$

where λ is the eigenvalue associated with $\hat{q}$.

In all, q_j is the eigenvector of $S_j^{\bar{k}}$ with the greatest eigenvalue λ_1 , which is also the maximum value attained by the problem in (7). q_{MRP} is extracted by setting the selection vector to g_{rm} .

1.3 Step 3: Orthogonal Factor Risk Premium Shocks Extraction

The approach to recover q_{FRP} is novel to the literature. Given q_{MRP} , recovered from the former step, q_{FRP} solves:

$$q_{FRP} = \arg \max_{\hat{q}} \mathcal{V}_f(\hat{q}) = \arg \max_{\hat{q}} \hat{q}'S_f^{\bar{k}}\hat{q}, \quad (11)$$

where $S_f^{\bar{k}}$ is constructed following Eq (5), using the selection vector g_f (which selects the row in Y_t corresponding to f_t). The maximization problem is subject to the unit length constraint as before:

$$\hat{q}'\hat{q} = 1, \quad (12)$$

but now with an additional orthogonality constraint:

$$\hat{q}'q_{MRP} = 0. \quad (13)$$

The corresponding Lagrangian is given by:

$$\mathcal{L}_{FRP} = \hat{q}'S_f^{\bar{k}}\hat{q} - \lambda(\hat{q}'\hat{q} - 1) - \psi(\hat{q}'q_{MRP}) \quad (14)$$

where λ and ψ are the Lagrangian multipliers of constraints (12) and (13), respectively.

Unlike the first-step maximization in (7), there is no eigenanalysis equivalent for Eq (14), resulting in a potentially high-dimensional non-linear maximization problem. To circumvent this problem, we show below that it is possible to recast the maximization to feature only a single *bounded* variable.

To see this, the first-order condition is given by:

$$\frac{\partial \mathcal{L}_{FRP}}{\partial \hat{q}} = 2S_f^{\bar{k}}\hat{q} - 2\lambda\hat{q} - \psi q_{MRP} = 0_{N \times 1} \quad (15)$$

Pre-multiply by $q^\top$, to obtain:

$$\hat{q}^\top \frac{\partial \mathcal{L}_{FRP}}{\partial \hat{q}} = 2\hat{q}^\top S_f^{\bar{k}}\hat{q} - 2\hat{q}^\top \lambda\hat{q} - \psi \hat{q}^\top q_{MRP} = 0 \quad (16)$$

Using the constraint in (13) the expression simplifies to:

$$\hat{q}^\top \lambda\hat{q} = \hat{q}^\top S_f^{\bar{k}}\hat{q} \equiv \mathcal{V}_f(\hat{q}) \quad (17)$$

From (12), it follows that $\mathcal{V}_f(\hat{q}) = \lambda$ at the critical point. Plugging this in Eq (15) yields:

$$\psi q_{MRP} = 2 \left[S_f^{\bar{k}} - \mathcal{V}_f(\hat{q}) \cdot \mathbb{I}_N \right] \hat{q} \quad (18)$$

It therefore must be the case that:

$$q_{MRP} \propto \left[S_f^{\bar{k}} - \mathcal{V}_f(\hat{q}) \cdot \mathbb{I}_N \right] \hat{q} \quad (19)$$

and hence, that:

$$\hat{q} \propto \left[S_f^{\bar{k}} - \mathcal{V}_f(\hat{q}) \cdot \mathbb{I} \right]^{-1} q_{MRP}. \quad (20)$$

The right-hand-side of Eq (20) is known except for the scalar value $\mathcal{V}_f(\hat{q})$. To find it, we follow the following algorithm:

(1) $\omega \leftarrow \omega_0$, diff $\leftarrow 1$

(2) while (diff>tol):

(2.1) Assume (20) holds: $\hat{q}^u \leftarrow \left(S_f^{\bar{k}} - \omega \cdot \mathbb{I} \right)^{-1} q_{MRP}$

(2.2) Normalize: $\hat{q} \leftarrow \frac{\hat{q}^u}{\|\hat{q}^u\|}$

(2.3) Check orthogonality: diff $\leftarrow |\hat{q}^\top q_{MRP} - 0|$

(2.4) $\omega \leftarrow \omega - \Delta$

Since the largest eigenvalue λ_1 of $S_f^{\bar{k}}$ is an upper bound of $\mathcal{V}_f(\hat{q})$ for all unit-length $\hat{q}$, we can set $\omega_0 = \lambda_1 - \epsilon$ with a very small $\epsilon > 0$. Upon convergence, the solution corresponds to the critical vector $\hat{q}_{FRP}$ with the highest value of ω , the objective function, and therefore solves (11) ¹.

¹To see this more clearly, note that the criteria in step (2) can be rearranged to show that $\left(S_f^{\bar{k}} - \omega \cdot \mathbb{I} \right) \hat{q}^u = q_{MRP} \implies \hat{q}^{u\top} \left(S_f^{\bar{k}} - \omega \cdot \mathbb{I} \right) \hat{q}^u = 0 \implies \hat{q}^{u\top} S_f^{\bar{k}} \hat{q}^u - \omega \|\hat{q}^u\|^2 = 0 \implies \omega = \hat{q}^\top S_f^{\bar{k}} \hat{q}$.

1.4 Step 4: Impulse Response Computation

Given the identified vector q_{MRP} , the impulse-response $IR(g_j, q_{MRP}, k)$ of variable j at time $t + k$ to a one standard deviation shock in the market risk premium is:

$$IR(g_j, q_{MRP}, k) := g_j^\top C_k \Sigma^{1/2} q_{MRP}. \quad (21)$$

Likewise, given q_{FRP} , the impulse-response $IR(g_j, q_{FRP}, k)$ of variable j at time $t + k$ to a one standard deviation shock to the factor's risk premium (where this shock is orthogonal to the market premium, by construction) is given by:

$$IR(g_j, q_{FRP}, k) := g_j^\top C_k \Sigma^{1/2} q_{FRP}. \quad (22)$$

We use equations (21) and (22) to construct impulse-responses to macroeconomic variables of interest. As in Uhlig (2004), for each VAR we can derive a joint posterior distribution for its coefficients B_ℓ , and the covariance of residuals Σ . These two objects follow a matrix-normal-inverse-Wishart posterior distribution with degrees of freedom given by T , the sample length.

To estimate confidence intervals for the impulse-responses, we randomly draw sets of $\{\hat{B}_\ell, \hat{\Sigma}\} \sim \mathbf{MNIW}(B_\ell, \Sigma, Y, T)$ from the joint posterior distribution, and compute impulse responses according to the procedure described in steps 1.1 - 1.3 and equations (21) and (22). The collection of these bootstrapped impulse-responses is used to construct confidence intervals. This approach accounts for all possible estimation errors of all statistical coefficients in the model.

1.5 Step 5: Macro-Relevance and Clustering

A candidate factor $f_t \in \mathbb{F}$ is macro-relevant factor (MRF) if the median impulse-response path from the factor risk premium shock onto consumption is statistically significant – at the 1% level, and economically significant – for at least one year (four quarters).

Once we identified and retained all MRFs, we employ a k-nearest-neighbour algorithm to sort them into clusters based on the centered cosine similarity of their median consumption impulse-response path up to horizon $\bar{k}$. This path corresponds to the median across

simulations of the set $\{IR(g_c, q_{MRP}, k)\}_{k \in \{1, \dots, \bar{k}\}}$, where g_c is the selection vector for consumption. This algorithm arranges factors so as to maximize their correlation to the aggregate consumption impulse-response paths within the group.

1.6 Benchmark Implementation

Data.

We source data on GDP, consumption (nondurables and services), investment, and their implicit price deflators from the Bureau of Economic Analysis (BEA) NIPA tables. To compute per-capita quantities we obtain population estimates from the U.S. Census Bureau. Our measure of labor comes from the Total Nonfarm Payroll measure provided by the Bureau of Labor Statistics. The price-to-dividend ratio is from the online database of Schiller (2023), and *cay* from the online database of Lettau (2023). Our measure of price levels is the Consumer Price Index for All Urban Consumers from FRED. We construct the term spread as the difference between the market yield on U.S. Treasury Securities at a 5-Year constant maturity and the effective fed funds rate, both obtained from the Board of Governors of the Federal Reserve System. The credit spread is the difference between Moody’s Seasoned Aaa and Baa corporate bond yields.

Our candidate factors $\mathbb{F}$ are from the replication data provided in Feng et al. (2020), which ends in 2017. Following Basu et al. (2021), to ensure that the risk time-series is stationary and avoid structural breaks, we start the sample after the Great Moderation (see Stock and Watson (2002)) at 1987.

Variable Choices.

In the benchmark analysis, we estimate Eq (1) using the observable set:

$$\Gamma_t \equiv \left[y_t, c_t, i_t, n_t, r_t^f, p_t^d, cay_t, r_t^{term}, r_t^{credit}, \pi_t \right]' \quad (23)$$

which are, in order: log real per-capita output, log real per-capita consumption, log real per-capita investment, log per-capita employment, real ex-post three-month treasury bill returns, the level of the price-dividend ratio, *cay*, the term spread, the credit spread, and log CPI. The model is estimated using maximum likelihood, with three lags in $B(L)$.

We set $\bar{k} = 20$, which translates to a target horizon of five years, which is standard in the literature. In the estimation we impose a restriction that $B(j, f, \ell) = 0$ for all variables $j \neq f$ and lags $\ell \in \{1, \dots, 3\}$. The restriction implies that the return of the candidate factor does not affect other variables in the future. The ordering of f in the last position of Y_t implies that all rows of $\Sigma^{1/2}$ will be invariant to the choice of factor except for the last. The last row will also only affect the propagation of shocks into the future factor return, and the factor return by our restriction will not affect the future expectations of other variables. A direct implication is that the output of step 1.2, q_{MRP} (i.e., market risk premium shock), will remain the same regardless of the specific candidate factor f_t in the VAR.

2 Macro-Relevant Factors

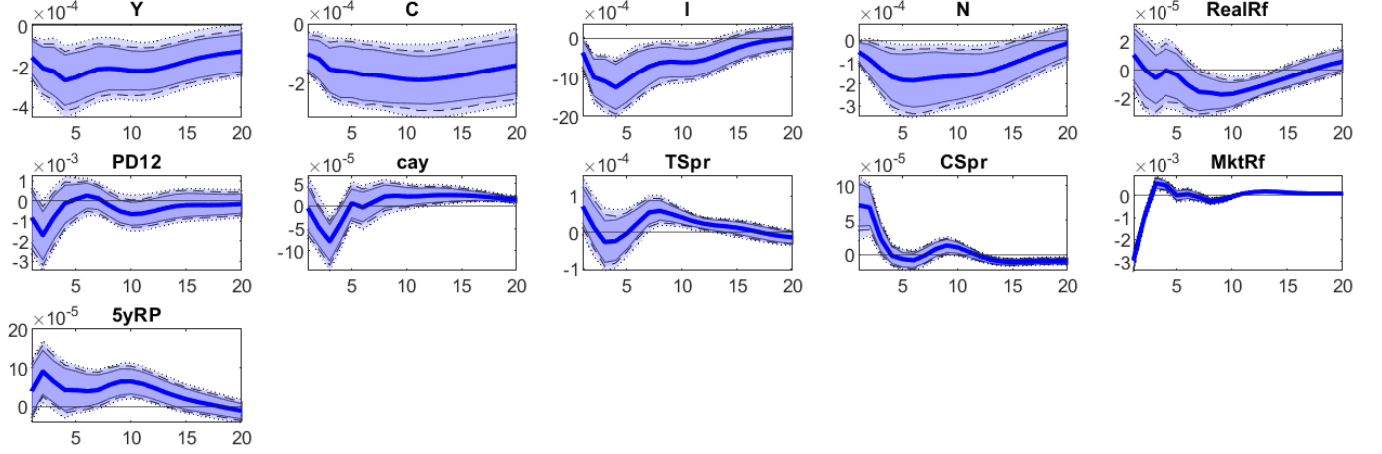
2.1 The impact of Market Risk Premium Shocks

Following the methodology of Sections 1.1 and 1.2, we extract market risk premium shocks and present evidence that aggregate risk fluctuations induce business cycles. Figure 1 shows impulse responses from market risk premium shocks to key macroeconomic and financial variables.

In accordance with the theoretical premise that an increase in the market risk premium is associated with an elevated discount rate applicable across most firms, thereby leading to an increased cost of capital, Figure 1 illustrates that such a shock instigates a synchronous fluctuation among all macroeconomic variables, characterized by a sustained decrease subsequent to the shock.

After the shock, the figure shows a decrease in output, consumption, and investment lasting approximately 20 quarters. The number of hours worked shows a reduction over a period of 15 quarters. The risk-free rate (term spread) experiences a decline (or increase) at an intermediate forecast horizon of 10 quarters, whereas the credit spread exhibits an increase in the short-term. The realized excess market return falls sharply, while the expected 5-year remains elevated, particularly in the medium run.

Figure 1: Market Risk Premium Shock Impulse-Response Functions



The figure shows impulse responses functions from market risk premium shocks to key macroeconomic variables: output Y , consumption C , investment I , labor N , the price dividend ratio PD , consumption to wealth CAY , the term spread $TSpr$, credit spread $CSpr$, the realized market excess return $MktRf$, and the five year expected return $5yRP$. The solid, dashed, and dotted lines represent the bootstrapped 10%, 5%, and 1% confidence intervals for each IRF, respectively. The horizontal axis represents quarters.

Overall, the data indicate that shocks to market risk exert a contractionary effect, aligning with the findings of Bloom (2009) and Basu et al. (2021). On a broader scale, the market factor holds macroeconomic significance: a rise in its risk level is linked with bad states of the world.

2.2 The Impact of Factors' Risk Premium Shocks

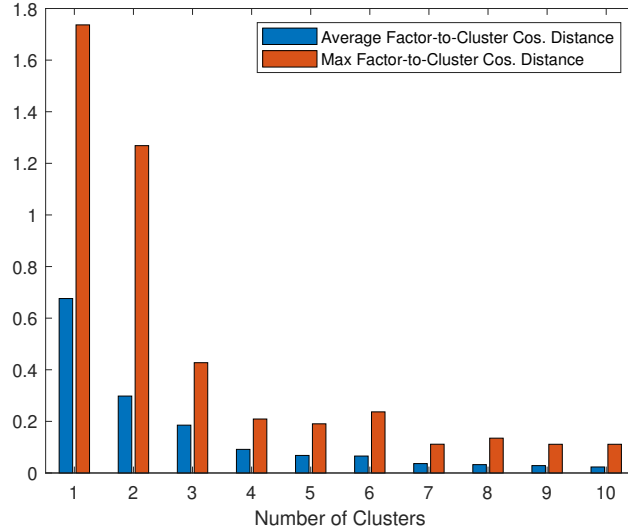
Priced and non-redundant asset-pricing factors ought to reflect additional types of systematic risk shocks, necessitating a premium from investors. Do fluctuations in the risk associated with cross-sectional factors also contribute to business cycles, beyond the influence of market risk? If so, which specific factors are significant on a macroeconomic scale?

Our candidate factors encompass the menu of factors examined by Feng et al. (2020). We maintain robust factors, whose unconditional risk premium remains statistically significant at the 10% significance level over our sample period, as well as the salient factors of Fama and French (2015) and Hou et al. (2021). For each of these factors we extract market-orthogonal risk premium shocks, using the methodology of Section 1.3, and compute their

impact on key macro variables as detailed in Section 1.4. We classify a factor as an MRF if its impulse-response to consumption is statistically significant – at the 1% confidence level, and economically significant – lasting for at least one year.

Among the potential factors, 20 qualify as MRFs. Given that the risk premia shocks of factors might be interrelated, we group MRFs using the approach outlined in Section 1.5. To ascertain the least number of clusters required, we evaluate between one to seven clusters. The average and maximum cosine distance measure for the consumption impact path of MRFs to their cluster average path is presented in Figure 2.

Figure 2: Cosine-Distance Within Each Cluster



The Figure shows the cosine distance of consumption-impact for MRFs within each cluster. We cluster all MRFs to one upto seven clusters. The horizontal axes represents the number of clusters. The vertical axis is the average cosine distance within each cluster.

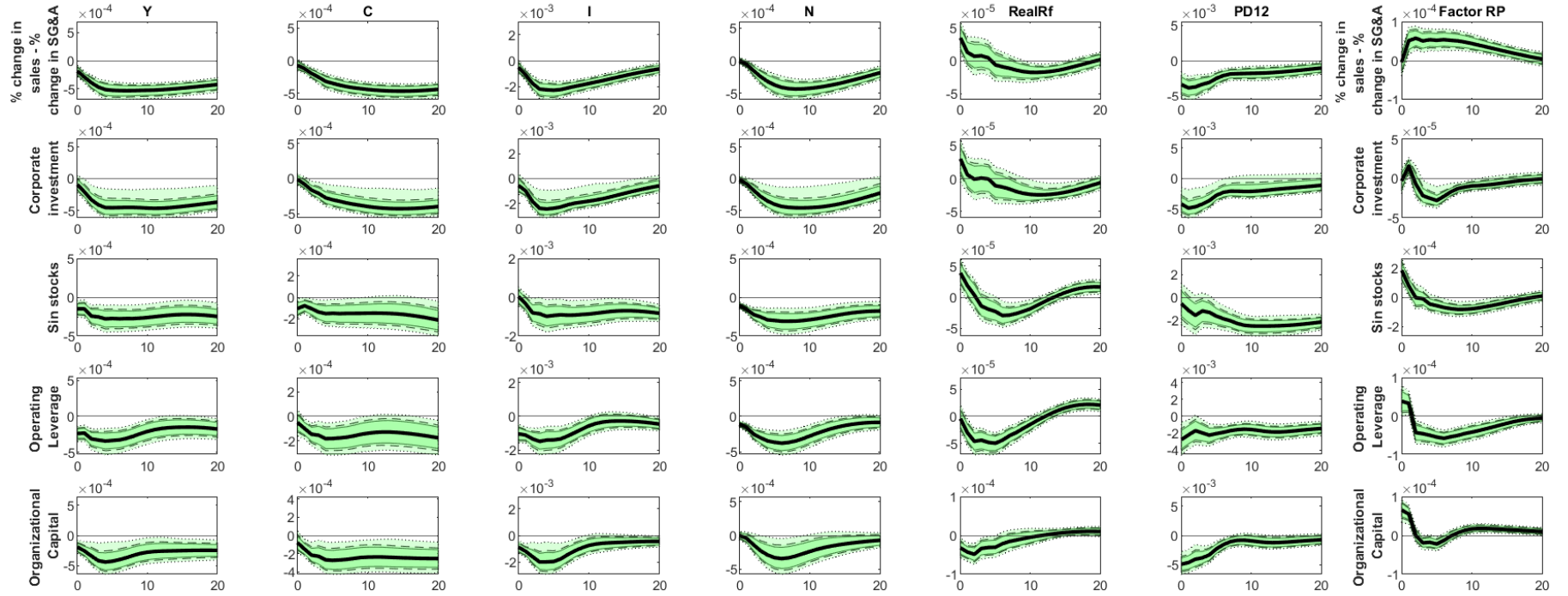
The cosine distance measures among clusters stabilize after the formation of four clusters. Consequently, we establish the number of clusters at four. Table 1 lists all MRFs according to their respective clusters. For each factor, we report its average annualized risk-premium impact on output, consumption, investment and hours, as well as for how many quarters ahead the impact is significant. Figures 3 through 6 depict the impulse-response functions resulting from the risk premia of MRFs to variables of interest.

Table 1: Macro-Relevant Factors by Cluster

Clus.	Factor	Paper	Y Effect	Per.	C Effect	Per.	I Effect	Per.	N Effect	Per.	Return Mean	Vol.
I	% change in sales - % change in SG&A	Abarbanell and Bushee (1998)	-0.24%	20	-0.19%	20	-0.75%	20	-0.15%	19	1.54%	0.77%
	Corporate investment	Titman, Wei, and Xie (2004)	-0.20%	20	-0.17%	19	-0.75%	16	-0.17%	17	1.66%	0.83%
	Sin stocks	Hong and Kacperczyk (2009)	-0.12%	20	-0.08%	13	-0.38%	19	-0.12%	20	3.58%	1.79%
	Organizational Capital	Eisfeldt and Papanikolaou (2013a)	-0.15%	20	-0.12%	20	-0.49%	12	-0.09%	7	2.30%	1.15%
	Operating Leverage	Novy-Marx (2011)	-0.11%	15	-0.07%	13	-0.38%	10	-0.11%	14	2.27%	1.13%
II	Cash flow to debt	Ou and Penman (1989)	0.20%	20	0.16%	20	0.60%	13	0.13%	15	1.84%	0.92%
	Quality Minus Junk	Asness, Frazzini, and Pedersen (2019a)	0.19%	20	0.16%	20	0.61%	15	0.14%	18	4.96%	2.48%
	HXZ Profitability	Hou, Xue, and Zhang (2015)	0.16%	20	0.14%	20	0.43%	12	0.12%	16	5.28%	2.64%
	Industry-adjusted cash flow to price ratio	Asness, Porter, and Stevens (2000)	0.15%	20	0.12%	20	0.41%	9	0.10%	13	3.13%	1.56%
	Financial statements score	Mohanram (2005)	0.19%	20	0.16%	20	0.55%	10	0.15%	15	2.89%	1.45%
	Return on invested capital	Brown and Rowe (2007)	0.15%	17	0.13%	20	0.41%	10	0.11%	13	2.05%	1.03%
III	% change sales-to-inventory	Ou and Penman (1989)	0.19%	20	0.14%	20	0.65%	20	0.16%	20	1.57%	0.79%
	Change in Current Operating Assets	Richardson, Sloan, Soliman, and Tuna (2005)	0.15%	20	0.11%	20	0.50%	20	0.09%	18	2.08%	1.04%
	Industry-adjusted change in asset turnover	Soliman (2008)	0.16%	18	0.13%	19	0.59%	20	0.14%	18	1.78%	0.89%
	Inventory Growth	Belo and Lin (2011)	0.15%	19	0.12%	19	0.50%	19	0.10%	19	1.34%	0.67%
	Change in inventory	Thomas and Zhang (2002)	0.12%	20	0.08%	14	0.42%	20	0.10%	20	2.18%	1.09%
IV	Change in Net Financial Assets	Richardson et al. (2005)	0.13%	20	0.10%	20	0.40%	16	0.14%	20	2.61%	1.30%
	Change in Financial Liabilities	Richardson et al. (2005)	0.11%	9	0.08%	8	0.31%	8	0.10%	11	1.89%	0.94%
	Total accruals	Richardson et al. (2005)	0.05%	3	0.04%	5	0.06%	0	0.07%	8	2.24%	1.12%
	Net debt finance	Bradshaw, Richardson, and Sloan (2006)	0.10%	6	0.07%	5	0.30%	5	0.08%	7	1.95%	0.98%

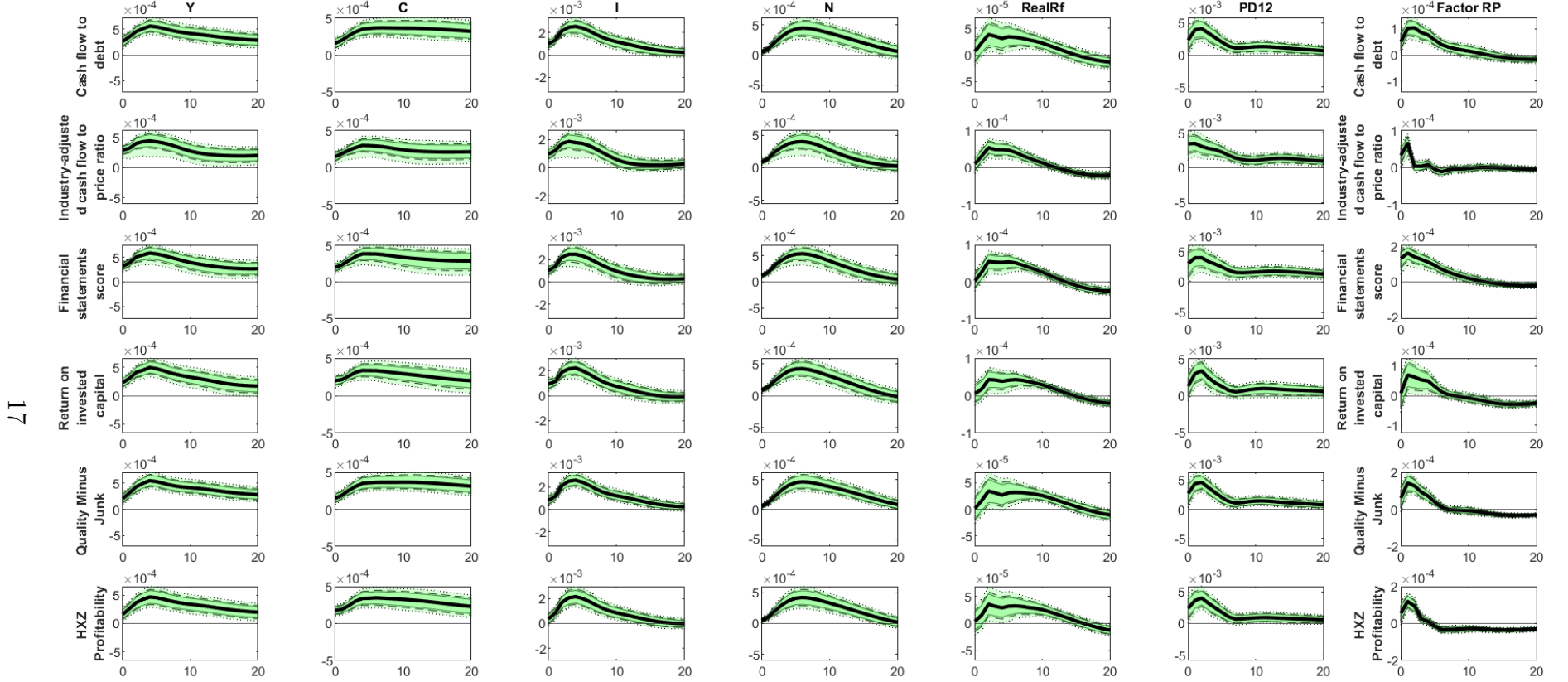
The table reports all macro-relevant factors (MRFs) divided into clusters. For each factor, we report its average risk-premium annualized impact (Effect) on output Y , consumption C , investment I and hours N , as well as for how many quarters ahead the impact is significant (Per.). We also report the average return and standard deviation of the factor within the sample period.

Figure 3: MRF Risk Premium Shock Impulse-Response Functions: Cluster I



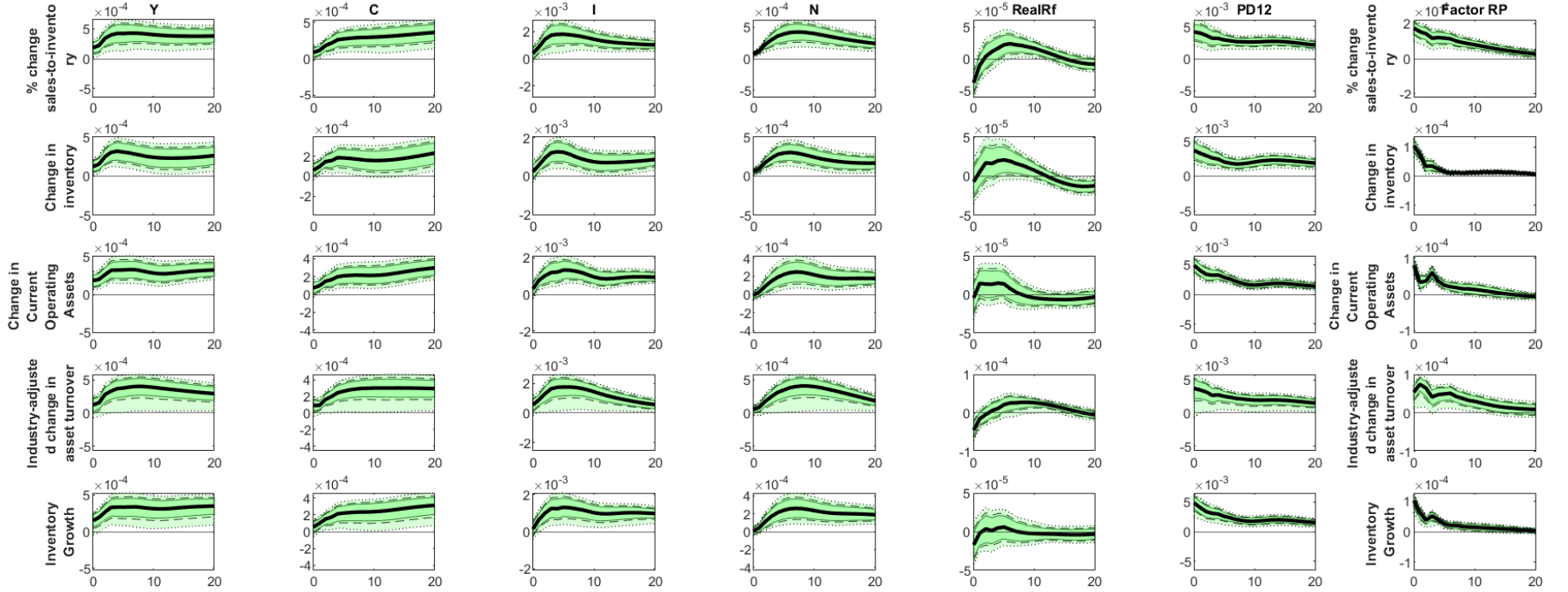
The figure shows impulse responses functions from macro-relevant factors in cluster I to key macroeconomic variables: output Y , consumption C , investment I , labor N , the price dividend ratio PD , and the real risk free rate, $RealRf$. The solid, dashed, and dotted lines represent the bootstrapped 10%, 5%, and 1% confidence intervals for each IRF, respectively. The horizontal axis represents quarters.

Figure 4: MRF Risk Premium Shock Impulse-Response Functions: Cluster II



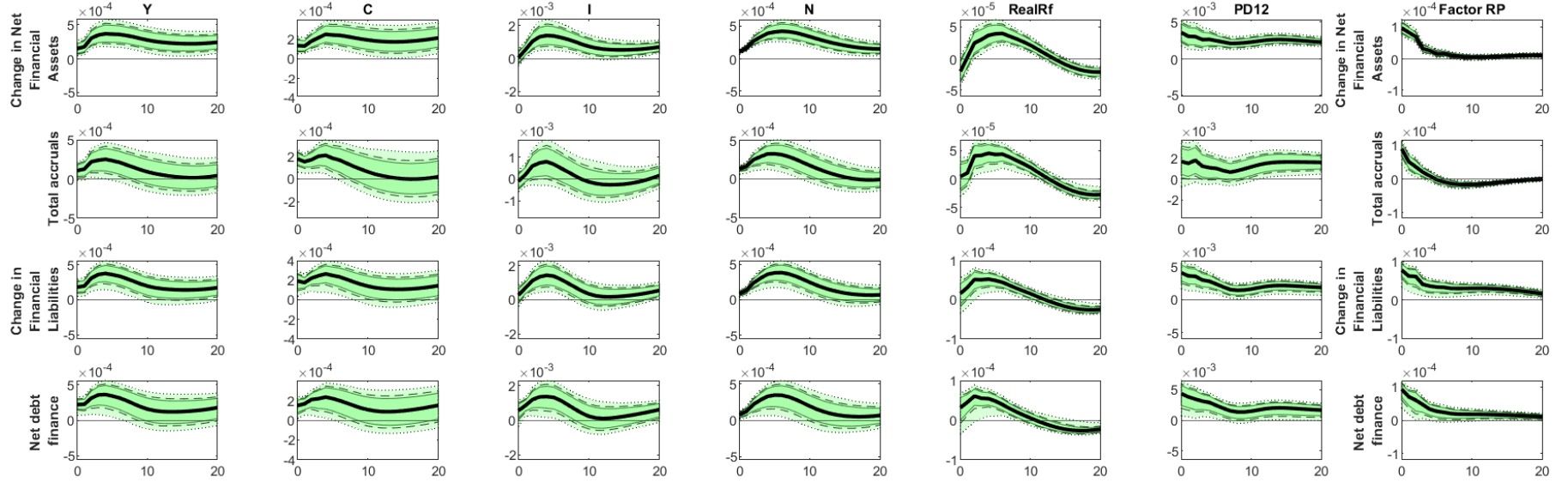
The figure shows impulse responses functions from macro-relevant factors in cluster II to key macroeconomic variables: output Y , consumption C , investment I , labor N , the price dividend ratio PD , and the real risk free rate, $RealRf$. The solid, dashed, and dotted lines represent the bootstrapped 10%, 5%, and 1% confidence intervals for each IRF, respectively. The horizontal axis represents quarters.

Figure 5: MRF Risk Premium Shock Impulse-Response Functions: Cluster III



The figure shows impulse responses functions from macro-relevant factors in cluster III to key macroeconomic variables: output Y , consumption C , investment I , labor N , the price dividend ratio PD , and the real risk free rate, $RealRf$. The solid, dashed, and dotted lines represent the bootstrapped 10%, 5%, and 1% confidence intervals for each IRF, respectively. The horizontal axis represents quarters.

Figure 6: MRF Risk Premium Shock Impulse-Response Functions: Cluster IV



The figure shows impulse responses functions from macro-relevant factors in cluster IV to key macroeconomic variables: output Y , consumption C , investment I , labor N , the price dividend ratio PD , and the real risk free rate, $RealRf$. The solid, dashed, and dotted lines represent the bootstrapped 10%, 5%, and 1% confidence intervals for each IRF, respectively. The horizontal axis represents quarters.

From the analysis of Figures 3 through 6, three primary insights emerge: Firstly, we observe that while ex-ante Macro Relevant Factors (MRFs) only need to induce a significant impact on consumption, ex-post analysis reveals that they also induce a notable impact on investment, output, and working hours. Crucially, for all MRFs, the direction of the impulse-response effect on these additional variables aligns with their impact on consumption. This suggests that the dynamics of the risk associated with MRFs plays a significant role in driving business cycles.

Secondly, the five factors within cluster I are observed to exert a negative impact on macroeconomic variables. This aligns with the effects observed from market risk premium shocks, but notably, the contractionary effect spans beyond that of market risk alone. Conversely, the heightened risk linked to the fifteen factors in clusters II, III, and IV manifests an expansionary effect. This suggests that an increase in the quantity of risk underlying the factors within these clusters is associated with good future states of the world.

Thirdly, the variation of risk associated with distinct clusters leads to differential impacts, not only in their directional influence but also in terms of their temporal effects. Factors in clusters I and II, despite having opposing signs, both yield a prolonged effect on consumption and output. However, the impact on capital and labor inputs starts to diminish after approximately a year (particularly for cluster II). The effect on market valuation is relatively transient, enduring around six quarters. In contrast, the expansionary effect of risk premia from cluster III demonstrates remarkable persistence in terms of both output variables and inputs, as well as market valuations. The effect on the risk-free rate, however, tends to be negligible and mostly insignificant. The impacts of risk-premium fluctuations in cluster IV, although positive, are short-lived. The effect on output, investment, and valuations spikes initially but reverts to baseline levels after two years.

Drawing from these observations, several conclusions can be made. A limited number of factors hold macroeconomic relevance, yet the risk quantities of those factors predominantly signal lower marginal utility states. The economic significance of risk fluctuations encapsulated within each cluster exhibits similarities, yet there are substantial differences across

clusters, particularly in the frequency domain of the effects.

2.3 Economic Interpretation

The four clusters of MRFs are formed solely based on the similarity of the risk premia's effect on the future consumption trajectory. While this classification is primarily statistical, ex-post analysis reveals economic resemblances between factors belonging to each cluster.

Factors within cluster I are primarily associated with organization capital. Lev and Radhakrishnan (2005) and Eisfeldt and Papanikolaou (2013b) demonstrate that firms with substantial organization capital are linked to a higher stock of Selling, General, and Administrative (SG&A) expenses. Increased SG&A expenses also lead to higher operating leverage and more significant corporate investment, particularly when considering working capital and fixed assets collectively. Similarly, 'Sin stocks' are characterized by strong brand names and considerable marketing expenses, as detailed in Du and Sun (2023).

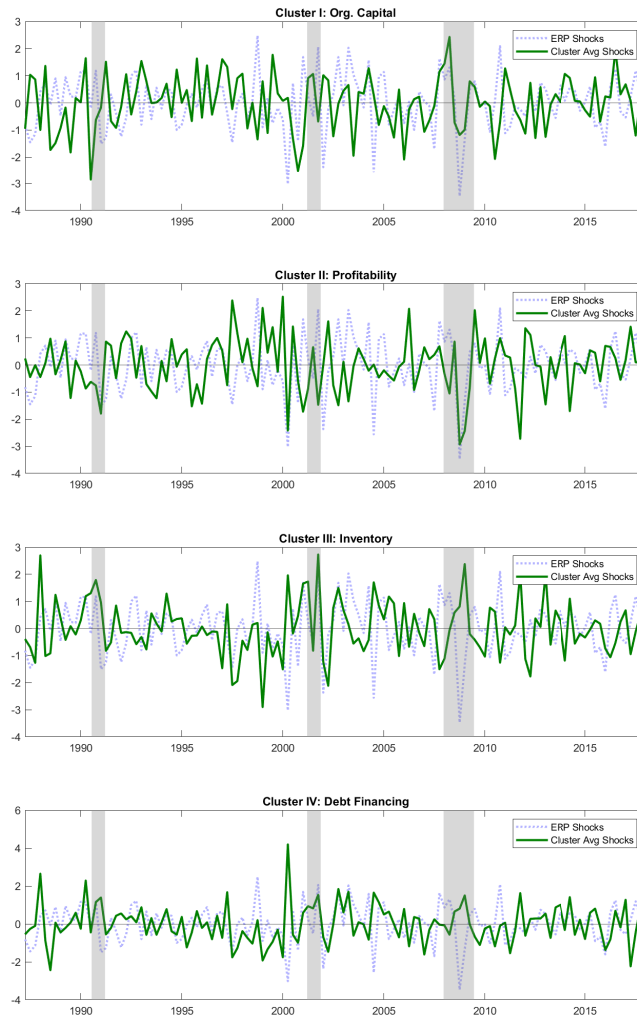
Factors belonging to cluster II fall under the umbrella of profitability. Profitability is directly accounted for when considering the profitability factor of Hou et al. (2021) and the quality factor of Asness, Frazzini, and Pedersen (2019b). The numerator of the cover ratio, cash flow to debt, is strongly and positively correlated with profits. Similarly, the theoretical study of Abel (2018) shows that an increase in current or expected future profitability reduces the denominator - the level of debt.

Factors associated with Cluster III uniformly pertain to inventory stock levels. For the majority of these factors, inventory figures are directly incorporated into the computation of the cross-sectional spread. In certain cases, inventory is considered indirectly. For instance, inventory constitutes a primary element of operating assets, while the asset turnover ratio, an indicator of operational efficiency, is influenced by inventory management among other factors.

Factors categorized within Cluster IV predominantly correlate with leverage and, more comprehensively, financial stability. In most of these factors, liabilities are explicitly considered in most of these factors' calculations. On an implicit level, liabilities are factored into

accruals, specifically current liabilities, while the price-to-cash flow multiple is influenced by both operational and financial leverage.

Figure 7: Average Risk Premium Shocks by Cluster



The figure shows for each cluster the time-series of risk premium shock, averaged across all factors within the cluster. The green lines represents clusters' risk premium shocks, while the dotted blue line represents market risk premium shocks. Shaded regions denote NBER recessions.

Figure 7 illustrates the time-series of the average risk premium shocks associated with factors within each identified cluster. The figure yields five key insights.

Firstly, for all clusters, the risk premium shock is orthogonal to that of the aggregate market, by construction. Secondly, the shock in the risk premium of the contractionary Cluster I, which is linked to organization capital, appears to precede economic recessions. This is evidenced by the notable increase in the cluster's risk premium innovations leading up

Table 2: **Innovation and Risk Premia Shocks**

<i>Panel A. Full Sample</i>						
Cluster	Chemical	Computers	Medical	Electronics	Mechanical	Other
I	-0.16	-0.09	-0.10	-0.11	-0.17	-0.18
II	-0.07	0.04	0.07	-0.06	-0.07	-0.05
III	0.14	-0.03	-0.06	0.09	0.13	0.12
IV	0.09	-0.05	-0.04	0.08	0.10	0.09
<i>Panel B. First Half</i>						
I	-0.23	-0.09	-0.24	-0.11	-0.23	-0.26
II	-0.10	0.04	0.04	-0.08	-0.13	-0.10
III	0.21	-0.05	-0.02	0.11	0.20	0.17
IV	0.10	-0.06	-0.06	0.12	0.15	0.12

The table shows the correlation between each cluster average risk premium shock and the growth of patent stock, segregated into categories by Hall, Jaffe, and Trajtenberg (2001), for the full sample as well as the first half.

to the recessions of the early 1990s, the dot-com bubble, and the Great Recession, indicating potential upcoming economic downturns. Conversely, Clusters III and IV, associated with inventory and leverage respectively, exhibit increased risk premium shocks towards the end of these recessions, which may signal impending economic recoveries.

Thirdly, the risk premium shock in the expansionary Cluster II, associated with profitability, demonstrates a significant decrease during the peak of the Great Recession, along with noticeable reductions during other recessionary periods. Additionally, this cluster's shocks show considerably high values throughout the late 1990s, coinciding with the dot-com era.

Fourthly, perturbations in Cluster III, related to inventory, display positive spikes during the later stage of the dot-com era, as well as during the housing bubble phase between 2005 and 2007, and a prominent increase right after onset of the Great Moderation. These fluctuations align with the expansionary characteristics of the cluster's shocks.

Finally, the risk premium shocks in Cluster IV, related to leverage, are somewhat less pronounced compared to other clusters. However, it is noteworthy that, although modest, the average fluctuations of this cluster during economic expansions surpass those during recessions, consistent with its expansionary economic effect. Furthermore, this cluster exhibits

a substantial positive jump around the turn of the millennium.

As noted earlier, only the risk premium shocks in Cluster I exert a contractionary effect. Considering that innovation is the primary driver of growth, we hypothesize that risk premium shocks in Cluster I correlate negatively with the growth of in-force patent stock, while those in Clusters II, III, and IV correlate positively. We sourced patent growth data from several sectors, including chemicals, computers, medical, electronics, mechanical, and others, as detailed in Marco, Carley, Jackson, and Myers (2015). This hypothesis is largely supported by the data, as shown in Table 2. Risk premium shocks to Cluster I are observed to decrease the growth of patents across all sectors. In contrast, for the other clusters, the correlation is either positive or, if negative, significantly more muted compared to Cluster I. Based on the highest absolute correlations associated with each cluster, we can broadly categorize profitability risk (Cluster II), inventory risk (Cluster III), and debt risk (Cluster IV) as being most strongly associated with high-tech innovation, chemical innovation, and mechanical innovation, respectively.

3 Weak Macro-Relevant Factors

3.1 Conditionally Relevant Factors

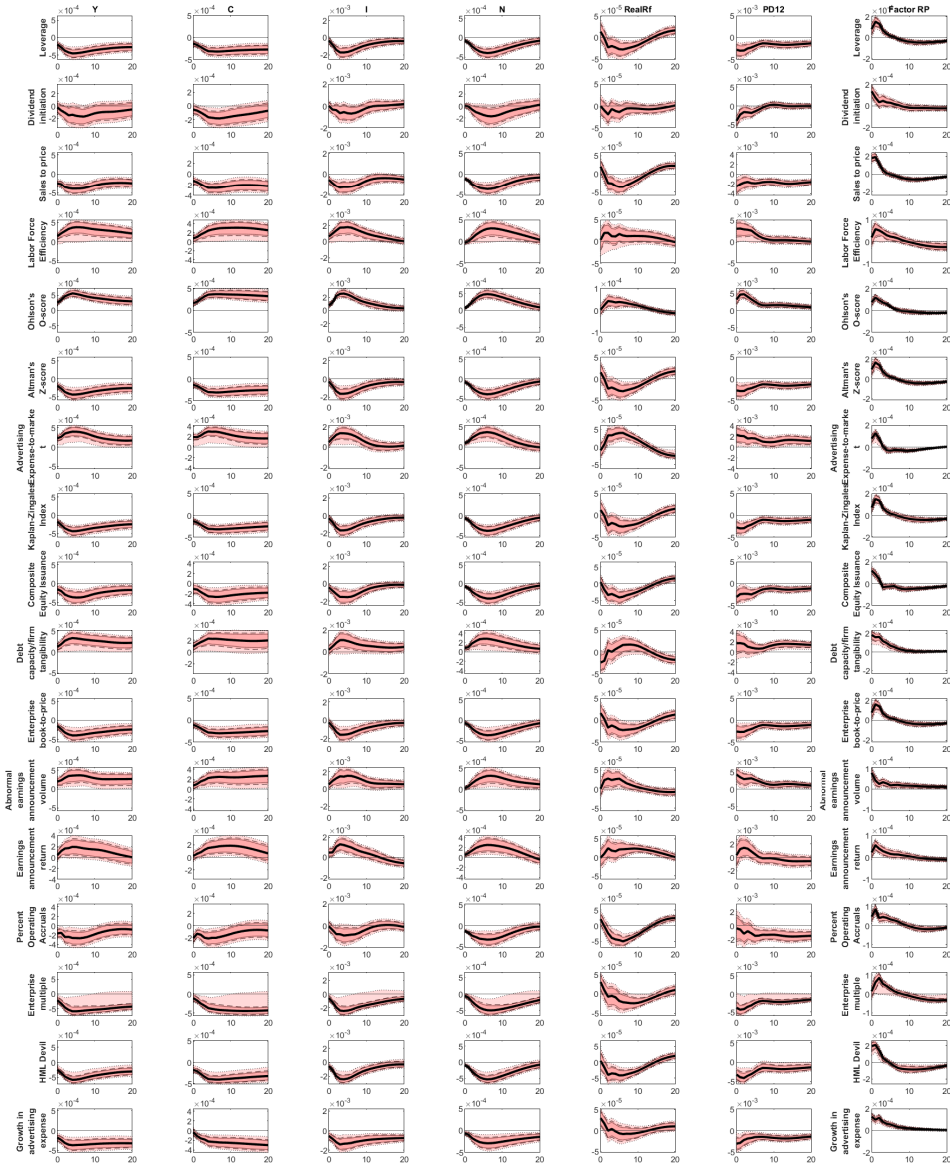
Our methodology examines the impact of risk premia shocks on consumption. Since this concept is dynamic in nature, it's possible that some factors may not exhibit a significant unconditional risk premium. Nevertheless, fluctuations in their conditional risk premia can significantly impact consumption. We categorize any such factor as a weak Macro-Relevant Factor (MRF), due to the absence of its average premium, which consequently hinders our ability to determine the sign of its impulse responses to consumption.²

We extend the analysis from Section 2.2 by including factors whose average return is

²Determining the impact's direction requires knowledge about the direction of the unconditional premium. For instance, if a long-short factor has a negative risk premium and its associated risk premium shocks negatively affect consumption, then the positively signed factor (i.e., short-long) would have a positive effect. Without statistically significant information about the sign of the unconditional premium, we cannot make this directional correction.

insignificant at the 10% confidence level. Figure 8 presents the impulse responses for all weak MRFs. Table 3 lists all of the factors and their impact's duration.

Figure 8: Weak MRFs: Risk Premium Shocks Impulse-Response Functions



The figure shows impulse responses functions from macro-relevant factors without a significant average return to key macroeconomic variables: output Y , consumption C , investment I , labor N , the price dividend ratio PD , and the real risk free rate, $RealRf$. The solid, dashed, and dotted lines represent the bootstrapped 10%, 5%, and 1% confidence intervals for each IRF, respectively. The horizontal axis represents quarters.

Table 3: Weak Macro-Relevant Factors by Theme

Theme	Factor	Paper	Y Per.	C Per.	I Per.	N Per.	Return Mean	Vol.
I	Growth in advertising expense	Lou (2014)	20	20	20	20	0.19%	0.10%
	Advertising Expense-to-market	Chan, Lakonishok, and Sougiannis (2001)	12	14	8	11	-0.66%	-0.33%
II	Sales to price	Barbee Jr, Mukherji, and Raines (1996)	20	20	13	15	2.59%	1.30%
	Ohlson's O-score	Dichev (1998)	20	20	14	18	0.74%	0.37%
	Altman's Z-score	Dichev (1998)	20	20	12	17	0.99%	0.49%
	Kaplan-Zingales Index	Lamont, Polk, and Saana-Requejo (2001)	20	20	13	17	1.35%	0.68%
	Enterprise multiple	Loughran and Wellman (2011)	9	10	6	11	-0.29%	-0.14%
IV	Leverage	Bhandari (1988)	20	20	15	18	1.16%	0.58%
	Composite Equity Issuance	Daniel and Titman (2006)	20	20	10	17	-0.15%	-0.08%
	Debt capacity/firm tangibility	Almeida and Campello (2007)	18	8	0	11	1.37%	0.69%
	Percent Operating Accruals	Hafzalla, Lundholm, and Winkle (2011)	10	8	1	13	1.54%	0.77%
	Dividend initiation	Michaely, Thaler, and Womack (1995)	0	7	0	0	-1.93%	-0.96%
	Change in Financial Liabilities	Richardson et al. (2005)	9	8	8	11	1.89%	0.94%
	Total accruals	Richardson et al. (2005)	3	5	0	8	2.24%	1.12%
	Net debt finance	Bradshaw et al. (2006)	6	5	5	7	1.95%	0.98%
Other	Enterprise book-to-price	Penman, Richardson, and Tuna (2007)	20	20	13	17	0.23%	0.11%
	Abnormal earnings ann. volume	Lerman, Livnat, and Mendenhall (2008)	20	20	10	10	-1.18%	-0.59%
	HML Devil	Asness and Frazzini (2013)	20	20	12	16	1.12%	0.56%
	Labor Force Efficiency	Abarbanell and Bushee (1998)	12	17	6	5	-0.64%	-0.32%
	Earnings announcement return	Brandt, Kishore, Santa-Clara, and Venkatachalam (2008)	0	10	9	13	-0.12%	-0.06%

The table reports all weak macro-relevant factors (MRFs) divided into themes based on the clusters from Section 2.2. For each factor, we report for how many quarters ahead the impact of the risk premium shock is significant (Per.) on output Y , consumption C , investment I and hours N . We also report the average return and standard deviation of the factor within the sample period.

Our observations reveal that approximately 15 factors do not consistently command an unconditional premium. Traditional asset pricing tests categorize these as non-robust. Despite this classification, their macro relevance is noteworthy: fluctuations in their conditional risk premia significantly affect variations in consumption and investment – although compared to the strong MRFs, the effects tend to have shorter durations (see Table 1).

Interestingly, most weak MRFs economically relate to the clusters identified in Section 2.2. The factors ‘Advertising expenses to market’ and ‘Growth in advertising’ relate to SG&A (Cluster I). The factors ‘O-score’, ‘Z-score’, ‘Kaplan-Zingales’ and ‘Sales to price’ relate to profitability (Cluster II). The factors ‘Leverage’, ‘Dividend initiation’, ‘Equity issuance’, ‘Debt capacity to tangibility’ and ‘Operating accruals’ relate to liabilities (Cluster IV).

However, there are two distinct themes not encompassed by the strong MRFs. Firstly, some weak MRFs are associated with earnings announcements (Abnormal earnings announcement volume’ and Announcement return’), though earnings-per-share could be considered alternative measures of profitability. Secondly, other weak MRFs are linked to value strategies (e.g., HML Devil’, Enterprise multiple’, ‘book-to-price’). The categorization of value-related factors as “weak” aligns broadly with the finding that HML may be a redundant factor (see Fama and French (2015)), spanned by investment and profitability. It also correlates with the observation that HML has underperformed in recent decades, partly due to the increasing significance of intangible assets.

Figure 8 underscores that there is a distinction between factor relevance from a macroeconomic perspective and a statistical view. Essentially, while these factors may not always exhibit strong, consistent risk premiums (or abnormal returns), their conditional impacts on key economic indicators cannot be overlooked, as they contribute to nuanced shifts in the broader economic landscape.

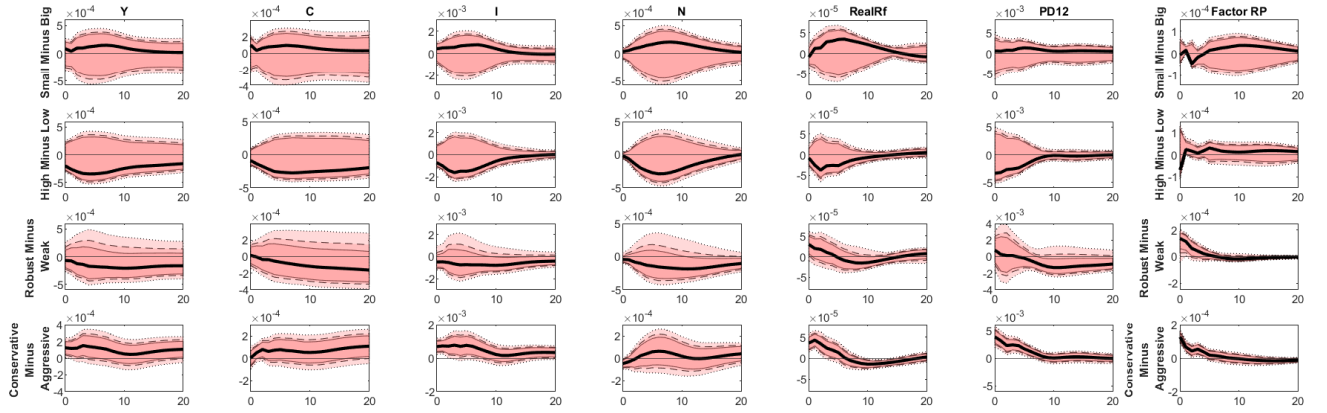
3.2 Examining Prominent Factors

The analysis presented in Section 2.2 reveals that, among the factors from the Fama and French (2015) and Hou et al. (2021) models, only the profitability factor, particularly its

variant in the q-factor model, is classified as a Macro-Relevant Factor (MRF). Considering the widespread application of these factor models in financial research, we display impulse-response functions from all Fama and French (2015) and Hou et al. (2021) risk premium shocks to pertinent variables in Figures 9 and 10, respectively.

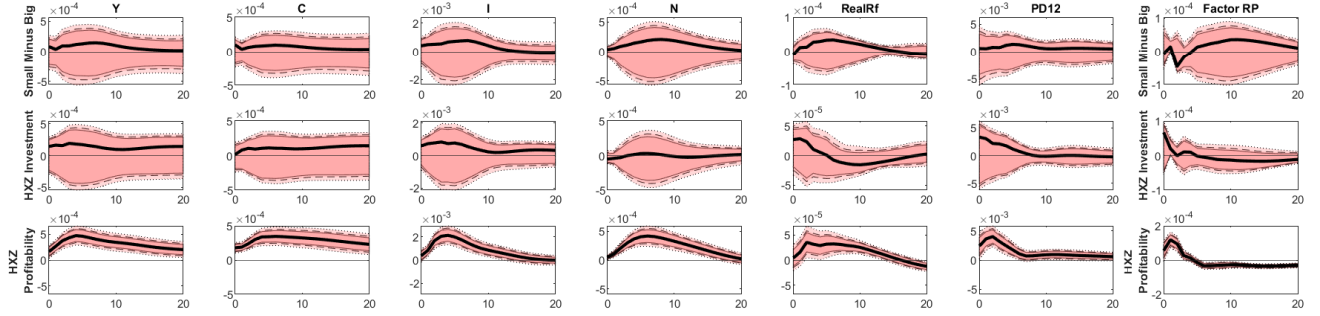
Two key insights emerge from these figures. Firstly, except for the profitability factor in the Hou et al. (2021) model, the risk premia of all other factors do not exert a significant impact on consumption. Secondly, the investment factor from Fama and French (2015) demonstrates a transient yet significant positive effect on output, investment, the risk-free rate, and the price-to-dividend ratio. However, its influence on consumption remains negligible. Given that the marginal utility of investors in structural models is contingent upon consumption or leisure, we do not categorize the investment factor as an MRF. Nonetheless, it is noteworthy that the risk premium shock of the investment factor does induce a limited macroeconomic impact.

Figure 9: Fama-French Factors: Risk Premium Shock Impulse-Response Functions



The figure shows impulse responses functions from the five factors of Fama and French (2015) to key macroeconomic variables: output Y , consumption C , investment I , labor N , the price dividend ratio PD , and the real risk free rate, $RealRf$. The solid, dashed, and dotted lines represent the bootstrapped 10%, 5%, and 1% confidence intervals for each IRF, respectively. The horizontal axis represents quarters.

Figure 10: Q-Factors: Risk Premium Shock Impulse-Response Functions



The figure shows impulse responses functions from the q-factors of Hou et al. (2021) to key macroeconomic variables: output Y , consumption C , investment I , labor N , the price dividend ratio PD , and the real risk free rate, $RealRf$. The solid, dashed, and dotted lines represent the bootstrapped 10%, 5%, and 1% confidence intervals for each IRF, respectively. The horizontal axis represents quarters.

4 Robustness

4.1 Number of Clusters

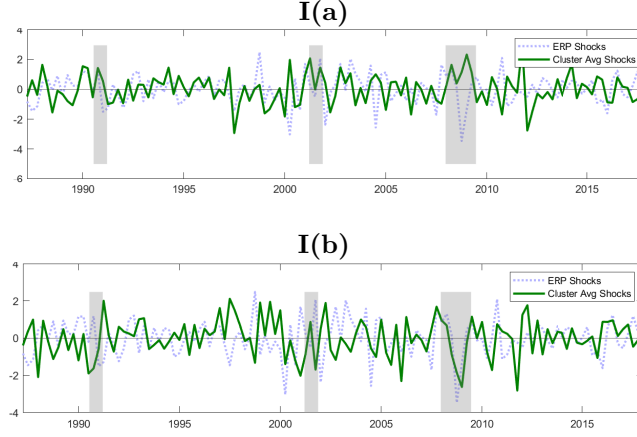
We repeat the benchmark analysis, setting the number of clusters determined by the nearest-neighbor algorithm to five. The benchmark Clusters II, III, and IV remain grouped together and unchanged. The contractionary cluster, Cluster I, is now divided into two subclusters: Cluster I(a), encompassing 'Organizational Capital' and 'Operating Leverage', and Cluster I(b), encompassing 'Change in SG&A', 'Corporate Investment', and 'Sin Stocks'. The two subclusters exhibit some differences in their statistical and economic interpretations.

Firstly, Figures OA.1.1 and OA.1.2 in the Online Appendix illustrate that risk premium shocks in Cluster I(a) have a more transient impact compared to those in Cluster I(b). The influence on consumption from factors in Cluster I(b) persists for 20 quarters, whereas in Cluster I(a), the effect diminishes after approximately 10 quarters.

Secondly, factors in Cluster I(a) are more closely related to organizational capital, including their associated fixed costs, while factors in Cluster I(b) pertain more broadly to various types of investment, whether in short- or long-term capital. Figure 11 displays the time-series fluctuations of risk premium shocks for these two clusters. The risk premium shocks

within the subclusters move in tandem, with one notable exception: during the Great Recession, shocks in Cluster I(a) remain elevated throughout. In contrast, the risk premium shock in Cluster I(b) precedes the recession but then exhibits a pronounced decline during the recession. This pattern mirrors the dynamics of the profitability cluster in this specific period. These observations align with the findings of Fama and French (2015), which suggest that investment and profitability are interconnected.

Figure 11: Average Risk Premium Shocks for Cluster I: Subclusters



The figure shows, for each sub-cluster of Cluster I, the time-series of risk premium shock, averaged across all factors within the cluster. The green lines represents clusters' risk premium shocks, while the dotted blue line represents market risk premium shocks. Shaded regions denote NBER recessions.

4.2 Predictive Variables

We repeat the analysis when the set of predictive variables are restricted to “core” macro and financial market variables, that is:

$$\Gamma_t \equiv \left[y_t, c_t, i_t, n_t, r_t^f, p_t^d \right]'. \quad (24)$$

Table 4 delineates the effects of modifying Γ_t on the macro-relevant factors. First, we observe that even when subjected to a more condensed set of predictive variables, the majority of benchmark MRFs maintain their relevance and characteristics, including the sign and duration of their risk premium shock impact. Second, among the twenty benchmark MRFs, four transition to insignificance under the new conditions: these include Operating Leverage (Cluster I), Change in Current Operating Assets and Inventory Growth (Cluster III), and Change in Financial Liabilities (Cluster IV).

Table 4: Robustness of Macro-Relevant Factors: Choise of Predictive Variables

Cl.	Factor	Y(Full)		(Core)		C(Full)		(Core)		I(Full)		(Core)		N(Full)		(Core)	
		Effect	Per.	Effect	Per.	Effect	Per.	Effect	Per.	Effect	Per.	Effect	Per.	Effect	Per.	Effect	Per.
I	% chg. Sales - % chg. SGA	-0.24%	20	-0.19%	20	-0.19%	20	-0.14%	20	-0.75%	20	-0.68%	20	-0.15%	19	-0.13%	19
	Corporate investment	-0.20%	20	-0.15%	20	-0.17%	19	-0.11%	19	-0.75%	16	-0.63%	20	-0.17%	17	-0.13%	20
	Sin stocks	-0.12%	20	-0.09%	0	-0.08%	13	-0.07%	5	-0.38%	19	-0.20%	0	-0.12%	20	-0.09%	4
	Organizational Capital	-0.15%	20	-0.13%	20	-0.12%	20	-0.09%	19	-0.49%	12	-0.55%	20	-0.09%	7	-0.10%	18
	Operating Leverage [†]	-0.11%	15	0.09%	0	-0.07%	13	0.06%	0	-0.38%	10	0.37%	0	-0.11%	14	0.08%	0
II	C.F. to debt	0.20%	20	0.18%	20	0.16%	20	0.14%	20	0.60%	13	0.61%	20	0.13%	15	0.14%	19
	Quality Minus Junk	0.19%	20	0.17%	20	0.16%	20	0.13%	20	0.61%	15	0.64%	20	0.14%	18	0.15%	20
	HXZ Profitability	0.16%	20	0.16%	0	0.14%	20	0.13%	8	0.43%	12	0.56%	0	0.12%	16	0.14%	6
	Ind.adj. C.F. to price ratio	0.15%	20	0.13%	20	0.12%	20	0.10%	20	0.41%	9	0.47%	20	0.10%	13	0.11%	20
	Fin. statements score	0.19%	20	0.16%	20	0.16%	20	0.13%	20	0.55%	10	0.54%	19	0.15%	15	0.16%	20
	Return on invested capital	0.15%	17	0.13%	20	0.13%	20	0.12%	20	0.41%	10	0.37%	10	0.11%	13	0.11%	15
III	% Chg. sales-to-inventory	0.19%	20	0.22%	20	0.14%	20	0.16%	20	0.65%	20	0.81%	20	0.16%	20	0.19%	20
	Chg. in Cur. Opr. Assets [†]	0.15%	20	-0.10%	0	0.11%	20	-0.07%	0	0.50%	20	-0.35%	0	0.09%	18	-0.07%	0
	Ind.-adj. chg. asset turnover	0.16%	18	0.19%	20	0.13%	19	0.15%	19	0.59%	20	0.76%	20	0.14%	18	0.16%	20
	Inventory Growth [†]	0.15%	19	0.17%	0	0.12%	19	0.13%	0	0.50%	19	0.63%	0	0.10%	19	0.13%	0
	Chg. in inventory	0.12%	20	0.15%	20	0.08%	14	0.11%	20	0.42%	20	0.53%	20	0.10%	20	0.14%	20
IV	Chg. in Net Fin. Assets	0.13%	20	0.16%	20	0.10%	20	0.13%	20	0.40%	16	0.50%	16	0.14%	20	0.16%	20
	Chg. in Fin. Liabilities [†]	0.11%	9	0.10%	0	0.08%	8	0.08%	0	0.31%	8	0.35%	2	0.10%	11	0.10%	0
	Total accruals	0.05%	3	0.07%	8	0.04%	5	0.07%	9	0.06%	0	0.14%	3	0.07%	8	0.10%	12
	Net debt finance	0.10%	6	0.10%	8	0.07%	5	0.07%	5	0.30%	5	0.36%	10	0.08%	7	0.09%	10

The table reports robustness results for macro-relevant factors (MRFs) when the set of predictive variables are constrained to $\Gamma_t \equiv [y_t, c_t, i_t, n_t, r_t^f, p_t^d]'$. For each factor, we report its average risk-premium annualized impact (Effect) on output Y , consumption C , investment I and hours N , as well as for how many quarters ahead the impact is significant (Per.). Non-italicized numbers reflect the benchmark specification, while the italicized numbers correspond to the alternate specification with only core macroeconomic variables. [†] indicates factors which do not pass our threshold for macro-relevance under the alternate variable specification.

It is noteworthy that the forecast error for each factor demonstrates greater reliability under the benchmark scenario, where the expanded set of predictive variables enhances the explanatory power. Third, an untabulated result shows that the investment factor ‘Conservative minus Aggressive’ from Fama and French (2015) gains macroeconomic relevance when the analysis is confined to “core” predictive variables. This is broadly consistent with CMA classified as a “weak” MRF in Section 3.2. However, the economic significance of this finding remains modest: the average impact of the CMA’s risk premium on consumption is quantified at 0.07% per annum, with a duration extending up to 11 quarters.

5 Conclusion

Our study advances the understanding of the intricate relationship between cross-sectional asset pricing and macroeconomic dynamics. Our novel methodology, which isolates factor-specific risk premium shocks from market risk premium influences, reveals that only a select group of factors, termed Macro-Relevant Factors (MRFs), exert a substantial impact on macroeconomic aggregates such as consumption, output, and investment. This finding challenges traditional macroeconomic as well as asset pricing models, highlighting that factors with significant macroeconomic implications may not always align with those identified by conventional cross-sectional return analyses. The identification of MRFs, particularly those related to profitability and organization capital, underscores the necessity of incorporating macroeconomic perspectives into asset pricing studies and vice versa. This approach not only enriches our understanding of the business cycle but also provides a more economically grounded framework for factor selection and evaluation.

Furthermore, our research uncovers the diverse nature of MRFs’ impacts across different economic cycles. The classification of MRFs based on their frequency domain effects – some influencing short-term dynamics while others shaping long-term trends – offers nuanced insights into the role of risk premia in economic fluctuations. Interestingly, the majority of MRFs are associated with ‘good’ uncertainty, stimulating consumption and investment, contrary to the traditional view of risk premia as purely contractionary. This finding suggests

a more complex and varied landscape of risk premia effects than previously acknowledged. Additionally, the finding that certain factors, such as Value, despite lacking a robust unconditional risk premium, still contribute to macroeconomic variations in a conditional context, further emphasizes the multifaceted nature of risk premia. Overall, our results not only contribute to a deeper understanding of the ‘factor zoo’, but also paves the way for future research exploring the broader implications of cross-sectional asset pricing premia for macroeconomists.

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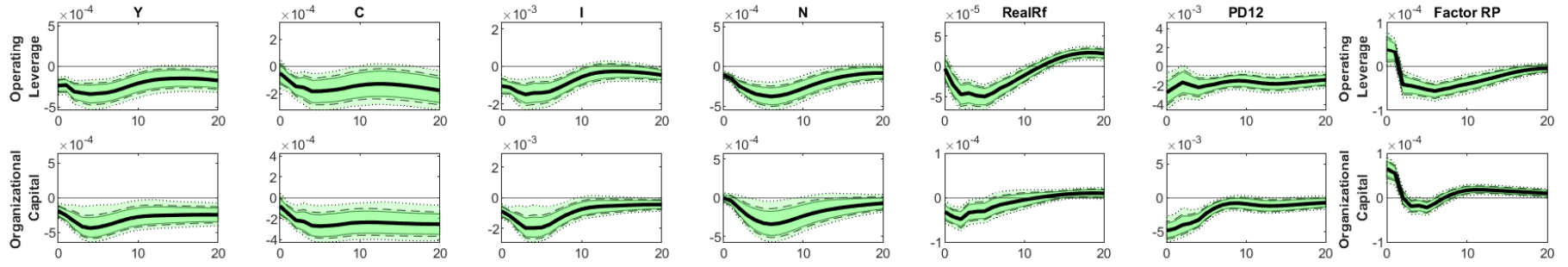
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Online Appendix

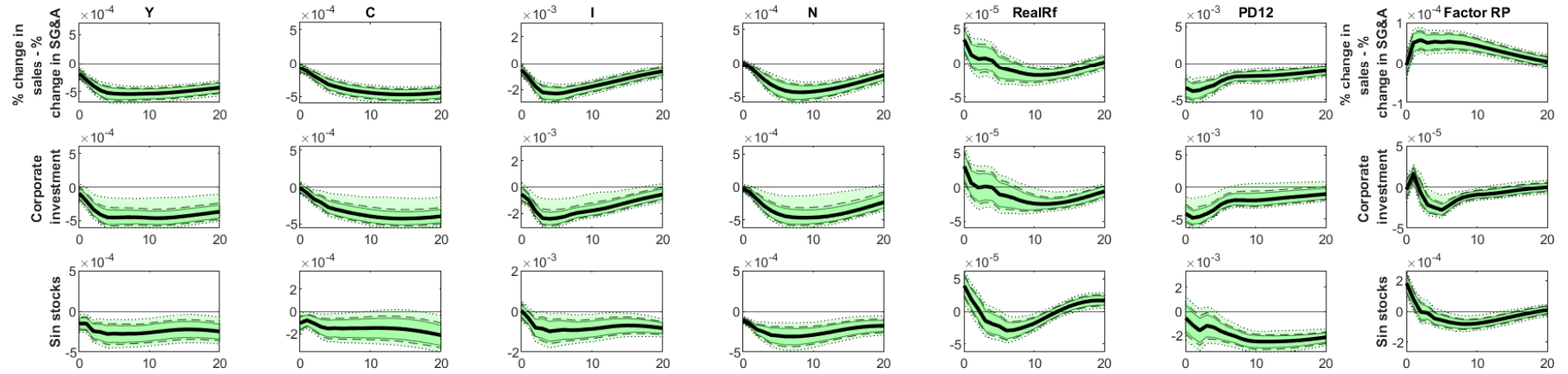
OA.1 Division of Cluster I

Figure OA.1.1: MRF Risk Premium Shock Impulse-Response Functions: Cluster I(a)



The figure shows impulse responses functions from macro-relevant factors in cluster I(a) (part of the 5-cluster robustness check) to key macroeconomic variables: output Y , consumption C , investment I , labor N , the price dividend ratio PD , and the real risk free rate, $RealRf$. The solid, dashed, and dotted lines represent the bootstrapped 10%, 5%, and 1% confidence intervals for each IRF, respectively. The horizontal axis represents quarters.

Figure OA.1.2: MRF Risk Premium Shock Impulse-Response Functions: Cluster I(b)



The figure shows impulse responses functions from macro-relevant factors in cluster I(b) (part of the 5-cluster robustness check) to key macroeconomic variables: output Y , consumption C , investment I , labor N , the price dividend ratio PD , and the real risk free rate, $RealRf$. The solid, dashed, and dotted lines represent the bootstrapped 10%, 5%, and 1% confidence intervals for each IRF, respectively. The horizontal axis represents quarters.